40 CFR §122.21(r)(2-8) NPDES APPLICATION REQUIREMENTS FOR FACILITIES WITH COOLING WATER INTAKE STRUCTURES

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Table of Contents

1.0 Introduction.....1

1.1 Regulatory Requirement.....1

1.2 Facility Description and Regulatory Status.....1

2.0 §122.21(r)(2) - Source Water Physical.....2

2.1 Source Waterbody Narrative Description.....2

2.2 Hydrological and Geomorphological Features.....6

2.2.1 Hydrology and Geomorphology.....6

2.2.2 Area of Influence.....9

2.3 Locational Maps.....9

3.0 §122.21(r)(3) - Cooling Water Intake Structure Data.....10

3.1 Narrative Description of the CWIS.....10

3.2 Latitude and Longitude of Cooling Water Structure.....11

3.3 CWIS Operation.....11

3.4 Water Balance.....12

3.5 Engineering Drawings.....12

4.0 §122.21(r)(4) - Source Water Baseline Biological Characterization Data.....13

4.1 Unavailable Data.....13

4.2 Taxa in the Vicinity of the CWIS.....13

4.2.1 Fish.....13

4.2.2 Unionid Mussels.....18

4.3 Species and Life Stages Susceptible to Impingement & Entrainment.....20

4.3.1 Impingement.....21

4.3.2 Entrainment.....23

4.4 Species Most Susceptible to Impingement and Entrainment at Beaver Valley.....27

4.5 Periods of Reproduction, Recruitment, and Peak Abundance.....28

4.6 Seasonal and Daily Activities.....32

4.6.1 General Daily & Seasonal Activities.....32

4.6.2 Seasonal Fisheries Data.....35

4.7 Threatened, Endangered, and Other Protected Species.....46

4.8 Public Participation and Agency Consultation.....47

4.9 Supplemental Field Studies.....47

4.10 Regulatory Requirement.....48

4.11 Protective Measures and Stabilization Activities Near the Intake.....48

4.12 Fragile Species.....48

4.13 Incidental Take Exemption or Authorization.....48

5.0 §122.21(r)(5) - Cooling Water System Data.....50

5.1 Narrative Description of Cooling Water System.....50

5.1.1 Circulating Water System.....50

5.1.2 Makeup Water System.....50

5.1.3 Blowdown System.....51

5.1.4 Cooling Water System Operation.....51

5.2 Design and Engineering Calculations.....51

5.2.1 Design Intake Flow.....51

5.2.2 Through-Screen Velocity.....52

5.2.3 Percent Reduction in Cooling Water.....52

5.2.4 Proportion of the Source Waterbody Withdrawn 52
5.3 Existing Impingement and Entrainment Technologies 53
6.0 §122.21(r)(6) - Chosen Method of Compliance with Impingement Mortality Standard 54
7.0 §122.21(r)(7) - Entrainment Performance Studies 55
8.0 §122.21(r)(8) - Operational Status 56
8.1 Narrative Description of Power Production 56
8.2 Descriptions of Uprates and USNRC Relicensing 57
8.3 New Unit Plans and Schedules 57
9.0 References 58
10.0 Attachments 63

List of Tables

Table 2-1: Daily Average Water Temperatures (°F) at the Montgomery L/D (October 2003-December 2017) 2
Table 2-2: Daily Average Dissolved Oxygen (mg/l) at the Montgomery L/D (October 2003-December 2017) 4
Table 2-3: Daily Average Specific Conductance (µS/cm) at the Montgomery L/D (October 2003-December 2017) 5
Table 2-4: Monthly Average Water Level at the Montgomery L/D 7
Table 2-5: Monthly Average Discharge (cfs) at USGS 03086000: Ohio River at Sewickley, Pennsylvania 8
Table 3-1: Beaver Valley Pump Design Capacities 11
Table 3-2: Design Intake Flow 11
Table 3-3: Maximum Actual Intake Flow (AIF) and Yearly Average Withdrawals 12
Table 4-1: Fish Species Collected in the New Cumberland Pool of the Ohio River 15
Table 4-2: Freshwater Mussels in the Ohio River at RM 34.5, Beaver County, PA, September 2012 19
Table 4-3: Mussels Collected in the New Cumberland Pool and their Glochidia Host Species 19
Table 4-4: General Factors Effecting Susceptibility to Impingement or Entrainment 21
Table 4-5: Relative Abundance of Impinged Fish at Beaver Valley 21
Table 4-6: Relative Abundance of Impinged Fish at NOVA/AES 22
Table 4-7: Relative Abundance of Impinged Fish at Sammis 23
Table 4-8: Ichthyoplankton Taxa Collected from the Main Channel of the Ohio River 24
Table 4-9: Estimated Annual Entrainment at Sammis 26
Table 4-10: Species Most Susceptible to Impingement and Entrainment at Beaver Valley 28
Table 4-11: Seasonal Results from Fisheries Sampling Conducted near Beaver Valley 36
Table 4-12: Monthly Impingement at NOVA/AES (2006 - 2007) 37
Table 4-13: Estimated Monthly Impingement at Sammis (July 2005 – June 2006) 39
Table 4-14: Ichthyoplankton Density (Organisms/100m^3) in the New Cumberland Pool by Month 41
Table 4-15: Diel Periodicity of Ichthyoplankton Densities (Organisms/100m^3) in the New Cumberland Pool (May and July 1987-1992) 44
Table 5-1: Calculated Through-screen Velocities 52
Table 5-2: Percent Reduction in Flow 52
Table 5-3: Average Monthly Proportion of Source Waterbody Withdrawn 53
Table 8-1: Capacity Utilization Factors 56

List of Figures

Figure 2-1: Average Monthly Water Temperature (˚F) Trends at the Montgomery L/D (October 2003-December 2017) 3
Figure 2-2: Average Dissolved Oxygen (mg/l) Trends at the Montgomery L/D (October 2003-December 2017) 5
Figure 2-3: Average Specific Conductance (µS/cm) Trends at the Montgomery L/D (October 2003-December 2017) 6
Figure 2-4: Monthly Average Discharge Trends at USGS 03086000: Ohio River at Sewickley, Pennsylvania 9

40 CFR §122.21(r)(2-8) NPDES APPLICATION REQUIREMENTS FOR FACILITIES WITH COOLING WATER INTAKE STRUCTURES

1.0 INTRODUCTION

1.1 REGULATORY REQUIREMENT

40 CFR §122.21(r) contains National Pollutant Discharge Elimination System (NPDES) application requirements for facilities with cooling water intake structures (CWISs). §122.21(r)(1)(ii) states that all existing facilities must submit to the Director for review the information required under paragraphs (r)(2) and (3), and applicable provisions of (r)(4), (5), (6), (7), and (8) of §122.21. This information consists of physical, biological, and operational data for each cooling water source, CWIS, and cooling water system utilized at the facility.

This document is intended to:

- Fulfill the regulatory requirement for submittal of §122.21(r)(2-8) information for the Beaver Valley Power Station (Beaver Valley), an existing facility subject to the 2014 Existing Facilities Rule; and
- Be submitted in support of the Beaver Valley NPDES permit renewal application.

1.2 FACILITY DESCRIPTION AND REGULATORY STATUS

Beaver Valley, located in Shippingport, Beaver County, Pennsylvania, is owned and operated by FirstEnergy Nuclear Operating Company (FENOC). It is located on a 453 acre site that sits along the Ohio River. The facility contains two pressurized water reactors, producing 1,884 megawatts-electric (MWe) (FENOC 2018). Unit 1 was licensed to operate in 1976 and Unit 2 was licensed in 1987 (FirstEnergy Generation 2016).

The Beaver Valley CWIS is located on the New Cumberland Pool of the Ohio River at river mile (RM) 34.8, approximately three river miles downstream of the Montgomery Lock and Dam (L/D) located at RM 31.7 and approximately 19 river miles upstream from the New Cumberland L/D (RM 54.3) (Attachment A). The New Cumberland Pool is 23 miles long and averages 1,325 feet wide with several islands consisting of alluvial sand and gravel with sediments deposited by flooding (USNRC 2007).

Beaver Valley is subject to the requirements of the Existing Facilities Rule at §122.21(r) since it meets the following three criteria stated in §125.91(a):

- The facility is a point source;
- The facility uses or proposes to use one or more CWISs with a cumulative design intake flow (DIF) of greater than 2 million gallons per day (MGD) to withdraw water from waters of the United States; and
- Twenty-five percent or more of the water the facility withdraws on an actual intake flow (AIF) basis is used exclusively for cooling purposes.

2.0 §122.21(r)(2) - SOURCE WATER PHYSICAL

2.1 SOURCE WATERBODY NARRATIVE DESCRIPTION

Regulatory requirement at §122.21(r)(2)(i): "A narrative description and scaled drawings showing the physical configuration of all source water bodies used by your facility, including areal dimensions, depths, salinity and temperature regimes, and other documentation that supports your determination of the waterbody type where each cooling water intake structure is located."

The Ohio River is formed at the confluence of the Monongahela and Allegheny Rivers in Pittsburgh, Pennsylvania (USACE 2016). The river stretches for approximately 980 miles southwest, where it empties into the Mississippi River in Cairo, Illinois (USACE 2016). Water in the Ohio River basin is primarily used for commercial navigation, recreation, public water supply, energy generation, and other industrial applications (Lock Hydro 2012). The USACE operates 20 navigational L/Ds along the Ohio River between Pittsburgh, Pennsylvania, and Cairo, Illinois (Lock Hydro 2012). Many of the dams constructed along the main tributaries regulate flow for flood control and to facilitate commercial navigation. The L/Ds divide the 981-mile-long river into 21 navigational pools and each is maintained at a minimum depth of 9 feet (Lock Hydro 2012).

Dissolved oxygen (DO) levels are significantly influenced by the L/D's of the Ohio River (USACE 2016). At a flow of 10,000 cubic feet per second (cfs), the Montgomery L/D is estimated to contribute 97,000 pounds of oxygen per day into the New Cumberland Pool. The influence of this influx of DO is evident more than 15 miles downstream (USACE 2016).

The United States Geological Survey (USGS) monitors water quality at USGS Station 03108490 located above the Montgomery L/D in Ohioview, PA, including water temperature, DO, pH, and specific conductivity (USGS 2018a). Water temperature data demonstrated typical trends expected in a temperate climate in eastern North America, with peaks during the summer and lows during the winter (Table 2-1; Figure 2-1). Ohio River water temperatures peak during late July (80.06°F max) and are lowest during mid-January (33.8°F) (USGS 2018a). DO was measured only between April and November and the data suggest healthy levels. The minimum daily average, 7.3 mg/L, occurred in mid-September, and no hypoxic or anoxic conditions were recorded (Table 2-2; Figure 2-2) (USGS 2018a). Winter (December-March) DO levels are likely high, due to cooler water temperatures and higher flow. Daily average specific conductance ranged from 249 to 448 µS/cm, and peaks during low flow periods between August and October (Table 2-3; Figure 2-3). Monthly average pH remained within a narrow range throughout the year: 7.5 – 7.62 (USGS 2018a).

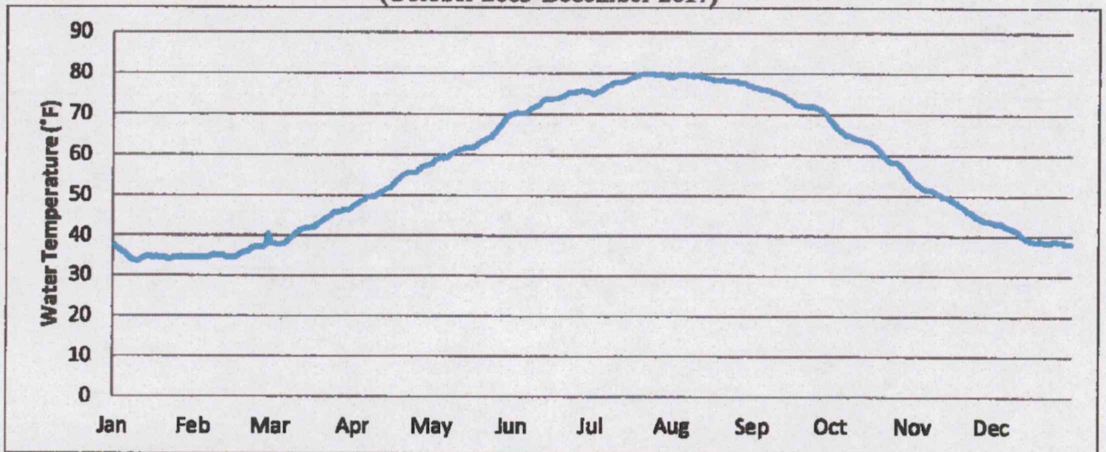
Table 2-1: Daily Average Water Temperatures (°F) at the Montgomery L/D (October 2003-December 2017)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	37.76	34.70	38.12	47.30	57.92	69.98	75.20	79.16	76.64	68.36	53.6	43.52
2	37.22	34.70	38.12	47.66	58.82	70.34	75.20	79.52	76.64	67.64	53.06	43.34
3	36.68	34.88	37.94	48.20	59.00	70.34	75.56	79.70	76.46	66.56	52.52	43.34
4	36.14	34.88	37.94	48.74	59.36	70.34	75.74	79.70	76.28	66.20	52.16	43.34
5	35.78	34.88	37.94	48.92	59.18	70.34	76.10	79.70	76.28	65.66	51.80	42.98
6	35.24	34.88	38.12	49.46	59.18	70.34	76.64	79.70	76.10	65.12	51.62	42.62
7	34.70	35.06	38.66	49.64	59.72	70.70	77.00	79.52	75.92	64.94	51.62	42.26
8	34.16	35.42	39.38	49.82	60.26	71.42	77.18	79.52	75.56	64.76	51.44	42.08
9	33.98	35.24	39.74	49.64	60.62	71.78	77.72	79.34	75.38	64.40	51.08	41.72
10	33.80	35.24	40.46	50.18	60.80	71.96	77.90	79.52	75.20	64.22	50.54	41.54
11	33.98	35.24	41.00	50.72	61.16	72.32	77.90	79.52	75.02	64.04	50.18	41.00
12	34.34	35.24	41.54	51.08	61.34	73.04	77.90	79.16	74.66	63.86	49.82	40.10

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
13	34.70	34.88	41.72	51.62	61.52	73.58	78.08	79.16	74.30	63.68	49.82	39.74
14	35.06	34.88	41.90	51.80	61.70	73.76	78.26	78.98	73.76	63.50	49.46	39.38
15	35.06	34.88	41.90	52.16	61.70	73.76	78.62	78.80	73.58	63.32	49.10	39.20
16	34.70	34.88	41.90	52.70	61.70	73.76	78.98	78.62	73.04	62.96	48.74	38.84
17	34.88	34.88	42.08	53.42	61.88	73.94	79.16	78.44	72.50	62.42	48.38	38.66
18	34.88	35.24	42.62	53.96	62.24	73.94	79.34	78.44	72.32	61.88	47.84	38.66
19	34.70	35.78	43.16	54.50	62.78	74.12	79.70	78.44	72.32	61.16	47.66	39.02
20	34.70	35.96	43.52	55.04	63.32	74.30	79.88	78.62	72.14	60.08	47.12	38.66
21	34.70	36.14	44.06	55.40	63.68	74.66	80.06	78.08	72.14	59.36	46.40	38.48
22	34.34	36.50	44.42	55.76	64.04	75.20	80.06	78.08	71.96	58.82	46.04	38.66
23	34.34	37.04	44.78	55.58	64.22	75.38	80.06	78.08	71.96	58.46	45.86	38.48
24	34.70	37.40	45.32	55.58	64.76	75.38	80.06	78.08	71.96	58.46	45.32	38.84
25	34.70	37.22	45.86	55.76	65.48	75.56	79.88	78.26	71.78	58.28	44.96	38.84
26	34.70	37.40	45.86	56.48	66.38	75.56	79.88	77.90	71.42	58.10	44.60	38.66
27	34.88	37.40	45.86	57.02	66.92	75.92	79.88	77.72	71.24	57.20	44.24	38.66
28	34.88	37.76	46.22	57.20	67.82	75.74	79.88	77.72	70.70	56.66	43.88	38.66
29	34.70	40.46	46.40	57.38	68.72	75.74	79.88	77.54	70.16	56.12	43.88	38.30
30	34.70	-	46.40	57.56	69.44	75.56	79.34	77.18	69.08	55.04	43.70	38.30
31	34.70	-	46.76	-	69.98	-	78.98	77.00	-	54.14	-	38.12
Min	**33.80**	**34.70**	**37.94**	**47.30**	**57.92**	**69.98**	**75.20**	**77.00**	**69.08**	**54.14**	**43.70**	**38.12**
Max	**37.76**	**40.46**	**46.76**	**57.56**	**69.98**	**75.92**	**80.06**	**79.70**	**76.64**	**68.36**	**53.60**	**43.52**
Mean	**34.96**	**35.83**	**42.25**	**52.68**	**62.76**	**73.30**	**78.39**	**78.68**	**73.55**	**61.79**	**48.55**	**40.13**

Source: USGS (2018a)

Figure 2-1: Average Monthly Water Temperature (°F) Trends at the Montgomery L/D (October 2003-December 2017)



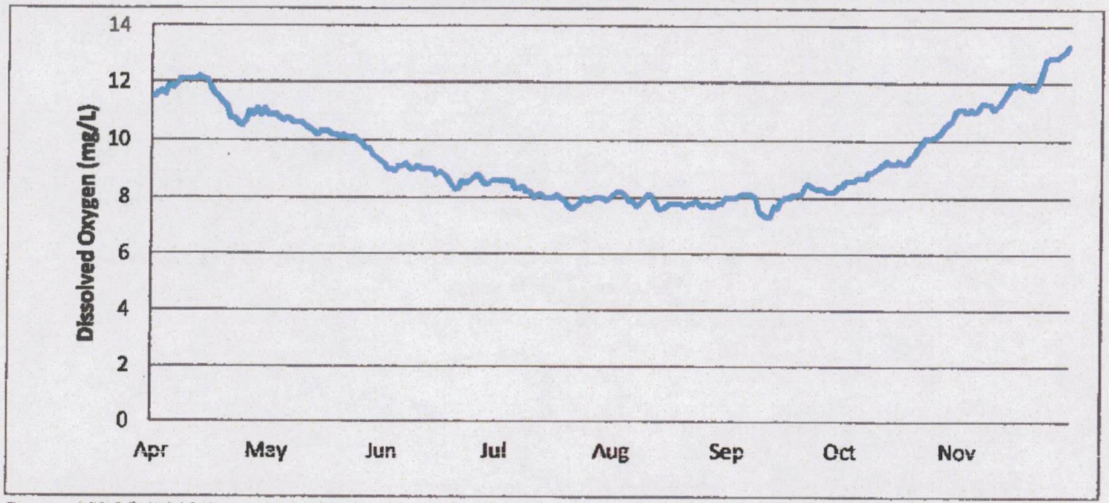
Source: USGS (2018a)

Table 2-2: Daily Average Dissolved Oxygen (mg/l) at the Montgomery L/D (October 2003-December 2017)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	11.5	10.9	9.2	8.6	8.1	8	8.4	11.1	-
2	-	-	-	11.6	10.9	9	8.6	8.2	8	8.6	11.1	-
3	-	-	-	11.7	10.9	9	8.6	8.2	8	8.6	11	-
4	-	-	-	11.6	10.8	8.9	8.6	8.1	8.1	8.6	11.1	-
5	-	-	-	11.9	10.7	9.1	8.6	7.9	8.1	8.7	11	-
6	-	-	-	11.8	10.8	9.1	8.3	7.9	8.1	8.7	11.1	-
7	-	-	-	11.9	10.7	9.2	8.3	7.7	8.1	8.7	11.3	-
8	-	-	-	12.1	10.6	9	8.4	7.8	8	8.9	11.3	-
9	-	-	-	12.1	10.6	9	8.2	7.9	7.5	8.9	11.3	-
10	-	-	-	12.1	10.6	9.1	8.2	8.1	7.4	9	11.1	-
11	-	-	-	12.1	10.5	9	8	8.1	7.3	9.1	11.2	-
12	-	-	-	12.1	10.4	9	8.1	7.9	7.3	9.2	11.3	-
13	-	-	-	12.2	10.3	9	8.1	7.6	7.7	9.3	11.5	-
14	-	-	-	12.1	10.2	9	8	7.6	7.6	9.2	11.7	-
15	-	-	-	12.1	10.3	8.8	8	7.7	7.9	9.2	11.9	-
16	-	-	-	11.8	10.3	8.9	8	7.8	8	9.3	11.9	-
17	-	-	-	11.6	10.3	8.8	8.1	7.8	8	9.2	12	-
18	-	-	-	11.5	10.2	8.7	8	7.8	8.1	9.2	11.9	-
19	-	-	-	11.3	10.2	8.5	7.9	7.8	8.1	9.4	11.9	-
20	-	-	-	11.2	10.1	8.3	7.7	7.7	8.1	9.5	11.8	-
21	-	-	-	10.8	10.2	8.3	7.6	7.8	8.4	9.7	11.8	-
22	-	-	-	10.8	10.1	8.6	7.7	7.8	8.5	9.9	12	-
23	-	-	-	10.6	10.1	8.5	7.8	7.9	8.4	10.1	12.4	-
24	-	-	-	10.5	10.1	8.6	8	7.8	8.3	10.1	12.8	-
25	-	-	-	10.7	10	8.7	7.9	7.7	8.3	10.1	12.9	-
26	-	-	-	11	9.9	8.8	7.9	7.8	8.3	10.2	12.9	-
27	-	-	-	10.9	9.7	8.7	8	7.7	8.2	10.3	12.9	-
28	-	-	-	11.1	9.7	8.5	8	7.7	8.2	10.5	13	-
29	-	-	-	10.9	9.5	8.5	8	7.8	8.2	10.6	13.1	-
30	-	-	-	11.1	9.4	8.6	7.9	7.8	8.4	10.7	13.3	-
31	-	-	-	-	9.3	-	8	8	-	11	-	-
Min	-	-	-	**10.5**	**9.3**	**8.3**	**7.6**	**7.6**	**7.3**	**8.4**	**11**	-
Max	-	-	-	**12.2**	**10.9**	**9.2**	**8.6**	**8.2**	**8.5**	**11**	**13.3**	-
Mean	-	-	-	**11.49**	**10.27**	**8.81**	**8.10**	**7.85**	**8.02**	**9.45**	**11.85**	-

Source: USGS (2018a)

Figure 2-2: Average Dissolved Oxygen (mg/l) Trends at the Montgomery L/D (October 2003-December 2017)



Source: USGS (2018a)

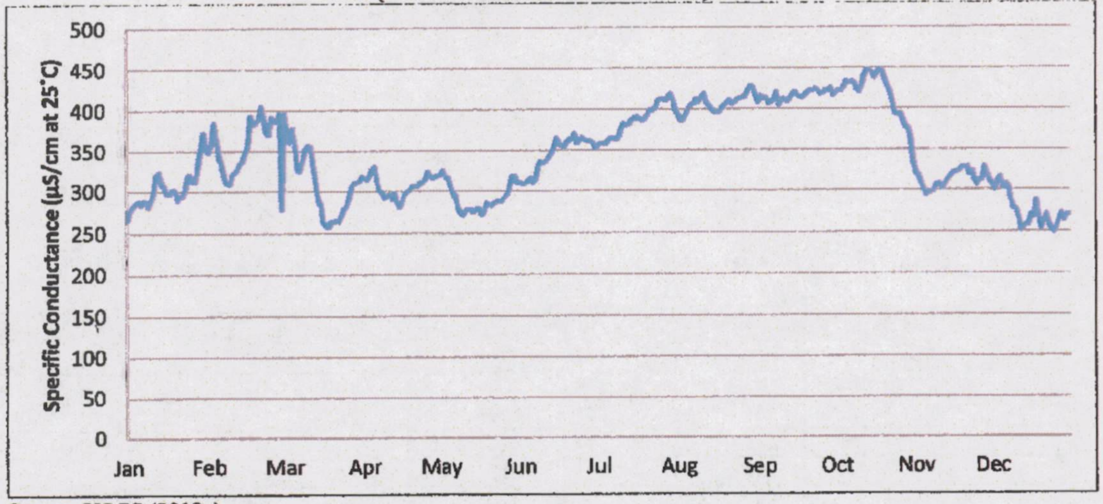
Table 2-3: Daily Average Specific Conductance (µS/cm) at the Montgomery L/D (October 2003-December 2017)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	267	348	396	317	321	310	357	393	408	421	321	307
2	277	358	373	314	326	309	358	386	416	423	319	300
3	282	385	361	319	317	309	359	387	413	422	311	312
4	286	366	378	328	317	312	358	394	414	427	301	316
5	288	340	358	331	307	316	362	401	407	434	294	302
6	284	335	327	310	296	310	365	405	408	432	296	308
7	289	316	325	301	294	313	365	407	411	434	297	304
8	287	310	340	298	277	331	363	412	421	432	299	288
9	282	309	352	292	275	336	367	409	405	425	306	277
10	290	320	357	294	271	334	378	415	411	421	308	277
11	300	324	355	296	277	337	383	419	412	428	303	270
12	321	327	334	290	278	341	381	408	409	441	304	252
13	324	335	315	297	277	345	382	404	411	448	310	255
14	309	337	289	286	275	353	387	400	417	448	315	258
15	307	348	284	281	278	365	389	396	421	445	318	258
16	297	354	264	287	279	360	391	396	417	439	322	270
17	297	393	259	297	272	355	388	396	415	444	322	267
18	302	383	257	300	273	354	386	401	414	448	324	287
19	302	384	263	302	285	360	388	404	417	447	328	268
20	290	388	264	306	283	363	393	408	421	437	328	254
21	294	405	265	307	282	364	399	411	423	428	329	263
22	294	393	264	306	285	370	399	406	423	422	320	270
23	304	373	271	311	287	359	401	408	425	408	324	260
24	320	370	279	310	287	363	408	412	422	395	312	252
25	320	391	282	315	287	366	412	413	418	393	307	249
26	312	387	291	324	291	363	413	414	420	394	313	255

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27	313	387	306	318	295	362	410	415	423	387	313	264
28	330	396	310	317	304	362	413	421	423	378	329	271
29	351	278	311	318	318	360	419	428	426	376	318	263
30	372	-	312	319	319	352	412	427	417	364	311	269
31	356	-	318	-	310	-	398	417	-	335	-	270
Min	**267**	**278**	**257**	**281**	**271**	**309**	**357**	**386**	**405**	**335**	**294**	**249**
Max	**372**	**405**	**396**	**331**	**326**	**370**	**419**	**428**	**426**	**448**	**329**	**316**
Mean	**305**	**357**	**312**	**306**	**292**	**344**	**387**	**407**	**416**	**419**	**313**	**275**

Source: USGS (2018a)

Figure 2-3: Average Specific Conductance (µS/cm) Trends at the Montgomery L/D (October 2003-December 2017)



Source: USGS (2018a)

2.2 HYDROLOGICAL AND GEOMORPHOLOGICAL FEATURES

Regulatory requirement at §122.21(r)(2)(ii): "Identification and characterization of the source waterbody's hydrological and geomorphological features, as well as the methods you used to conduct any physical studies to determine your intake's area of influence within the waterbody and the results of such studies."

2.2.1 HYDROLOGY AND GEOMORPHOLOGY

The Ohio River comprises a total drainage area of 203,943 mi² (square miles; USNRC 2007). The drainage area at the New Cumberland L/D is 23,829 mi² (USNRC 2007).

The gradient change in the Ohio River is minimal, with the river's elevation only dropping 429 feet over its 981 mile long course (USACE 2016). The Ohio River in Pennsylvania averages 0.8 miles in width and has an average gradient change of 1 foot per mile.

The New Cumberland Pool consists of deep channel habitat with low current velocities (USNRC 2007). The navigation channel is steep-sided, with depths less than 9 feet occurring only within 100 feet of the shoreline, over submerged islands, and around the perimeters of existing islands. The New Cumberland L/D maintains a normal pool elevation of 664.5 feet National Geodetic Vertical Datum (NGVD) at river flows at an average of 20,000 cfs (USNRC 2007). The Beaver River and Raccoon Creek are two principle tributaries that have confluences with Upper Ohio River in the vicinity of Beaver Valley (PFBC 2011).

The Upper Ohio River in Pennsylvania is within the Pittsburgh Low Plateau physiographic province (PFBC 2011). Pittsburgh Low Plateau contains the lowest elevation of the Appalachian Plateau in Pennsylvania, 664.5 feet above mean sea level (MSL) (at normal "in pool" river stage), at the New Cumberland Pool of the Ohio River in Beaver County.

During normal "in pool" river stage, the Ohio River is approximately 2,150 feet wide where it starts in Pittsburgh and approximately 1,250 feet wide at the Pennsylvania border with Ohio (PFBC 2011). The substrata of the upper Ohio River basin are comprised of deposited glaciofluvial material, including gravel, sand, silt, and clay (PFBC 2011). Substrate in the New Cumberland Pool consists of gravel (22%), cobble (19%), silt (19%), boulder (16%), and mud (8%; USACE 2016). Another estimate of sediment composition in the New Cumberland Pool was 29.5% gravel, 27.9% sand, 21.2% fine sediment, 15.0% cobble, and 4.7% boulder (ORSANCO 2012).

The New Cumberland Pool has been dredged in recent years for commercial-grade, high silica gravel and sand (PFBC 2011). The mean depth of the Ohio River is 14 feet and 33 feet in dredged areas, but the river bottom in the New Cumberland Pool is punctuated with dredging pits up to 60 feet deep (PFBC 2011). Stream banks generally average 20-25 feet in height (USACE 2016).

Periods of relatively high river discharge typically occur from November through April when soils are saturated or frozen and most conducive for runoff. Overall river discharge for the Ohio River exhibits little seasonal variability. The upper Ohio River basin is prone to flood events due to extreme dissection, high local relief, precipitous slopes, and narrow and discontinuous floodplains of the Appalachian Plateau (PFBC 2011). Flood events occur in the spring and fall during periods of heavy rain or snowmelt. Both 100-year and 500-year floodplains are generally narrow and intermittent, restricted by the steep slopes of the river valley (PFBC 2011).

The United States Geological Survey (USGS) operates gauge station 03108500 on the Ohio River below the Montgomery L/D in Monaca, Pennsylvania; about two river miles upstream of Beaver Valley Facility (USGS 2018b). Water level data from Montgomery L/D is presented in Table 2-4.

Table 2-4: Monthly Average Water Level at the Montgomery L/D (October 2015-November 2017)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Water Gauge Height (feet)												
2015	-	-	-	-	-	-	-	-	-	12.64	12.69	12.69
2016	12.703	12.589	12.59	12.61	12.59	12.68	12.68	12.66	12.64	12.64	12.58	-
2017	12.626	12.529	12.53	12.58	12.66	12.65	12.65	12.6	12.63	12.58	12.59	-
Average	12.66	12.56	12.56	12.6	12.62	12.67	12.66	12.63	12.64	12.62	12.62	12.6

Source: USGS (2018b)
(-) data not available

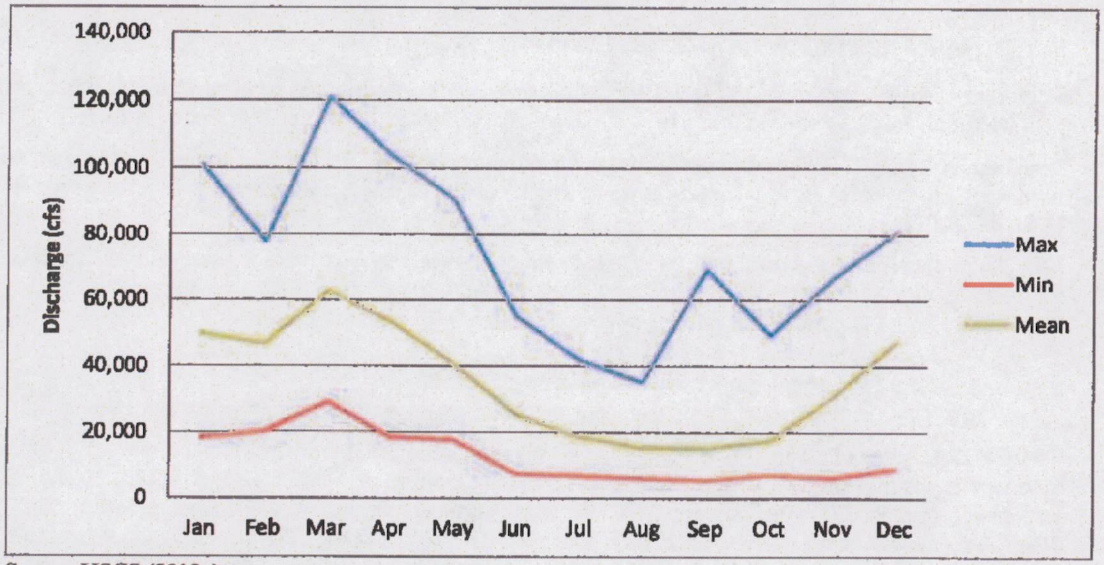
Discharge data from the closest main channel USGS discharge gauge was used to determine flow regime for Beaver Valley (USGS 2018c). The nearest gauge is 03086000 located approximately 20 miles upstream of the Beaver Valley CWIS at Sewickley, Pennsylvania within the Dashields Pool of the Ohio River. The drainage area at this gauge is 19,500 square miles. Average monthly discharge data and trends are provided in Table 2-5 and Figure 2-4. Discharge is regulated by Dashields and Montgomery L/Ds before reaching Beaver Valley. Data representing the 25 year average monthly flow (1992-2017) demonstrates flow tends to peak in March and April, while it is lowest during August and September.

Table 2-5: Monthly Average Discharge (cfs) at USGS 03086000: Ohio River at Sewickley, Pennsylvania

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1992	29,750	36,290	52,610	50,720	25,250	9,555	31,690	26,720	23,820	20,070	41,840	48,860
1993	66,000	25,910	76,530	81,470	19,970	14,170	7,314	6,546	12,090	16,900	49,440	52,000
1994	44,560	71,010	105,400	93,500	36,900	24,440	16,340	34,930	15,000	13,640	28,000	43,660
1995	43,630	30,070	43,120	29,820	38,930	20,250	9,461	8,665	5,374	8,874	29,280	30,140
1996	72,970	65,300	74,160	44,440	90,380	32,480	34,780	24,740	39,450	42,950	59,730	65,350
1997	35,390	52,380	83,430	29,620	45,410	31,330	10,680	11,800	9,415	11,570	44,670	41,460
1998	71,380	49,780	56,430	59,480	41,710	28,870	16,450	8,690	6,953	7,566	6,269	9,022
1999	54,940	45,150	52,880	59,530	22,610	7,539	6,804	6,003	5,471	8,238	18,090	32,160
2000	24,170	53,100	39,750	63,750	30,690	29,390	13,780	21,980	14,040	15,100	11,860	31,590
2001	18,460	56,700	41,420	52,990	20,650	20,900	14,690	9,629	7,170	7,212	8,701	27,170
2002	24,730	37,680	44,950	59,690	73,320	30,770	11,040	7,235	6,553	10,290	27,010	39,670
2003	37,980	36,810	72,950	45,900	45,550	51,860	35,650	30,090	37,850	31,240	66,620	62,580
2004	55,390	43,390	80,120	70,460	56,410	33,370	22,660	25,210	69,260	17,680	31,190	56,030
2005	100,800	49,830	52,600	53,040	24,560	9,961	9,194	6,433	7,814	12,250	26,110	41,210
2006	65,660	36,400	28,930	34,170	25,100	23,450	26,340	13,630	26,340	49,180	56,620	30,530
2007	71,270	24,950	92,860	60,020	22,380	8,751	9,608	19,420	7,554	8,766	24,200	80,630
2008	45,880	77,680	83,110	41,810	50,740	26,340	21,260	9,963	7,677	7,990	12,490	69,030
2009	41,340	58,090	42,910	43,750	40,940	25,060	14,360	22,460	8,793	19,980	19,180	43,630
2010	51,600	30,040	70,230	22,340	38,480	20,800	9,965	8,440	6,858	12,070	21,090	51,230
2011	24,630	50,350	121,100	103,700	69,520	18,210	9,887	9,545	23,200	36,630	53,470	61,670
2012	67,420	38,090	53,040	18,520	34,310	10,550	10,370	8,521	8,461	15,310	35,070	57,520
2013	50,000	54,200	41,350	47,880	22,090	32,590	34,020	23,910	13,320	12,180	27,390	65,090
2014	47,030	47,140	45,150	51,010	59,870	39,770	23,590	22,560	10,760	16,880	20,060	41,000
2015	28,450	20,260	79,700	67,360	17,680	54,700	41,670	7,168	7,634	14,880	22,760	41,620
2016	33,680	62,290	39,550	32,790	40,660	18,190	11,160	11,270	8,493	22,310	18,940	54,470
2017	82,220	56,420	50,680	67,630	58,180	32,200	33,690	14,770	9,521	13,010	-	-
Max	100,800	77,680	121,100	103,700	90,380	54,700	41,670	34,930	69,260	49,180	66,620	80,630
Min	18,460	20,260	28,930	18,520	17,680	7,539	6,804	6,003	5,374	7,212	6,269	9,022
25 Year Avg.	49,600	46,500	62,500	53,300	40,500	25,200	18,700	15,400	15,300	17,400	30,400	47,100

Source: USGS (2018c)

Figure 2-4: Monthly Average Discharge Trends at USGS 03086000: Ohio River at Sewickley, Pennsylvania



Source: USGS (2018c)

2.2.2 *AREA OF INFLUENCE*

No physical studies were performed to determine the Beaver Valley intake area of influence within the waterbody. A desktop analysis was performed to define the approximate area of influence within the 0.5 feet per second (fps) velocity contour. The USEPA considers this velocity to be a *de minimis* value relative to significant impingement concerns because fish have the swimming ability to overcome this velocity and avoid impingement. Based on the physical dimensions of the intake structure, the DIF, the minimum intake water elevation, and the bathymetry in the vicinity of the intake structure, velocities have been computed[1] at the face of the intake structure and at various points from the face of the intake to each traveling water screen's port. Based on these calculations (Section 10 - Attachment B), the maximum approach velocity at the face of the intake structure is approximately 0.29 fps. Therefore, the hydraulic zone of influence does not extend past the intake structure face.

2.3 LOCATIONAL MAPS

Regulatory requirement at §122.21(r)(2)(iii): "Locational maps."

Location maps are provided in Section 10 – see Attachment A.

[1] Using Velocity = Flow / Area

3.0 §122.21(r)(3) - COOLING WATER INTAKE STRUCTURE DATA

3.1 NARRATIVE DESCRIPTION OF THE CWIS

Regulatory requirement at §122.21(r)(3)(i): "A narrative description of the configuration of each of your cooling water intake structures and where it is located in the water body and in the water column"

The Beaver Valley CWIS is a shoreline intake located on the Ohio River. The water is withdrawn and used as makeup water for the cooling towers, which consist of one natural draft cooling tower per unit (USNRC 2007).

The CWIS consists of a screenhouse/pump room structure recessed from the shoreline with the following major components:

- Four (4) parallel intake bays/openings that are flush with the shoreline;
- Four (4) vertical bar racks;
- Four (4) through-flow traveling water screens; and
- Two (2) river water pumps, one (1) raw water pump, and two (2) service water pumps.

The CWIS is situated on the Ohio River, along the southern shore, parallel to the shoreline. The intake structure is approximately 112-feet wide and common to both Unit 1 and Unit 2 (USNRC 2007). The structure occupies the water column from the water surface (normal water surface elevation 664'-6" NVGD) to the elevation of the base CWIS floor slab (646'-0" NVGD). The operating floor houses the cooling water pumps in cubicles with flood proof doors at an elevation of 705'-0" NGVD (USNRC 2007). The lower two levels consist of the intake bay floor at an invert elevation of 646'-0" NGVD and a service platform at elevation 677'-0". The upper two levels include the pump floor, which houses the makeup water pumps, at an elevation of 694'-0". The low and normal water elevations at the face of the intake are 654'-0" and 664'-6" above MSL, respectively (USNRC 2007).

Water enters the intake through four intake bays with openings that are each 15 feet wide and 13.5 feet high. The tops of the intake bay openings are typically submerged at normal river elevations to prevent entry of floating objects. Water in each bay then passes through vertical bar racks that are spaced horizontally at 3.5 inches on center (USNRC 2007). The trash racks protect the intake bays from large debris and ice. The traveling water screens have a tray width of 14 feet, and incorporate 3/8-inch square openings (USNRC 2007). Traveling water screens are rotated and backwashed as needed to remove debris. The debris is sluiced to a collection basket and transported to an approved disposal site. After passing through the traveling water screens, water is pumped to either the Unit 1 raw water system, the Unit 1 river water system, or the Unit 2 service water system; these systems supply makeup cooling water to the two circulating water systems.

The DIF, assuming all pumps listed in Table 3-1 are operating, is 92.2 MGD (64,000 gallons per minute [GPM]). The second river water pump included in Table 3-1 is operated when source water temperatures are high, typically July through October; the DIF also includes flows from both service water pumps. A diesel fire water pump is installed in each bay, but is not included in the DIF. The AIF, based on 2015-2017 monthly withdrawal data, is approximately 65.1 MGD (45,188 GPM). The maximum monthly AIF based on the 2015-2017 withdrawal data is approximately 82.2 MGD (57,090 GPM).

Table 3-1: Beaver Valley Pump Design Capacities

Operation	Pump Capacity
River Water Pumps	9,000 GPM (13 MGD)
River Water Pumps	9,000 GPM (13 MGD)
Raw Water Pumps	16,000 GPM (23 MGD)
Service Water Pumps	15,000 GPM (22 MGD)
Service Water Pumps	15,000 GPM (22 MGD)
Total Design Intake Flow	**64,000 GPM (92.2 MGD)**

Source: USNRC (2007)

To accommodate the unlikely event that the CWIS is rendered inoperable, an emergency alternate intake structure has been constructed upstream from the intake structure and the Shippingport Bridge. The alternate intake structure is smaller, but has similar design features. It is typically operated for periodic testing and maintenance only. The alternate intake structure supports the auxiliary river water system, which is designed to provide sufficient cooling water for safe shutdown and subsequent cooldown after a postulated loss of the intake structure (USNRC 2007).

3.2 Latitude and Longitude of Cooling Water Structure

Regulatory requirement at §122.21(r)(4)(ii): "Latitude and longitude in degrees, minutes and seconds for each of your cooling water structures"

The Beaver Valley CWIS is located at 40°37'27.00" North, 80°26'05.00" West (USEPA 2000).

3.3 CWIS Operation

Regulatory requirement at §122.21(r)(4)(iii): "A narrative description of the operation of each of your cooling water intake structures, including design intake flows, daily hours of operation number of days of the year in operation and seasonal changes, if applicable"

Beaver Valley is a nuclear-powered facility that operates two units at all times of the year with no seasonal changes except in the case of seasonal maintenance. Typically, the units are on separate, alternating outage schedules where one unit is shut down every 18 months for approximately 26 days. The CWIS operates to provide a continuous supply of water to Beaver Valley's circulating water and service water systems, which then provide makeup water to replace consumptive and non-consumptive losses in the two circulating cooling water systems.

Four of the five intake pumps operate continuously, 365 days out of the year, to provide makeup water for cooling; a second river water pump is used when river temperatures are high, typically from July to October, and has been included in the DIF (USNRC 2007). Of the five pumps included in the DIF, two are service water pumps. Screen wash pumps operate intermittently to remove debris from the traveling water screens. The flow of the fire pumps and screen wash pumps are not included in the DIF.

The total DIF with all makeup water pumps in operation (i.e., excluding fire protection pumps and spray wash pumps) is 92.2 MGD (64,000 GPM) (Table 3-2). The average AIF, calculated as the average of all the monthly cooling water intake flows from January 2015 to December 2017, is approximately 65.1 MGD (45,188 GPM) (Table 3-3).

Table 3-2: Design Intake Flow

Operation	Design Intake Flow (MGD)
Makeup Water	49.0
Service Water	43.2
Total Design Intake Flow	**92.2 MGD**

Source: USNRC (2007)

Table 3-3: Maximum Actual Intake Flow (AIF) and Yearly Average Withdrawals

Year	Maximum Actual Intake Flow (MGD)	Average Actual Intake Flow (MGD)
2015	77.6	64.1
2016	80.5	65.1
2017	82.2	66.0
Actual Intake Flow	**82.2**	**65.1**

Source: FirstEnergy (2018)

3.4 WATER BALANCE

Regulatory requirement at §122.21(r)(4)(iv): "A flow distribution and water balance diagram that includes all sources of water to the facility, recirculating flows, and discharges"

A schematic drawing showing the flow distribution and water balance that includes all sources of water to Beaver Valley is provided in Section 10 as Attachment C – Drawings and Schematics.

3.5 ENGINEERING DRAWINGS

Regulatory requirement at §122.21(r)(4)(v): "Engineering drawings of the cooling water intake structure"

Engineering drawings of the CWIS are provided in Section 10 as Attachment C – Drawings and Schematics.

4.0 §122.21(r)(4) - SOURCE WATER BASELINE BIOLOGICAL CHARACTERIZATION DATA

4.1 UNAVAILABLE DATA

Regulatory requirement at §122.21(r)(4)(i): "A list of the data in paragraphs (r)(4)(ii) through (vi) of this section that are not available and efforts made to identify sources of the data."

All data required for the completion of the §122.21(r)(4) report were available. Available impingement and entrainment data for Beaver Valley was supplemented by more recent studies conducted within the New Cumberland Pool of the Ohio River.

4.2 TAXA IN THE VICINITY OF THE CWIS

Regulatory requirement at §122.21(r)(4)(ii): "A list of species (or relevant taxa) for all life stages and their relative abundance in the vicinity of the cooling water intake structure."

4.2.1 FISH

An extensive history of fish community sampling within the New Cumberland Pool of the Ohio River was available to characterize the aquatic resources near Beaver Valley. The Pennsylvania Fish and Boat Commission (PFBC) maintains a cumulative record of all fish species collected in the New Cumberland Pool from 1970 through 2011 (PFBC 2011). Additionally, data are available from the USACE Pittsburgh District 2008-2009 study to characterize the presence and distribution of larval fish in the main channel, backwaters, and tributaries of the Ohio River (Stauffer et al. 2010); the 2011 Ohio River Valley Water Sanitation Commission (ORSANCO) study throughout the New Cumberland Pool (ORSANCO 2012); fish community data collected by the Ohio Department of Natural Resources (ODNR)(ORSANCO 2018); and sampling near Beaver Valley from 1970 through 2016 via seining and electrofishing (FENOC 2017)(Table 4-1).

Generally, the species of fish found in the Ohio River near Beaver Valley can be found in three distinct habitat types found in the New Cumberland Pool; open water, river bottom, and shallow water habitats (USNRC 2007). Open water species that are abundant in the New Cumberland Pool of the Ohio River include gizzard shad, skipjack herring, emerald shiner, freshwater drum, and white bass. Common species occurring within the river bottom habitats of the News Cumberland Pool include redhorse species, catfish species, and sauger. Species common to the shallow water habitats of the New Cumberland Pool include common carp, silver chub, smallmouth buffalo, smallmouth bass, black crappie, white crappie, and bluegill. Shallow water habitats are where most minnow, shiner, and sunfish species occur (USNRC 2007).

Spawning habitats within the New Cumberland Pool include island backchannels, flooded stream mouths, and dam tailwaters (USNRC 2007). Low current, shallow backwater habitats such as island back channels and flooded stream mouths provide spawning and nursery habitat particularly for centrarchid species and other nest building species. They also provide habitat for young-of-year suckers and other games species. Dam tailwaters provide spawning habitat for sauger, and provide habitat for recreational species such as white bass and channel catfish, as well as sauger (USNRC 2007).

The most recent fisheries collection data available are from the Beaver Valley seine and electrofishing studies in 2016 (FENOC 2017). Nineteen taxa were collected, dominated by gizzard shad, redhorse sucker species, smallmouth buffalo, carp, and smallmouth bass. Between 19070 and 2016, a total of 73 species and five hybrids representing 15 families were collected in the vicinity of Beaver Valley (FENOC 2017).

Sampling by ORSANCO in 2011 in the New Cumberland Pool captured 39 species, with minnow/carp species comprising almost half the taxa collected. Two protected species were collected (mooneye and silver chub), as well as abundant game species (smallmouth bass and bluegill) (ORSANCO 2012). The most recent fish population data available from ORSANCO (2018) for the New Cumberland Pool collected by ODNR shows 35 taxa were collected in 2012, dominated by channel shiner and gizzard shad (combined representing over 25% of the catch). Other species that were more than 5% of the total catch included channel darter, emerald shiner, river darter, smallmouth buffalo, and white bass (ORSANCO 2018).

Lockchamber surveys at the Montgomery L/D were conducted as early as 1957, with a total of 17 surveys conducted between 1957 and 2005 (PFBC 2011). The peak number of species (28) and individuals (14,320) collected occurred in 2005. During that year, 89% of fish collected consisted of gizzard shad (PFBC 2011).

The USACE Pittsburgh District designed a study in 2008-2009 to characterize the presence and distribution of larval fish in the main channel, backwaters, and tributaries of the Ohio River (Stauffer et al. 2010). Collections from the New Cumberland Pool averaged 16 species per event with the most diverse event occurring August 2009 (2,063 individuals representing 24 taxa) and the least diverse event occurring October 2009 (2,862 individuals from 10 taxa). Sampling Station 24 (1.8 miles upriver in the main channel), Station 25 (tributary confluence 0.8 miles upriver), and Station 26 (back channel 2 miles downriver) were located near Beaver Valley and provide fish community data in the vicinity of Beaver Valley. Trawl data from those stations found the benthic fish community to be dominated by channel darter and mimic shiner (Stauffer et al. 2010).

Table 4-1: Fish Species Collected in the New Cumberland Pool of the Ohio River

Family	Common Name	Scientific Name	FENOC 1970-2016	ORSANCO 2011	ODNR 2012	PFBC 1970-2011	USACE 2008-2009
Polyodontidae	Paddlefish	*Polyodon spathula*				X	
Lepisosteidae	Longnose gar	*Lepisosteus osseus*	X	X	X	X	
Hiodontidae	Goldeye	*Hiodon alosoides*	X			X	
	Mooneye	*Hiodon tergisus*	X	X	X	X	
Anguillidae	American eel	*Anguilla rostrata*				X	
Clupeidae	Skipjack herring	*Alosa chrysochloris*	X			X	X
	Alewife	*Alosa pseudoharengus*	X			X	
	Gizzard shad	*Dorosoma cepedianum*	X	X	X	X	X
	Threadfin shad	*Dorosoma petenense*				X	
Cyprinidae	Central stoneroller	*Campostoma anomalum*	X			X	
	Goldfish	*Carassius auratus*	X			X	
	Grass carp	*Ctenopharyngodon idella*	X			X	
	Spotfin shiner	*Cyprinella spilopterus*	X	X		X	
	Common carp	*Cyprinus carpio*	X	X	X	X	
	Carp-goldfish hybrid	*C. carpio x C. auratus*	X				
	Streamline chub	*Erimystax dissimilis*			X		
	Striped shiner	*Luxilus chrysocephalus*	X	X		X	
	Silver chub	*Macrhybopsis storeriana*	X	X		X	X
	River chub	*Nocomis micropogon*	X			X	
	Golden shiner	*Notemigonus crysoleucas*	X			X	
	Emerald shiner	*Notropis atherinoides*	X	X	X	X	X
	River shiner	*Notropis blennius*				X	
	Silverjaw minnow	*Notropis buccatus*	X			X	
	Spottail shiner	*Notropis hudsonius*	X	X		X	X
	Silver shiner	*Notropis photogenis*				X	
	Rosyface shiner	*Notropis rubellus*	X			X	
	Sand shiner	*Notropis stramineus*	X			X	
	Mimic shiner	*Notropis volucellus*	X			X	X
	Channel shiner	*Notropis wickliffi*		X	X	X	
	Bluntnose minnow	*Pimephales notatus*	X	X	X	X	
	Fathead minnow	*Pimephales promelas*	X			X	
	Blacknose dace	*Rhinichthys atratulus*	X			X	
	Creek chub	*Semotilus atromaculatus*	X			X	

Family	Common Name	Scientific Name	FENOC 1970-2016	ORSANCO 2011	ODNR 2012	PFBC 1970-2011	USACE 2008-2009
Catostomidae	River carpsucker	*Carpiodes carpio*	X	X		X	
	Quillback	*Carpiodes cyprinus*	X	X	X	X	
	Highfin carpsucker	*Carpiodes velifer*	X	X		X	
	White sucker	*Catostomus commersonii*	X			X	
	Northern hogsucker	*Hypentelium nigricans*	X	X	X	X	X
	Smallmouth buffalo	*Ictiobus bubalus*	X	X	X	X	
	Black buffalo	*Ictiobus niger*	X			X	
	Spotted sucker	*Minytrema melanops*	X			X	
	Silver redhorse	*Moxostoma anisurum*	X	X	X	X	
	Smallmouth redhorse	*Moxostoma breviceps*		X	X	X	
	River redhorse	*Moxostoma carinatum*	X			X	
	Black redhorse	*Moxostoma duquesnii*	X			X	
	Golden redhorse	*Moxostoma erythrurum*	X	X	X	X	X
	Shorthead redhorse	*Moxostoma macrolepidotum*	X				
Ictaluridae	White catfish	*Ameiurus catus*	X			X	
	Blue catfish	*Ameiurus furcatus*	X				
	Black bullhead	*Ameiurus melas*	X			X	
	Yellow bullhead	*Ameiurus natalis*	X			X	
	Brown bullhead	*Ameiurus nebulosus*	X			X	
	Channel catfish	*Ictalurus punctatus*	X	X	X	X	X
	Stonecat	*Noturus flavus*	X			X	
	Flathead catfish	*Pylodictis olivaris*	X	X	X	X	X
Esocidae	Northern pike	*Esox lucius*	X			X	
	Tiger muskellunge	*Esox lucius x E. masquinongy*	X			X	
	Muskellunge	*Esox masquinongy*	X			X	
Salmonidae	Rainbow trout	*Oncorhynchus mykis*	X				
Percopsidae	Trout-perch	*Percopsis omiscomaycus*	X			X	
Fundulidae	Banded killifish	*Fundulus diaphanus*	X		X	X	
Atherinopsidae	Brook silverside	*Labidesthes sicculus*	X	X	X	X	X
Moronidae	*Morone* sp.	*Morone* sp.		X			
	White perch	*Morone americana*				X	
	White bass	*Morone chrysops*	X	X	X	X	X
	Hybrid striped bass	*Morone chrysops x M. saxatilis*	X		X	X	
	Striped bass	*Morone saxatilis*	X				

Family	Common Name	Scientific Name	FENOC 1970-2016	ORSANCO 2011	ODNR 2012	PFBC 1970-2011	USACE 2008-2009
Centrarchidae	Rock bass	*Ambloplites rupestris*	X	X	X	X	
	Green sunfish	*Lepomis cyanellus*	X			X	
	Pumpkinseed	*Lepomis gibbosus*	X	X		X	
	Orangespotted sunfish	*Lepomis humilis*		X		X	
	Bluegill	*Lepomis macrochirus*	X	X	X	X	X
	Longear sunfish	*Lepomis megalotis*		X		X	
	Redear sunfish	*Lepomis microlophus*	X			X	
	Pumpkinseed-redear sunfish hybrid	*Lepomis gibbosus x L. microlophus*	X				
	Smallmouth bass	*Micropterus dolomieu*	X	X	X	X	X
	Spotted bass	*Micropterus punctulatus*	X	X	X	X	
	Largemouth bass	*Micropterus salmoides*	X	X		X	
	White crappie	*Pomoxis annularis*	X			X	
	Black crappie	*Pomoxis nigromaculatus*	X	X	X	X	
Percidae	Greenside darter	*Etheostoma blennioides*	X		X	X	X
	Rainbow darter	*Etheostoma caeruleum*				X	X
	Bluebreast darter	*Etheostoma camurum*			X	X	X
	Fantail darter	*Etheostoma flabellare*				X	
	Johnny darter	*Etheostoma nigrum*	X			X	X
	Tippecanoe darter	*Etheostoma tippecanoe*			X		X
	Banded darter	*Etheostoma zonale*	X			X	X
	Yellow perch	*Perca flavescens*	X	X	X	X	
	Logperch	*Percina caprodes*	X	X	X	X	X
	Channel darter	*Percina copelandi*	X	X	X	X	X
	River darter	*Percina shumardi*			X	X	X
	Sauger	*Sander canadense*	X	X	X	X	
	Saugeye	*Sander canadense x S. vitreum*	X			X	
	Walleye	*Sander vitreum*	X	X	X	X	
Sciaenidae	Freshwater drum	*Aplodinotus grunniens*	X	X	X	X	X

Source: PFBC (2011); ORSANCO (2012, 2018); Stauffer et al. (2010); FENOC (2017)

4.2.2 *Unionid Mussels*

The New Cumberland Pool is the furthest upstream pool of the Ohio River where live unionid mussels have been reported (Lock Hydro 2012). The population of unionid mussels in the New Cumberland Pool, as well as the Ohio River itself, was reduced in both species diversity and abundance as a result of the impoundment of the Ohio River, as well as poor water quality (USNRC 2007). A population resurgence of mussel species in the Ohio River has been observed in recent years, believed to be the result of improved water quality. However, many species of mussels historically found in the Ohio River require clean-swept, coarse sand and gravel substrates. Presently, those conditions are limited to habitat within dam tailwaters and high current areas around river islands (USNRC 2007).

Historically, 36 species of unionid mussels resided within the New Cumberland Pool (USNRC 2007). Nine species were found in the pool during surveys that took place from 1993-1997: mucket (*Actinonaias ligamentina*), fatmucket (*Lampsilis siliquoidea*), fluted shell (*Lasmigona costata*), fragile papershell (*Leptodea fragilis*), pink heelsplitter (*Potamilus alatus*), giant floater (*Pyganodon grandis*), mapleleaf (*Quadrula quadrula*), fawnsfoot (*Truncilla donaciformis*), and paper pondshell (*Utterbackia imbecillis*). These species were found within the tailwaters of the Montgomery Dam and the backchannel of Phillis Island. The invasive species Asiatic clam (*Corbicula fluminea*) and zebra mussel (*Dreissena polymorpha*) are both found in the New Cumberland Pool of the Ohio River. Both species are known to foul cooling water intakes, and are also recognized as a threat to native unionid mussel populations (USNRC 2007).

During September and October of 2012, EnviroScience performed a unionid mussel survey and translocation service in the New Cumberland Pool at approximately RM 34.5 to support an effort to reduce environmental impacts from construction of shipping barge mooring cells in the vicinity of Beaver Valley (EnviroScience 2013). The most upstream sample transects were performed in the channel starting near the downstream left bank in front of the southwestern corner of the adjacent Bruce Mansfield Power Plant (Mansfield), just below a portion of dredged river bottom that is maintained by FirstEnergy for fleeting purposes (EnviroScience 2013). The downstream extent of the survey was limited by the existing raw water intake of Beaver Valley. A map providing the mussel sampling transects are provided in Attachment A.

Heterogeneous river bottom habitat was split into ten 100-meter long transects, 60 meters apart, and each was surveyed by a team of divers searching perpendicular to river flow. Water depth was recorded and bottom composition was characterized every ten meters (EnviroScience 2013). Mussels collected were identified, enumerated and assessed for health before being translocated to higher quality river habitat in a backchannel approximately 1.1 miles downstream. From the total of 351 live mussels collected, no federal or state-listed mussel species were detected (EnviroScience 2013). Of the six unionid species collected, mapleleaf was most abundant at 58.1% of total recovery. Pink heelsplitter (*Potamilus alatus*) accounted for 29.1% of the total recovery (Table 4-2).

Though habitat assessment of the river bottom showed a lack of "significant" areas of mussel resources, the study area was determined to be generally acceptable for mussel habitation (EnviroScience 2013). The majority of mussels were collected in a small section of habitat in front of the Beaver County boat launch, on the left descending bank of the river, within an unindustrialized stretch of shoreline downriver of Mansfield and upriver from Beaver Valley (EnviroScience 2013). The entire study featured intermittent quality mussel habitat. Furthermore, there was evidence of cohabitation with and colonization on native species by zebra mussel.

Table 4-2: Freshwater Mussels in the Ohio River at RM 34.5, Beaver County, PA, September 2012

Species Common Name	Scientific Name	Live Mussels Collected	Weathered Dead or Subfossil Shells	Relative Abundance
Mapleleaf	*Quadrula quadrula*	204	0	58.1%
Pink heelsplitter	*Potamilus alatus*	102	0	29.1%
White heelsplitter	*Lasmigona complanata*	22	0	6.3%
Threehorn wartyback	*Obliquaria reflexa*	20	0	5.7%
Mucket	*Actinonaias ligametina*	2	0	0.6%
Black sandshell	*Ligumia recta*	1	0	0.3%
Wabash pigtoe	*Fusconaia flava*	0	1	0%
Fragile papershell	*Leptodea fragilis*	0	1	0%
Total		351	2	100%

Source: EnviroScience (2013); PNHP (2017a)

Unionid mussels are at risk for impingement and entrainment during their glochidia life stage. Glochidia are parasitic larvae of unionid mussels that attach to the gills of a host fish. Once they are large enough to survive on their own, glochidia will detach from the host and settle into the substrate. Mussel impingement may occur as a result of the impingement of a fish with glochidia attached. Host species for the mussel species identified in Enviroscience (2013) and USNRC (2007) are provided in Table 4-3. Host species provided are limited to those fish species impinged at Beaver Valley and other nearby facilities. Impingement data are provided in Section 4.3.1.

Table 4-3: Mussels Collected in the New Cumberland Pool and their Glochidia Host Species

	Mussel Species												
Known Glochidia Host Species*	Black sandshell	Fatmucket	Fawnsfoot	Flutedshell	Fragile papershell	Giant floater	Mapleleaf	Mucket	Paper pondshell	Pink heelsplitter	Threehorn wartyback	Wabash pigtoe	White heelsplitter
Banded killifish	X			X		X		X	X				X
Black crappie	X	X		X		X		X	X			X	X
Bluegill	X	X		X		X			X			X	
Bluntnose minnow		X		X		X							
Brown bullhead				X									
Channel catfish				X			X		X				
Common carp	X			X		X							X
Common shiner		X		X		X					X		
Creek chub				X		X			X			X	
Fathead minnow				X									
Flathead catfish				X			X						
Freshwater drum			X	X	X	X				X	X		
Gizzard shad				X							X		X
Golden shiner				X		X			X				
Goldfish				X		X			X				
Green sunfish	X	X		X		X		X	X				X
Johnny darter				X		X							
Largemouth bass	X	X		X		X		X	X		X	X	X
Logperch				X									
Mimic shiner				X									
Northern hogsucker				X									
Pumpkinseed	X			X		X			X			X	

Known Glochidia Host Species*	Mussel Species												
	Black sandshell	Fatmucket	Fawnsfoot	Flutedshell	Fragile papershell	Giant floater	Mapleleaf	Mucket	Paper pondshell	Pink heelsplitter	Threehorn wartyback	Wabash pigtoe	White heelsplitter
Quillback				X									
Rock bass	X	X		X		X		X	X				
Sand shiner		X											
Sauger	X	X	X	X				X					
Shorthead redhorse				X									
Silver chub				X									
Silver redhorse				X									
Silver shiner												X	
Skipjack herring						X					X		
Smallmouth bass		X		X				X					
Spottail shiner				X									
Trout-perch				X									
Walleye	X	X		X							X		
White bass		X				X		X					
White crappie	X	X				X		X				X	X
White perch	X												
Yellow bullhead				X		X	X						
Yellow perch	X	X		X		X		X	X				X

* Impinged at Beaver Valley or nearby facilities.

Sources: ENSR (2008); Enviroscience (2013); FirstEnergy (2007); INHS (2018); Kinectrics (2007); Mulcrone (2005); USNRC (2007)

4.3 SPECIES AND LIFE STAGES SUSCEPTIBLE TO IMPINGEMENT & ENTRAINMENT

Regulatory requirement at §122.21(r)(4)(iii): "Identification of the species and life stages that would be most susceptible to impingement and entrainment. Species evaluated should include the forage base as well as those most important in terms of significance to commercial and recreational fisheries."

Susceptibility to impingement or entrainment is dependent on a number of biotic and abiotic factors, as shown in Table 4-4. Impingement is often dominated by herring species and freshwater drum (King et al. 2010). Most fish impinged are juvenile or age-1 specimens, or adults of smaller species. Impingement of certain taxa tends to correlate with environmental conditions such as high discharge, low water levels, low dissolved oxygen, and both high and low water temperatures (Saalfeld 2006). Additionally, high populations do not necessarily correlate to high probability of impingement, or vice versa. Life history traits that may result in the increased likelihood of impingement include nearshore spawning and pelagic behavior during early life stages (Saalfeld 2006). Species with lower impingement rates are demersal or associated with covered habitats, rather than open water (King et al. 2010). Taxa most susceptible to entrainment are those with pelagic lifestages with little to no swimming ability (Graham et al. 2008).

Table 4-4: General Factors Effecting Susceptibility to Impingement or Entrainment

Category	Factor Type	Factors
Impingement	Abiotic Factors	Water temperature, dissolved oxygen, turbidity, CWIS design, and intake velocities
	Biotic Factors	Swimming ability, body shape, size, diel and seasonal movements, and health of the organism
Entrainment	Abiotic Factors	Intake location, water volume used for cooling, velocity at intake, and screen mesh size
	Biotic Factors	Organism size, swimming ability, swimming behavior (pelagic or benthic) diurnal behavior, and spawning habitat

Source: Baker (2007); Graham et al. (2008)

4.3.1 IMPINGEMENT

Impingement studies were conducted at Beaver Valley from the 1970's to 1995 (USNRC 2007). In 1983, the United States Nuclear Regulatory Commission (USNRC) permitted the discontinuation of mandatory impingement studies by Beaver Valley. A voluntary program was continued in its place in order to provide a non-disruptive database of biological data. Impingement sampling was conducted weekly at Beaver Valley using a 0.25 inch mesh collection basket placed at the end of the screen washwater sluiceway. Each sample was a 24-hour sample. Gizzard shad and emerald shiner, which are pelagic forage species, were the most frequently impinged species (Lange 2007).

FirstEnergy (2007) provided raw impingement data collected at Beaver Valley from 1980 through 1985 and 1987 through 1992. Impingement over the 12 year period that data were available was dominated by gizzard shad, freshwater drum, channel catfish, bluegill, and emerald shiner. All other species represented 3% or less of the total (Table 4-5).

Table 4-5: Relative Abundance of Impinged Fish at Beaver Valley

Species	Number of Years Impinged	Percent of Total Impingement (1980-1985 & 1987-1992)
Gizzard shad	12	43.3
Freshwater drum	11	11.9
Channel catfish	12	9.6
Bluegill	12	9.2
Emerald shiner	12	8.7
Rock bass	10	3.0
Green sunfish	12	2.3
Spotted bass	11	2.0
Common carp	9	1.8
Flathead catfish	9	1.4
Smallmouth bass	11	0.7
White crappie	8	0.6
Brown bullhead	7	0.6
Johnny darter	7	0.5
Logperch	7	0.4
Bluntnose minnow	5	0.4
Mimic shiner	5	0.4
White bass	5	0.4
Largemouth bass	4	0.4
Black crappie	7	0.3
Trout-perch	5	0.3
Pumpkinseed	4	0.3

Species	Number of Years Impinged	Percent of Total Impingement (1980-1985 & 1987-1992)
Sand Shiner	4	0.3
Yellow bullhead	4	0.3
Walleye	3	0.2
Yellow perch	3	0.1
Banded darter	2	0.1
Sauger	2	0.1
Striped bass hybrid	2	0.1
Spottail shiner	2	<0.1
Banded killifish	1	<0.1
Channel darter	1	<0.1
Common shiner	1	<0.1
Creek chub	1	<0.1
Fathead minnow	1	<0.1
Golden shiner	1	<0.1
Goldfish	1	<0.1

Source: FirstEnergy (2007)

NOVA/AEC is located on the same shoreline as Beaver Valley, approximately five miles upriver in the Montgomery Pool (ENSR 2008). A year-long impingement study was conducted at the NOVA/AES CWIS in 2006 and 2007. Twenty taxa were collected over 46 sampling events (Table 4-6). The majority of fish collected (99%) were gizzard shad. Additionally, most fish were in the YOY life stage. No threatened or endangered species were collected.

Table 4-6: Relative Abundance of Impinged Fish at NOVA/AES

Species	Relative Abundance (%) (2006-2007)
Gizzard shad	99.09
Freshwater drum	0.41
White bass	0.38
Bluegill	0.03
Channel catfish	0.02
Sauger	0.01
White crappie	0.01
Quillback	0.01
Common carp	<0.01
Emerald shiner	<0.01
Flathead catfish	<0.01
Striped bass	<0.01
Black crappie	<0.01
Largemouth bass	<0.01
Mimic shiner	<0.01
Rainbow smelt	<0.01
Silver chub	<0.01
Silver redhorse	<0.01
Silver shiner	<0.01
Smallmouth bass	<0.01

Source: ENSR (2008)

Impingement characterization studies were also conducted at the W.H. Sammis Plant (Sammis) in Stratton Ohio (Kinectrics 2007). The facility is located at Ohio River mile 53 at the downstream portion of the New Cumberland Pool. The most recent impingement sampling was conducted from July 2005 to August 2006 (Kinectrics 2007). Gizzard shad accounted for 98.2% of impingement, followed by freshwater drum (0.7%), and white perch (0.4%)(Table 4-7). Initial condition of impinged fish was also recorded during the 2005-2006 study (Kinectrics 2007). The majority of fish impinged (63%) were considered recently dead. Approximately 19% were considered dead prior to impingement (Kinectrics 2007).

Table 4-7: Relative Abundance of Impinged Fish at Sammis

Common Name	Relative Abundance (%) (2005-2006)
Gizzard shad	98.21
Freshwater drum	0.74
White perch	0.40
White bass	0.33
Sauger	0.19
Bluegill	0.03
Largemouth bass	0.03
Walleye	0.02
Channel catfish	0.02
Black crappie	0.01
Quillback	0.01
Silver chub	<0.01
Logperch	<0.01
Shorthead redhorse	<0.01
Golden shiner	<0.01
Emerald shiner	<0.01
Mooneye	<0.01
Yellow perch	<0.01
Smallmouth bass	<0.01
Northern hogsucker	<0.01
Skipjack herring	<0.01
Flathead catfish	<0.01
White crappie	<0.01

Source: Kinectrics (2007)

4.3.2 ENTRAINMENT

Entrainment characterization studies were conducted at Beaver Valley from 1976 to 1995 (Lange 2007). Ichthyoplankton surveys were conducted in the main channel of the Ohio River to determine species composition, relative abundance, and distribution of ichthyoplankton near Beaver Valley from 1976 to 1995 (Lange 2007). In 1980 the USNRC permitted the studies to be discontinued, but the program was voluntarily continued in order to provide a non-disruptive database of biological data. Studies from 1976-1979 indicated samples collected in front of the intake were representative of entrainment at Beaver Valley; therefore ichthyoplankton samples for entrainment characterization were collected from the main channel of the Ohio River adjacent to the intake. The most predominant species collected were minnows, gizzard shad, shiners, freshwater drum, and common carp. These species are generally broadcast spawners with early life stages that frequent the pelagic zone (Lange 2007).

FirstEnergy provided ichthyoplankton data collected from the main channel of the Ohio River adjacent to the Beaver Valley intake via secure file transfer. The files contained results from studies conducted from 1980 through 1992; no studies were conducted in 1986 (USNRC 2007). Data were collected at five stations from a designated transect in the Ohio River near Beaver Valley. Samples were collected via a

0.5-meter plankton net. Data provided did not include sampling details such as mesh size of the plankton net, depths sampled, etc. Taxa collected were identified as eggs, larvae, juveniles, and adult specimens. However, it is important to note that the collection of adult emerald shiner would not be representative of actual entrainment, as they are too large to pass through the traveling water screens at Beaver Valley; this is also likely the case with some juvenile specimens as well. Sampling was conducted once per month from April through July from 1980 to 1985, and then extended to include the month of August from 1987 to 1992.

Over the course of the study, a total of 17,262 organisms were collected. Collections were dominated by freshwater drum eggs, which consisted of 25.2% of the total collected ichthyoplankton. Other dominant taxa collected included post-yolk sac gizzard shad larvae (17.2%), yolk-sac gizzard shad larvae (14.1%), shiner (*Notropis* spp.) post-yolk sac larvae (10.8%), Cyprinidae spp. post yolk-sac larvae (5.6%), adult emerald shiner (4.0%), freshwater drum yolk sac larvae (3.8%), and common carp post-yolk sac larvae (3.7%) (Table 4-8).

Table 4-8: Ichthyoplankton Taxa Collected from the Main Channel of the Ohio River

Taxon	Scientific Name	Life Stage[1]	1980-1992 Total Collected	1980-1992 Percent Composition
Freshwater drum	*Aplodinotus grunniens*	Egg	4,348	25.2
Gizzard shad	*Dorosoma cepedianum*	Post yolk-sac larvae	2,969	17.2
		Yolk-sac larvae	2,438	14.1
Shiner species	*Notropis* spp.	Post yolk-sac larvae	1,869	10.8
Cyprinidae species	Cyprinidae spp.	Post yolk-sac larvae	972	5.6
Emerald shiner	*Notropis atherinoides*	Adult	699	4.0
Freshwater drum	*Aplodinotus grunniens*	Yolk-sac larvae	663	3.8
Common carp	*Cyprinus carpio*	Post yolk-sac larvae	636	3.7
Unidentified	N/A	Egg	495	2.9
Gizzard shad	*Dorosoma cepedianum*	Juvenile	302	1.7
Freshwater drum	*Aplodinotus grunniens*	Post yolk-sac larvae	254	1.5
Cyprinid species	Cyprinidae spp.	Yolk-sac larvae	229	1.3
Cyprinid species	Cyprinidae spp.	Egg	146	0.8
Minnow species	*Pimephales* spp.	Post yolk-sac larvae	144	0.8
White bass	*Morone chrysops*	Post yolk-sac larvae	139	0.8
Common carp	*Cyprinus carpio*	Yolk-sac larvae	133	0.8
Emerald shiner	*Notropis atherinoides*	Post yolk-sac larvae	94	0.5
Gizzard shad	*Dorosoma cepedianum*	Post yolk-sac larvae (LL)	80	0.5
Shiner species	*Notropis* spp.	Yolk-sac larvae	73	0.4
Darter species	*Etheostoma* spp.	Post yolk-sac larvae	57	0.3
Unidentifiable	N/A	Yolk-sac larvae	57	0.3
White bass	*Morone chrysops*	Egg	50	0.3
White bass	*Morone chrysops*	Yolk-sac larvae	44	0.3
Yellow perch	*Perca flavescens*	Post yolk-sac larvae	39	0.2
Pike-perch species	*Sander* spp.	Yolk-sac larvae	34	0.2
Common carp	*Cyprinus carpio*	Egg	30	0.2
Crappie species	*Pomoxis spp.*	Post yolk-sac larvae	29	0.2
Darter species	*Etheostoma* spp.	Yolk-sac larvae	25	0.1
Unidentifiable	N/A	Egg	25	0.1
Sucker species	Catostomidae spp.	Post yolk-sac larvae	22	0.1
Emerald shiner	*Notropis atherinoides*	Juvenile	20	0.1
Sunfish species	*Lepomis* spp.	Post yolk-sac larvae	18	0.1
Perch species	Percidae spp.	Post yolk-sac larvae	14	0.1

Taxon	Scientific Name	Life Stage[1]	1980-1992	
			Total Collected	Percent Composition
Pike-perch species	*Sander* spp.	Post yolk-sac larvae	13	0.1
Yellow perch	*Perca flavescens*	Yolk-sac larvae	11	0.1
Sunfish species	*Lepomis* spp.	Yolk-sac larvae	10	0.1
Perch species	Percidae spp.	Yolk-sac larvae	7	<0.1
Sunfish species	*Lepomis* spp.	Post yolk-sac larvae (LL)	7	<0.1
Shiner species	*Notropis* spp.	Juvenile	6	<0.1
Golden shiner	*Notemigonus crysoleucas*	Post-yolk sac larvae	5	<0.1
Catfish species	*Ictalurus spp.*	Post yolk-sac larvae	4	<0.1
Cyprinidae species	Cyprinidae spp.	Post yolk-sac larvae (LL)	4	<0.1
Freshwater drum	*Aplodinotus grunniens*	Juvenile	4	<0.1
Minnow species	*Pimephales spp.*	Yolk-sac larvae	4	<0.1
Perch species	Percidae spp.	Egg	4	<0.1
Sand shiner	*Notropis stramineus*	Juvenile	4	<0.1
Banded killifish	*Fundulus diaphanus*	Yolk-sac larvae	3	<0.1
Sunfish species	*Lepomis spp.*	Juvenile	3	<0.1
Bluntnose minnow	*Pimephales notatus*	Adult	2	<0.1
Bluntnose minnow	*Pimephales notatus*	Juvenile	2	<0.1
Channel catfish	*Ictalurus punctatus*	Juvenile	2	<0.1
Freshwater drum	*Aplodinotus grunniens*	Post yolk-sac larvae (LL)	2	<0.1
Shiner species	*Notropis* spp.	Post yolk-sac larvae	2	<0.1
Smallmouth bass	*Micropterus dolomieu*	Post yolk-sac larvae	2	<0.1
Common carp	*Cyprinus carpio*	Juvenile	1	<0.1
Darter species	*Etheostoma* spp.	Juvenile	1	<0.1
Darter species	*Etheostoma* spp.	Post yolk-sac larvae (LL)	1	<0.1
Darter species	*Percina* spp.	Juvenile	1	<0.1
Freshwater drum	*Aplodinotus grunniens*	Unknown stage larvae	1	<0.1
Johnny darter	*Etheostoma nigrum*	Adult	1	<0.1
Logperch	*Percina capriodes*	Adult	1	<0.1
Redhorse species	*Moxostoma* spp.	Juvenile	1	<0.1
Sand shiner	*Notropis stramineus*	Adult	1	<0.1
Sucker species	Catostomidae spp.	Yolk-sac larvae	1	<0.1
Temperate bass species	*Morone* spp.	Egg	1	<0.1
White catfish	*Ictalurus catus*	Juvenile	1	<0.1
White crappie	*Pomoxis annularis*	Post yolk-sac larvae (LL)	1	<0.1
Yellow perch	*Perca flavescens*	Post yolk-sac larvae (LL)	1	<0.1

[1] Post yolk-sac larvae: Specimens with no yolk and/or globules and with no development of fin rays and/or spiny elements.

Post yolk-sac larvae (LL): Specimens with developed fin rays and/or spiny elements and evidence of a fin fold.

Note that smaller lifestages (eggs, larvae, and small juveniles) presented in this table are representative of potential entrainment; larger juveniles and adults would not likely be entrained through the traveling water screens.

Recent entrainment characterization studies were conducted at Sammis in Stratton Ohio. The facility is located at Ohio River mile 53 at the downstream portion of the New Cumberland Pool (EPRI 2017). The CWIS is approximately a half-mile above the New Cumberland L/D. Although the plant's CWIS is approximately 19 miles downstream from Beaver Valley, data from Sammis provides a more recent characterization of ichthyoplankton community data for New Cumberland Pool of the Ohio River.

Entrainment samples were collected from March through September with plankton nets from within the CWIS Area of Influence at Sammis. This method of entrainment survey was used at a series of plants along the Ohio River. Although it is effective as establishing a baseline characterization of entrainable ichthyoplankton in the CWIS Area of Influence, the method doesn't represent true entrainment because it doesn't select out juvenile and small adults that wouldn't otherwise be susceptible to entrainment due to size and age-specific morphology. Ichthyoplankton samples were measured, assigned to lowest identifiable taxa, and enumerated by life stage.

The Ictiobinae sp. taxa dominated entrainment at Sammis during 2015, comprising of 75.3% of the annual entrainment. Other dominant taxa included freshwater drum (7.3%) gizzard shad (3.9%), common carp (3.4%), *Morone* sp. (not striped bass; 1.7%) emerald shiner type (1.4%), and Cyprinidae type (1.2%). All remaining taxa represented less than 1% of entrainment composition.

Gizzard shad dominated entrainment at Sammis during 2016, comprising of 19.5% of the annual entrainment. Other dominant taxa included Cyprinidae type (16.9%), *Pimephales* type (14.2%), Clupeidae sp. (12.1%), emerald shiner type (5.5%), Ictiobinae sp. (5.4%), logperch type (4.0%) and *Lepomis* sp. (2.5%). All remaining taxa represented less than 2% of entrainment composition. Both years of data are provided in Table 4-9.

Table 4-9: Estimated Annual Entrainment at Sammis

Species	Life Stage	2015		2016	
		Count	Composition (%)	Count	Composition (%)
Clupeidae sp.	YSL	358,986	0.25%	87,625	0.20%
	PYSL	181,595	0.13%	2,477,961	5.78%
	Larvae	119,662	0.08%	2,632,526	6.14%
Gizzard Shad	YSL	202,516	0.14%	189,251	0.44%
	PYSL	5,004,161	3.53%	8,027,353	18.73%
	Larvae	337,527	0.24%	67,850	0.16%
	Adult	-	-	56,942	0.13%
Dorosoma sp.	YSL	-	-	49,302	0.12%
Mooneye	YSL	67,505	0.05%	-	-
Common Carp	Egg	-	-	356,071	0.83%
	YSL	4,617,009	3.25%	388,264	0.91%
	PYSL	214,707	0.15%	-	-
Shiner type	PYSL	-	-	604,200	1.41%
Striped shiner type	PYSL	107,353	0.08%	-	-
Emerald Shiner	PYSL	-	-	93,945	0.22%
	Juvenile	-	-	60,541	0.14%
Emerald Shiner Type	Egg	127,072	0.09%	22,928	0.05%
	YSL	371,930	0.26%	37,942	0.09%
	PYSL	1,479,081	1.04%	2,279,432	5.32%
Pimephales type	YSL	532,991	0.38%	1,347,384	3.14%
	PYSL	252,052	0.18%	4,445,409	10.37%
	Larvae	62,250	0.04%	278,940	0.65%
Cyprinidae Type	Egg	1,677,837	1.18%	2,109,282	4.92%
Cyprinidae sp.	Egg	132,281	0.09%	-	-
	YSL	315,556	0.22%	2,025,263	4.73%
	PYSL	107,353	0.08%	1,422,537	3.32%
	Larvae	132,281	0.09%	1,466,409	3.42%
	Unid	-	-	219,185	0.51%
Catostominae sp.	PYSL	124,665	0.09%	-	-
Ictiobinae sp.	YSL	96,831,362	68.23%	2,068,111	4.83%
	PYSL	10,063,628	7.09%	61,107	0.14%
	Larvae	-	-	171,220	0.40%

Species	Life Stage	2015		2016	
		Count	Composition (%)	Count	Composition (%)
Moxostoma sp.	YSL	-	-	26,695	0.06%
	Larvae	-	-	53,391	0.12%
Quillback	YSL	-	-	16,646	0.04%
Morone sp.	YSL	-	-	240,016	0.56%
	PYSL	625,732	0.44%	34,288	0.08%
	Larvae	62,250	0.04%	-	-
Morone sp. (Not Striped Bass)	YSL	1,776,502	1.25%	348,012	0.81%
	PYSL	564,953	0.40%	472,539	1.10%
Striped Bass	YSL	-	-	31,081	0.07%
White bass	PYSL	107,353	0.08%	-	-
Lepomis sp.	YSL	-	-	58,438	0.14%
	PYSL	396,240	0.28%	906,761	2.12%
	Larvae	-	-	118,979	0.28%
Largemouth bass	Juvenile	62,250	0.04%	-	-
Pomoxis sp.	PYSL	39,887	0.03%	-	-
Banded darter type	PYSL	61,411	0.04%	-	-
Darter (Not Logperch) sp.	PYSL	-	-	75,910	0.18%
Darter sp.	YSL	-	-	95,933	0.22%
	Larvae	-	-	27,528	0.06%
Etheostoma sp.	Juvenile	60,168	0.04%	116,876	0.27%
Etheostoma Type	YSL	-	-	85,040	0.20%
	Larvae	-	-	9,065	0.02%
Logperch Type	YSL	672,597	0.47%	1,492,937	3.48%
	PYSL	233,325	0.16%	203,819	0.48%
	Larvae	103,487	0.07%	-	-
Percidae (Not *Sander*) sp.	YSL	-	-	82,460	0.19%
Percidae sp.	PYSL	124,665	0.09%	-	-
Walleye	YSL	38,010	0.03%	-	-
	PYSL	-	-	82,460	0.19%
Yellow perch	YSL	152,039	0.11%	-	-
Freshwater Drum	Egg	4,342,206	3.06%	562,031	1.31%
	YSL	4,154,202	2.93%	1,865,168	4.35%
	PYSL	1,798,616	1.27%	795,331	1.86%
	Juvenile	107,353	0.08%	-	-
Cyprinidae/Catostomidae	Egg	127,014	0.09%	-	-
Cyprinidae/Catostomidae type	Egg	62,332	0.04%	-	-
	PYSL	62,332	0.04%	-	-
Unidentified	Egg	2,489,414	1.75%	1,782,152	4.16%
	Larvae	282,792	0.20%	222,706	0.52%
Total		141,928,490		42,853,242	

Source: EPRI (2017)
YSL = Yolk-Sac Larvae; PYSL = Post-Yolk Sac Larvae; Juv = Juvenile; Unid = Unidentified Life Stage

4.4 SPECIES MOST SUSCEPTIBLE TO IMPINGEMENT AND ENTRAINMENT AT BEAVER VALLEY

Relevant taxa for life history review were determined by the most frequently collected taxa during recent available entrainment and impingement studies. These species are provided in Table 4-10 below.

Table 4-10: Species Most Susceptible to Impingement and Entrainment at Beaver Valley

Species	Justification
Bluegill	• The 4th most impinged species at Beaver Valley • Frequently collected in Beaver Valley electrofishing and seining surveys • The 6th most impinged species at Sammis
Bluntnose minnow	• Representative of Cyprinidae sp. • Common larvae in Ohio River ichthyoplankton survey • *Pimephales* type and Cyprinidae sp. larvae among the most entrained taxa at Sammis
Channel catfish	• The 3rd most impinged species at Beaver Valley • Frequently collected in Beaver Valley electrofishing and seining surveys
Common carp	• Among the most collected ichthyoplankton during Sammis entrainment and Ohio River ichthyoplankton surveys • Common in Beaver Valley impingement collections
Emerald shiner	• The 5th most impinged species at Beaver Valley • Representative for shiner sp. which was among the most collected ichthyoplankton during Sammis entrainment and Ohio River ichthyoplankton surveys
Freshwater drum	• The 2nd most impinged species at Beaver Valley, NOVA/AES, and Sammis • Among the most collected ichthyoplankton during Sammis entrainment and Ohio River ichthyoplankton surveys
Gizzard shad	• The most impinged species at Beaver Valley, NOVA/AES, and Sammis • Among the most collected ichthyoplankton during Sammis entrainment and Ohio River ichthyoplankton surveys
Smallmouth bass	• Frequently collected game species in Beaver Valley electrofishing and seining surveys • Frequently recorded to become impinged at Beaver Valley
Smallmouth buffalo	• Frequently collected game species in Beaver Valley electrofishing and seining surveys • Representative for Ictiobinae sp., one of the most entrained taxa at Sammis
White bass	• The 3rd most impinged species at NOVA/AES • The 4th most impinged species at Sammis • *Morone* sp. one of the most entrained taxa at Sammis

4.5 PERIODS OF REPRODUCTION, RECRUITMENT, AND PEAK ABUNDANCE

Regulatory requirement at §122.21(r)(4)(iv): "Identification and evaluation of the primary period of reproduction, larval recruitment, and period of peak abundance for relevant taxa."

Bluegill

Bluegill spawning in Ohio typically occurs multiple times between May and August (ODNR 2018). Spawning occurs in water temperatures ranging from 60.1°F to 89.6°F (Wallus and Simon 2006a). Spawning peaks in June and can continue into August, but spawning will typically cease when temperatures exceed 80°F (Mecozzi 2008). Males build nests in shallow water near the shoreline over sand or gravel substrates, but may also build nests over mud substrates that are covered in debris (Wang and Kernehan 1979). Nests may occur in groups up to 40 or 50 nests (Mecozzi 2008). Eggs are demersal and adhesive (Wang and Kernehan 1979). Fecundity can reach as high as 25,000 eggs, but averages approximately 12,000 (Mecozzi 2008). Eggs hatch in 2-3 days (Wang and Kernehan 1979). The male will remain at the nest to guard the eggs and larvae several days after hatching (Mecozzi 2008). Larvae remain demersal until after the yolk-sac is absorbed. After the yolk-sac is fully absorbed, larvae begin to school above the nest. Larvae are free swimming approximately 4 days after hatching. Juveniles will disperse from the school and use shallow shoreline habitat as a nursery. Juveniles move into deeper habitats as they grow (Wang and Kernehan 1979).

Bluntnose Minnow

Bluntnose minnow spawning in Ohio starts in May and continues into August (ODNR 2018). They are fractional spawners, spawning repeatedly during this period (ODNR 2018). Water temperatures during spawning typically range from 70-79°F (Becker 1983). They are nest builders, and construct these nests over sandy or gravel shores. Eggs are adhesive and stick to the undersides of logs, rocks, and other flat, submerged objects at the nest site. The male protects the nest, and keeps the nest free of accumulating sediments. Spawning activity tends to occur at night, but has been recorded to occur during the day as well. Spawning may occur two or more times per year. During a single spawning event, a female may lay between 40 and 408 eggs. Multiple females may spawn in the same nest as a single male, resulting in nests recorded to contain greater than 5,000 eggs laid within as 48 hour period. Larvae are 4.6 mm in length after hatching, and then range from 5.5-5.7 mm within three days. For the first eight days after hatching, the young tend to school near the water's surface (Becker 1983).

Channel Catfish

Channel catfish spawning is triggered when water temperatures reach 69.8°F and occurs in temperatures up to 86°F (McMahon and Terrel 1982). USGS (2018a) water temperature data for the Ohio River provided in Section 2.1 suggest spawning near Beaver Valley would likely be triggered in late May or early June. Spawning takes place in a nest built by the male within a cavity of a submerged object or shoreline. Immediately after mating, the male chases the female away from the nest, but she remains within the vicinity of the nest and protect it from predators from a distance (McMahon and Terrel 1982). Fecundity is as high as 20,000 eggs per female (Pool 2007). Eggs are demersal and very adhesive (Wang and Kernehan 1979). Eggs hatch in 6-7 days at 80.6°C (McMahon and Terrel 1982). Larvae remain in the nest for 7-8 days, and then disperse into shallow water areas with cover (McMahon and Terrel, 1982). Young channel catfish tend to school and frequent inshore waters (Wang and Kernehan 1979). Larvae concentrate in slow flowing (<0.5 fps) areas near rocky riffles, debris covered gravel, or sand bars in clear streams, or in shallow (< 1.6 feet) mud or sand substrate edges of flowing channels in turbid rivers and bayous (McMahon and Terrel 1982). Larvae avoid vegetation due to high predation by centrarchids. Larvae will overwinter under boulders in riffles or move into cover within deeper water. Juveniles reside in similar habitat to larvae (McMahon and Terrel 1982).

Common Carp

Common carp spawn in Ohio typically from late April through June (ODNR 2018). They spawn in waters in the range of 64.4°F to 73.4°F over areas of submerged vegetation at depths of less than 1.6 feet (Edwards and Twomey 1982). In warmer water, spawning may occur over a prolonged period of time, but spawning activity decreases or ceases if water temperatures are less than 64.4°F or greater than 78.8°F (Edwards and Twomey 1982).

Females lay eggs in groups of 500-600 eggs (Becker 1983). Fecundity is variable, depending on the age and size of the female. An Age-4 female may produce an average of 56,400 eggs, while an older, large 10-15 lb female may lay more than one million eggs. Eggs are demersal and adhesive, sticking to debris, plants, or sinking to the bottom. Eggs hatch after approximately 3-16 days, dependent on temperature; at 68°F, eggs will hatch in 3-5 days. After hatching, larvae attach to or lie near vegetation for the first two days. The yolk-sac is fully absorbed after 4-5 days. After approximately 18 days, larvae will move into deeper, but still vegetated waters, remaining there for the remainder of the summer. Young carp will leave the safety of the vegetated areas at a length of 76.2-101.6 mm (Becker 1983).

Emerald Shiner

Emerald shiner spawning generally occurs in late spring through mid-summer (Etnier and Starnes 1993). During that period, emerald shiner may spawn more than once (Etnier and Starnes 1993). Spawning behavior is triggered once water temperatures reach 72°F (Becker 1983). Emerald shiners are broadcast spawners. Large schools spawn at night over 7-20 feet of water, 1-2 feet from the surface. Individuals may spawn multiple times during the spawning season. Average fecundity has been estimated to be approximately 2,000 eggs. The demersal, non-adhesive eggs are typically laid over a gravel substrata and hatch between 24-36 hours (Becker 1983).

Larvae are approximately 4 mm long after hatching and reach 8.9 mm in 11 days (Becker 1983). After hatching, prolarvae remain near bottom for 72-96 hours. After 96 hours, larvae become free-swimming and begin to occur within the upper 6.6 feet of the water column in large schools (Becker 1983).

Freshwater Drum

Spawning occurs between May and late-June at water temperatures of 66-72°F in the Ohio River (Wallus and Simon 2006b). They are broadcast spawners and spawn in open water away from shore (Becker 1983). Fecundity of freshwater drum in Lake Erie was recorded to range between 43,000 to 508,000 eggs (Becker 1983). Eggs are 1.0 mm in diameter. Eggs are pelagic, floating near the water's surface, and hatch between 24-48 hours (Becker 1983). The vertical distribution of eggs in the water column is uniform during the day, but is denser towards the bottom at night (Wallus and Simon 2006b). Egg abundance peaks in the early summer (Wallus and Simon 2006b).

Larvae are approximately 3 mm long after hatching (Becker 1983). Larvae remain at the water's surface until they develop horizontal swimming abilities (Becker 1983). Horizontal swimming behavior begins six days after hatching at approximately 10 mm in length (Becker 1983; Wallus and Simon 2006b). Yolk-sac larvae are abundant near the surface during the day, while post yolk-sac larvae are more abundant near the surface at night. Once fish reach 25 mm, behavior is strictly benthic (Becker 1983).

Gizzard Shad

Spawning can begin in late-April or early-May, and last into early-August (Becker 1983). Gizzard shad typically spawn during the month of May in Ohio (ODNR 2018). Gonads begin to ripen when water temperatures reach 44.6°F to 50.0°F (Williamson and Nelson 1985). Spawning activity begins when water temperatures reach 59.9°F to 61.7°F, and peaks at 66.2°F to 69.8°F. The maximum spawning temperature recorded for gizzard shad is 80.6°F (Williamson and Nelson 1985). Spawning habitat includes sandy, rocky bars in 2-4 feet of water (Becker 1983). Spawning is random, occurs near the surface at night, and involves large schools (Becker 1983; Etnier and Starnes 2001).

Average fecundity is 300,000 eggs per female per year (Etnier and Starnes 2001). Eggs are demersal, adhesive, and 0.75 mm in diameter. Eggs hatch into 3.5 mm long larvae in 36 to 95 hours, in waters 80°F and 61°F, respectively (Becker 1983). After one day, larvae reach 4.5-5.0 mm (Williamson and Nelson 1985). The yolk-sac is absorbed in 2-3 days (Williamson and Nelson 1985). Three to 4 days after hatching, swimming behavior constitutes upward swimming and downward settling. Larvae are either negatively geotaxic, positively phototaxic, or both. They tend to occur closer to the surface until they reach approximately 4 weeks old, and then move into deeper waters. Larvae will occur closer to the surface in turbid waters (Williamson and Nelson 1985). Larvae are generally poor swimmers for several weeks after hatching until they reach approximately 25 mm (Becker 1983; Williamson and Nelson 1985).

Smallmouth Bass

Smallmouth bass spawning in Pennsylvania typically occurs from May through early June when water temperatures reach 60°F to 70°F (PFBC 2017). Males build nests, which typically range from 14 to 30 inches in diameter, in areas typically 3 to 4 feet deep (PFBC 2017). Nests are built along the shorelines of rivers and lakes, typically over gravel and rubble, but have also been found over sand and large rock substrata (Becker 1983). Multiple females will spawn over the same nest, adding 2,000 to 7,000 eggs per pound of body weight (PFBC 2017). The eggs are demersal, adhesive, and 1.2-2.5 mm in diameter (Scott and Crossman 1998). Hatching occurs after 9.5 days at 55°F to 2.25 days at 75°F (Becker 1983). The male protects the nest, and the young are typically protected for 2-9 days, but the male could guard the nest for as long as 28 days (Becker 1983).

Yolk-sac absorption occurs approximately 6-15 days after hatching, and coincides with the larvae leaving the nest (IDNR 2017). At the time of yolk sac absorption, larvae are approximately a half inch in length (IDNR 2017). Young smallmouth bass feed on midge larvae, daphnia, and other small crustaceans even prior to yolk-sac absorption (Becker 1983). By the time they reach 3 inches in length, juvenile smallmouth bass actively feed on crayfish, other bass fry, and almost any other suitably-sized life form that swims or floats (Becker 1983).

Poor reproductive success during spawning seasons is often correlated to flooding, which results in a rapid drop in water temperature and/or excessive siltation, or events involving low water levels (Becker 1983).

Smallmouth Buffalo

Smallmouth buffalo in Ohio spawn between April and May (ODNR 2018). Spawning occurs at water temperatures of 60-65°F (Becker 1983). This species sometimes ascend small streams to spawn. Spawning behavior appears to be attributed with rising waters during the spring, when marshes or low-lying meadows become flooded. Prior to spawning season, males tend to congregate over shoals 4-10 feet deep. Spawning will begin as females join, and will tend to spawn in 4-8 feet of water over inundated vegetation. They are random spawners, broadcasting eggs over the inundated vegetation (Becker 1983). They have also been reported to prefer spawning over rocks and gravel (Simon 1999).

Fecundity is known to range between 18,200 and 525,500 eggs (Becker 1983). Eggs are demersal and adhesive. Hatching occurs in 8-14 days, depending on water temperatures (Becker 1983). One study found eggs to complete hatching at 108 hours at 69.8°F (Wrenn and Grinstead 1971). Egg size averages 2.2 mm in diameter. Newly hatched larvae averaged 6.0 mm in total length (TL). Immediately post-hatch, larvae swim to the water's surface and then drift to the bottom where they laterally rest for 10-60 seconds. Yolk-sacs are fully absorbed in 3-5 days. Post yolk-sac larvae feed near the surface, and rest on the bottom in an upright position. After approximately two weeks of development, feeding behavior occurs at both the surface and bottom. Feeding behavior is primarily bottom-oriented by the fifth week of development (Wrenn and Grinstead 1971). However, Simon (1999) describes smallmouth buffalo larvae as benthic larvae, which hide within the interstitial spaces or stones. The juvenile stage occurs approximately 7-9 weeks after hatching, where fish are 17-32 mm in length (Wrenn and Grinstead 1971).

White Bass

White bass spawning occurs between late-April and May in Ohio (ODNR 2018). Spawning typically occurs when water temperature reach 54.5°F-79°F (Becker 1983). Spawning activity peaks between water temperatures of 62.4°F -72.7°F. White bass prefer to spawn in the running waters of tributary streams. They spawn at the surface, preferably over sand, gravel, rubble or rock substrate, but may also spawn over aquatic plants or debris. Spawning occurs during both day and night. Older fish spawn earlier in the spawning season, while the numbers of young fish spawning increase later in the season. White bass do not build nests or provide parental care to young (Becker 1983).

The average fecundity of white bass is 565,000 eggs (Becker 1983). The adhesive, demersal eggs are approximately 0.80 mm in diameter, and hatch between 41-45 hours. Larvae are approximately 2 mm long at hatching. Swimming behavior after hatching involves active swimming to the surface, followed by passive sinking to the bottom. Larvae swim to the surface once they touch bottom. Horizontal swimming behavior begins approximately four days after hatching. The yolk-sac is fully absorbed after eight days. Larvae between 4.2 mm to 8.5 mm long are planktonic and occur in nearshore waters 3-6 feet below the surface. Larvae longer than 8 mm occur in 6-13 feet of water and continue to move into deeper waters as they grow (Becker 1983).

4.6 Seasonal and Daily Activities

Regulatory requirement at §122.21(r)(4)(v): "Data representative of the seasonal and daily activities (e.g., feeding and water column migration) of biological organisms in the vicinity of the cooling water intake structure."

4.6.1 General Daily & Seasonal Activities

Bluegill

Bluegill prefers warm water in temperatures ranging between 85°F-88°F, and it can tolerate temperatures of up to 95°F (Mecozzi 2008). It prefers warm, shallow waters, and is attracted to areas of industrial discharges during the winter. During the spring, bluegill may move into slow flowing tributaries or channels that warm up faster than the main body of water (Mecozzi 2008). Bluegill will move into deeper waters during the summer to seek cooler temperatures, as well as during the winter to seek warmer water (Stuber et al. 1982). This species congregates into schools of 10 to 20 fish and may mix with other sunfish or minnows (Mecozzi 2008). Bluegill tends to remain in a small home range and does not migrate long distances. Bluegill of all life stages are opportunistic feeders, feeding on a diverse diet including algae, aquatic vegetation, zooplankton, insects, insect larvae, fish eggs, and occasionally minnows and small fish throughout the water column (Mecozzi 2008; Stuber et al. 1982). Feeding occurs primarily at dusk and dawn, but bluegill will feed throughout the day (Mecozzi 2008). Bluegill moves closer inshore at night, but will swim in open waters during the day. Bluegill is very intolerant of low dissolved oxygen levels (Mecozzi 2008).

Bluntnose Minnow

Bluntnose minnows occur in a variety of habitats in lakes, ponds, rivers, and creeks (Becker 1983). They most frequently occur in clear waters, but are common in slightly turbid to turbid waters. Their presence is often associated with submerged vegetation. They are primarily a bottom feeding fish, but will occasionally feed on surface insects and plankton. Their diet during the winter has been described to compose of diatoms and filamentous algae, while during the summer months they will feed on insect larvae and pupae. During the winter, bluntnose minnows will remain near the bottom, and then enter shoal areas after ice out. Recorded behavior shows that bluntnose minnow will occur in small schools in waters 2-4 m deep among aquatic plants, or will associate into larger schools with species such as mimic shiner in waters approximately one meter deep. Schools often consist of 10-20 bluntnose minnows (Becker 1983).

Channel Catfish

Channel catfish are native east of the Appalachian Mountains, but have been introduced throughout the Atlantic drainages and the 48 contiguous states (McMahon and Terrell 1982). All life stages of channel catfish concentrate in the warmest sections of rivers and reservoirs. They strongly seek cover, residing in cavities, boulders, and areas of debris in low velocity waters. Optimum habitats are considered deep pools and littoral areas less than 16 feet deep with more than 40% suitable cover, though cover may not be necessary in waters with high turbidity (McMahon and Terrell 1982). They prefer sand, gravel, or rubble bottoms, but will tolerate mud (Wellborn 1988).

During daytime hours, channel catfish typically reside in holes within submerged structure such as logs or boulders (Wellborn 1988). Adults have high site fidelity and tend to be sedentary, while juvenile behaviors include much more movement, especially at night when feeding (Wellborn 1988). Channel catfish are nocturnal foragers (Pool 2007); feeding primarily occurs at night just after sunset and just before sunrise. At night, channel catfish will leave their cover to feed along riffles, runs, tributaries, and shorelines (McMahon and Terrell 1982). They tend to be benthic feeders, utilizing external sensory organs on their body to sense prey (Wellborn 1988). Young catfish primarily feed on aquatic insects, while adults feed on insects, snails, crawfish, green algae, aquatic plants, seeds, and small fish. Fish are important for their diet once they reach 18 inches, and will constitute as much as 75% of their diet (Wellborn 1988). Young fish will move much more extensively than adults, who rarely move from one area to another (McMahon and Terrell 1982).

Common Carp

Common carp are native to Asia, but have been introduced to waters of every continent except Antarctica (Edwards and Twomey 1982). They prefer habitats that are relatively warm, have sluggish currents, and are well-vegetated over mud or silt substrates (Edwards and Twomey 1982) and are rarely reported below depths of 100 feet (Becker 1983). Carp are opportunistic feeders, utilizing any available food source such as littoral fauna, benthic fauna, worms, insect larvae, algae, and detritus (Edwards and Twomey 1982). They are extremely tolerant of turbidity, as long as it is not forage limiting. Growth is optimum between a pH of 6.8 and 7.5 and is reduced when pH is less than 6.0; pH levels less than 5.0 are harmful and a pH of greater than 10.5 is lethal. Adults are tolerant of low dissolved oxygen levels common in warm, fertile waters. When dissolved oxygen levels are less than 0.5 mg/l, adults can gulp surface air for respiration (Edwards and Twomey 1982). Carp do little feeding in water below 50°F, and none at 35.1°F to 40.1°F (Becker 1983). Increasing temperatures lead to increasing activity, including leaping out of the water. Carp may move extensive distances, and have migrated as far as 674 miles over 28 months (Becker 1983).

Emerald Shiner

Emerald shiners inhabit the mid and/or surface depths of large bodies of water (Becker 1983). They frequent open waters and do not require vegetation. They most commonly occur in clear water between 2-5 feet deep over sandy substrates. Emerald shiners tend to remain in the middle of the water column or near the bottom in clear water, during the day. Behavior is primarily pelagic. They occur near the surface at night during the summer to feed on midges and other small insects. Their preferred water temperature is approximately 77°F. During the spring, emerald shiners may travel into the warmer waters of tributaries, returning to the mainstem by mid-June (Becker 1983).

Freshwater Drum

Freshwater drum inhabit large rivers, lakes, and impoundments (Becker 1983). They prefer warm, sluggish, open water areas over muddy substrates. They are a schooling species. Freshwater drum rarely occur in shallow, vegetated areas. They prefer turbid waters, but may occur in clear waters. They are benthic feeders, and will feed during all times of the day (Becker 1983). Freshwater drum typically feed on benthic invertebrates such as cladocerans and mollusks (Hardisty 2007). Juvenile fish show some planktonic behavior, as their diet primarily consists of planktonic cladocerans. Adults 250+ mm may also turn to piscivorous behavior, feeding on small fish and fish eggs (Hardisty 2007).

Gizzard Shad

Gizzard shad occur in numerous water bodies. They are primarily a pelagic species, inhabiting waters at or near the surface, but have been collected at depths of up to 108 feet. Adults feed in both the limnetic zone and near the benthos. This is evidenced by the occurrence of both plankton and sand in their digestive system; the sand in the tract is believed to be used to aid in grinding food (Becker 1983).

Gizzard shad are most abundant over muddy substrates, particularly within protected bays and the mouths of tributaries (Miller 1960). Their abundance is greatest in the late summer/early fall due to the addition of juvenile fish, which prefer habitats close to shore in shallow waters. Young fish form compact schools after hatching, but dissipate by the fall (Miller 1960). Fish begin to move into deeper waters once temperatures reach less than 55.4°F in the fall (Williamson and Nelson 1985). During the winter, gizzard shad migrate into the deep portions of lakes, or may overwinter in sheltered coves with refugia provided by spring-fed streams (Williamson and Nelson 1985).

Gizzard shad behavior and abundance is affected by water temperatures. The preferred temperature range is from 71.6°F-84.2°F, with a maximum tolerance of 93.2°F and lethal threshold of 97.7°F (Williamson and Nelson 1985).Populations can be significantly affected by cold winters, resulting in high mortality rates, especially for YOY shad (Williamson and Nelson 1985). Mortality events typically occur when water temperatures fall below 38°F, primarily effecting juvenile fish. Older shad are susceptible to mortality when exposed to temperatures below 38°F for an extended period of time, or if water temperatures fall below 36°F. Warm winter water temperatures often correlate with increases in gizzard shad populations. Gizzard shad, especially juveniles, are extremely sensitive to sudden changes in water temperature. Even when temperatures are moderate, sudden changes, even if only by a few degrees, can disrupt equilibrium and swimming capabilities. Loss of equilibrium or mortality occurs from sudden rises or drops in temperature. They congregate near the warm waters of industrial discharges (Miller 1960). However, issues arise if the discharge stops, as the sudden change in water temperature can disrupt equilibrium and/or result in mortality events.

Populations may be most dense in areas of high turbidity (Williamson and Nelson 1985). Higher catch rates were observed within a turbid portion of Lake Erie, Sandusky Bay, than areas of low turbidity within Lake Erie. However, individual shad collected from more turbid waters were smaller and spawned earlier than those of clear waters. Distribution is also influenced by dissolved oxygen levels. Gizzard shad are absent from waters with dissolved oxygen levels $\leq$ 2 mg/l and occur only above the thermocline during the summer months (Williamson and Nelson 1985).

<u>Smallmouth Bass</u>

Smallmouth bass have been extensively introduced throughout North America (Becker 1983). Smallmouth bass are native to the Great Lakes and Ohio River watersheds, but were stocked throughout the United States due to their popularity as a sport-fish (PFBC 2017). Smallmouth bass occur over rocky habitats of medium to large streams where water temperatures range from 60°F to 80°F in the summer. Preferred stream habitat includes pools, pocket water, and deep, moving waters (PFBC 2017). They tend to avoid aquatic vegetation, due to the likelihood of competition with or predation by largemouth bass (Becker 1983). Smallmouth bass are non-migratory, and rarely demonstrate schooling behavior (Becker 1983). Site fidelity is high, and annual movement is estimated to be limited to less than 5 miles (Scott and Crossman 1998). During the day, smallmouth bass occur in pools, undercut banks, or deep waters, but swim openly during dusk and dawn and actively feed near the shore (Becker 1983). Nighttime behavior includes lying on the bottom, but they may be more active during moonlit nights.

When water temperatures reach below 50°F, the bass become lethargic and retreat to deeper waters. At this time, they are semi-dormant, and demonstrate limited feeding behavior (Becker 1983). When juvenile smallmouth bass are exposed to water temperatures below 41°F for seven or more days, survival becomes impaired (Horning II and Pearson 1973).They will also retreat to deeper, cooler waters during the summer when water temperatures are high (Scott and Crossman 1998); mortality occurs at temperatures above 96.8°F (Mundahl 1990). During the summer, juvenile smallmouth bass occur in waters slightly warmer than the preference of adult bass (Lower Columbia Fish Recovery Board 2004).

Smallmouth bass prefer waters with pH values greater than 6.3 (Johnson et al. 1977). Reproduction is limited or absent where the pH falls between 5.5 and 6.0, and densities are impacted when values are less than 5.5 (Kane and Rabeni 1987). In acidified waters, juvenile smallmouth bass are prone to slower growth rates and over wintering mortality (McCormick and Leino 1999).

Smallmouth bass generally prefer clear water with Secchi depths greater than 10 feet (Johnson et al. 1977). They prefer water with nephelometric turbidity unit (NTU) readings of 1.6 or less. Smallmouth bass are somewhat intolerant of waters having NTU readings between 1.6 and 4.0 (Whittier and Hughes 1998).

Smallmouth bass dissolved oxygen preferences range from 2.9 to 6.5 mg/L (Johnson et al. 1977). The early life stages of smallmouth bass are most susceptible to low dissolved oxygen levels. Survival of swim-up fry may decrease by 20% if dissolved oxygen levels are around 4 mg/L, and almost all the swim-up fry die within one week of exposure to waters with 2.5 mg/L dissolved oxygen (Siefert et al. 1974).

Smallmouth bass forage on fish, crayfish, and aquatic insects. Fish forage includes various cyprinids, perch, and sunfish (Becker 1983). Smallmouth bass diets are typically 40% fish, 30% crayfish, and 20% insects (IDNR 2017). When crayfish are abundant, they can constitute up to 66% of smallmouth bass diets. Small fish and insects become the bulk of their diets once they reach 1.5 inches in length (IDNR 2017).

Smallmouth Buffalo

Smallmouth buffalo inhabits pools, oxbow lakes, and deep waters of large rivers (Becker 1983). This benthic species tends to be associated with muddy or sandy bottoms. Younger individuals school over mud bottoms in relatively shallow waters (Becker 1983). It is common in clear waters with a modest current, and tends to be most productive in habitats with abundant aquatic vegetation and silty benthos (Dalquest and Peters 1966; Lee 1980).

Smallmouth buffalo is an opportunistic feeder, foraging on whatever organisms are most abundant (Becker 1983). Diet varies depending on forage availability. Smallmouth buffalo in an Arizona waterbody fed primarily on diatoms in November through February; cladocerans, copepods, and green algae in March and April; clams in May and June; and blue-green algae from July through October. In the Missouri River, smallmouth buffalo preferred zooplankton and attached algae. This species is not believed to exhibit any seasonal migration. Movements may be correlated with populating habitats that presently have low smallmouth buffalo populations. The maximum temperature tolerance of smallmouth buffalo is approximately 92.5 °F (Becker 1983).

White Bass

White bass occur in open, clear to turbid waters (Becker 1983). They are most abundant in waters less than six meters deep and prefer sandy or muddy substrates (Becker 1983). They are opportunistic feeders and form large schools at the surface to search for prey (Hamilton and Nelson 1984).White bass occurrence is not habitat driven, but driven by forage availability. Diet varies seasonally due to prey availability and current life stage. Juveniles less than 38 mm long commonly feed on macroinvertebrates, while larger white bass are piscivorous, preferring clupeids as prey. Adult diets will shift to macroinvertebrates or zooplankton if there is a lack of forage fish. Production is highest in areas of large clupeid populations (Hamilton and Nelson 1984).

White bass activity peaks, from the early spring to the fall, at the surface during the early morning and late afternoon (Becker 1983). They can often be found near floating vegetation or other emergent structures with little movement at night. Older bass occur primarily in the pelagic zone, while younger bass will be found in the littoral zone. Young white bass prefer sandy beaches. White bass occur near the bottom during the winter, but are primarily found near the surface during the summer. White bass also appear to have a strong homing tendency to a specific spawning ground (Becker 1983).

4.6.2 SEASONAL FISHERIES DATA

Fisheries sampling in the vicinity of Beaver Valley has been conducted since 1970 (FENOC 2017). Each sampling year comprised of a spring, summer, winter, and fall samples. Seasonal results from the previous four years of sampling (2016, 2015, 2014, and 2013) and provided below in Table 4-11. No distinct seasonal peaks appear to occur from 2013 through 2016 sampling for any species. However, data indicates that species such as bluegill, gizzard shad, golden redhorse, longnose gar, smallmouth bass, and smallmouth buffalo are commonly occurring species found near Beaver Valley year-round (FENOC 2017).

Table 4-11: Seasonal Results from Fisheries Sampling Conducted near Beaver Valley

Species	Spring	Summer	Fall	Winter
2013				
Black crappie	1	-	-	-
Bluegill	1	1	2	1
Channel catfish	-	-	1	1
Flathead catfish	-	-	1	-
Freshwater drum	-	-	1	1
Gizzard shad	1	1	1	-
Golden redhorse	8	3	2	6
Longnose gar	2	-	1	-
Pumpkinseed	1	-	-	-
Quillback	2	-	-	-
River carpsucker	2	-	1	-
Rock bass	1	-	-	3
Sauger	-	1	-	-
Shorthead redhorse	10	-	-	7
Smallmouth bass	7	2	1	2
Smallmouth buffalo	1	3	-	-
Spotted bass	2	-	1	-
Walleye	-	-	1	-
Yellow perch	-	-	-	1
Total	**39**	**11**	**13**	**22**
2014				
Bluegill	-	-	-	1
Channel catfish	2	-	-	-
Common carp	2	1	4	6
Freshwater drum	2	-	-	-
Gizzard shad	12	14	26	13
Golden redhorse	3	-	-	4
Largemouth bass	-	-	1	-
Longnose gar	4	1	-	4
River carpsucker	1	-	-	-
Shorthead redhorse	4	3	2	1
Smallmouth bass	4	1	-	1
Smallmouth buffalo	3	6	-	4
Spotted bass	2	-	-	-
Walleye	5	-	-	-
Yellow perch	-	-	1	-
Total	44	26	34	34
2015				
Bluegill	-	-	1	-
Channel catfish	-	-	-	1
Common carp	1	-	-	-
Flathead catfish	1	1	-	-
Freshwater drum	3	-	-	1
Gizzard shad	-	9	286	60
Goldfish	1	-	-	-

Species	Spring	Summer	Fall	Winter
Golden redhorse	7	-	-	-
Longnose gar	6	2	2	1
Pumpkinseed	-	1	2	-
Quillback	1	-	-	-
Rock bass	1	-	-	-
Shorthead redhorse	2	-	-	1
Smallmouth bass	3	1	-	2
Smallmouth buffalo	2	1	-	17
Spotted bass	1	-	-	-
Walleye	1	-	-	-
Total	30	15	291	83
2016				
Black crappie	-	-	-	1
Bluegill	2	-	1	-
Channel catfish	-	-	1	-
Common carp	1	1	-	14
Freshwater drum	1	-	-	3
Gizzard shad	10	-	21	5
Golden redhorse	2	-	2	5
Largemouth bass	-	-	-	2
Longnose gar	-	2	4	2
Pumpkinseed	1	-	-	1
Quillback	-	-	1	1
Sauger	-	1	-	2
Shorthead redhorse	5	-	-	3
Silver redhorse	-	-	-	3
Smallmouth bass	1	1	2	4
Smallmouth buffalo	1	8	4	13
Spotted bass	-	-	-	1
Walleye	1	-	-	-
Yellow perch	-	-	-	4
Total	25	13	36	64

Source: FENOC (2017)

Monthly impingement at the NOVA/AES demonstrated peak impingement occurring during July and August, as a result of gizzard shad impingement (ENSR 2008).

Table 4-12: Monthly Impingement at NOVA/AES (2006 - 2007)

Species	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Gizzard shad	-	8	129	8	3	-	9	10,941	36,393	260	37
Freshwater drum	-	1	-	-	2	-	2	35	147	7	3
White bass	-	-	-	2	3	-	5	173	1	-	-
Bluegill	-	1	-	1	2	-	-	-	6	1	3
Channel catfish	-	1	-	-	2	1	-	2	2	3	1
Sauger	-	1	2	3	-	-	-	-	-	-	1
White crappie	-	-	-	1	3	-	-	-	2	-	-
Quillback	-	-	-	-	-	1	-	-	2	-	-
Common carp	-	-	-	-	-	-	2	-	-	-	-
Emerald shiner	-	-	-	-	-	-	-	1	1	-	-
Flathead catfish	-	-	-	1	-	-	-	-	-	-	1

Species	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Striped bass	-	-	-	-	-	-	-	-	-	1	-
Black Crappie	-	-	-	-	-	-	-	-	-	-	1
Largemouth bass	-	-	-	1	-	-	-	-	-	-	-
Mimic shiner	-	-	-	-	-	-	1	-	-	-	-
Rainbow smelt	-	-	-	-	1	-	-	-	-	-	-
Silver chub	-	-	-	-	-	-	-	-	1	-	-
Silver redhorse	-	-	-	-	-	-	1	-	-	-	-
Silver shiner	-	-	-	1	-	-	-	-	-	-	-
Smallmouth bass	-	1	-	-	-	-	-	-	-	-	-
Total	-	113	131	18	16	2	20	11,153	36,555	272	47

Source: ENSR (2008)

Monthly data from the 2005-2006 impingement sampling at Sammis indicate peak impingement occurring in September and November; comprising of 40.8% and 31.0% of the annual impingement, respectively (Kinectrics 2007). Large impingement events of 100,000 or more fish were the result of gizzard shad impingement. Disregarding gizzard shad impingement, impingement for other species peaked in March (26.9%), July (18.7%), and January (10.6%). Peak impingement in March, disregarding gizzard shad, was primarily freshwater drum and sauger. High impingement events in July were mostly white perch. High impingement events in January were influenced by freshwater drum.

Table 4-13: Estimated Monthly Impingement at Sammis (July 2005 – June 2006)

Common Name	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
Gizzard shad	41,715	323,963	1,708,819	56,366	1,295,907	404,886	151,148	83,865	44,872	8,265	18	201	4,120,025
Freshwater drum	296	1,588	1,294	112	-	2,013	7,585	5,775	12,198	165	60	-	31,086
White perch	12,797	2,374	-	21	-	660	-	158	741	-	-	-	16,751
White bass	758	1,187	2,087	213	2,097	181	84	266	87	925	915	5,167	13,967
Sauger	141	-	-	-	-	841	305	-	6,103	-	86	300	7,776
Bluegill	-	74	-	-	-	841	-	-	206	13	-	-	1,134
Largemouth bass	-	-	99	-	674	330	-	-	-	-	-	-	1,103
Channel catfish	43	221	211	-	-	-	-	-	-	-	-	234	709
Walleye	-	-	-	-	-	-	-	-	436	-	-	282	718
Black crappie	-	-	-	-	-	330	-	-	-	-	-	-	330
Quillback	-	-	-	-	-	-	-	158	109	-	60	-	327
Silver chub	-	-	-	-	-	-	-	-	196	-	-	-	196
Logperch	25	-	-	-	-	-	-	-	-	89	-	-	114
Shorthead redhorse	-	-	-	-	-	-	-	-	-	13	-	146	159
Golden shiner	-	-	-	-	-	-	-	33	-	-	-	112	145
Emerald shiner	-	74	57	-	-	-	-	-	-	-	-	-	131
Mooneye	-	74	-	-	-	-	-	33	-	-	-	-	107
Yellow perch	-	-	-	-	-	-	-	-	97	-	-	-	97
Smallmouth bass	-	82	-	-	-	-	-	-	-	-	-	-	82
Northern hogsucker	-	74	-	-	-	-	-	-	-	-	-	-	74
Skipjack herring	-	-	46	-	-	-	-	-	-	-	-	-	46
Flathead catfish	-	-	-	13	-	-	-	-	-	-	-	-	13
White crappie	-	-	-	-	-	-	-	-	-	13	-	-	13
Total	55,775	329,711	1,712,613	56,725	1,298,678	410,082	159,122	90,288	65,045	9,483	1,139	6,442	4,195,103
Monthly Composition	1.3%	7.9%	40.8%	1.4%	31.0%	9.8%	3.8%	2.2%	1.6%	0.2%	0.0%	0.2%	

Source: Kinectrics (2007)

40 CFR §122.21(r)(2-8) NPDES APPLICATION REQUIREMENTS FOR FACILITIES WITH COOLING WATER INTAKE STRUCTURES

FirstEnergy provided ichthyoplankton data collected from the main channel of the Ohio River adjacent to the Beaver Valley intake. These studies were from 1980 through 1992; no studies were conducted in 1986 (FirstEnergy 2007). Data were collected at five stations from a designated transect in the Ohio River near Beaver Valley. Samples were collected via a 0.5-meter plankton net. Data provided did not include sampling details such as mesh size of the plankton net, depths sampled, etc. Taxa collected were identified as eggs, larvae, juveniles, and adult specimens. However, it is important to note that the collection of adult emerald shiner would not be representative of actual entrainment, as they are too large to pass through the traveling water screens at Beaver Valley; this is also likely the case with some juvenile specimens as well. Sampling was conducted once per month from April through July from 1980 to 1985, and then extended to include the month of August from 1987 to 1992. The peak density occurred primarily in July and averaged 98.1 organisms/100 cubic meters (m^3). Peak annual densities occurred during June in 1988, 1990, and 1992, and once in April in 1982. With the exception of 1982, where April collections were dominated by a large catch of adult emerald shiners, April typically had the lowest density of entrained ichthyoplankton during the study. Data from 1987 through 1992 shows a significant drop off in collections during August, with an average density of 12.9 organisms/100 m^3 (FirstEnergy 2007).

Seasonal and diel ichthyoplankton data from Beaver Valley are available (FirstEnergy 2007). Data collected between 1980 and 1992 indicate densities of entrainable organisms in the New Cumberland Pool of the Ohio River peaks in July, followed by June. The average density of entrainable organisms in July was 98.08 organisms per $100m^3$, which is approximately double the 43.96 organisms per $100m^3$ average for June. The most dominant data collected during July samples were gizzard shad larvae (34.4%), followed by freshwater drum eggs (25.2%), Cyprinidae sp. larvae (14.3%), and shiner sp. larvae (11.8%). Dominant taxa in June included gizzard shad larvae (51.4%), common carp larvae (12.4%), shiner sp. larvae (9.4%), and freshwater drum eggs (6.0%; FirstEnergy 2007).

Entrainment in April is limited, and typically involves members of the Percidae family (FirstEnergy 2007). While the average density of April is 11.77 entrainable organisms per $100m^3$, this is largely a product of a single large collection of adult, emerald shiner. Removal of that outlier resulted in an average density of 0.27 entrainable organisms per $100m^3$ (FirstEnergy 2007). Monthly entrainment characterization data are provided in Table 4-14.

Diel data indicated the average density for all entrainable lifestages was generally higher at night (FirstEnergy 2007). Data between 1987 and 1992 collected day and night samples in the months of May and July. The overall daytime density of entrainable organisms was approximately one-third of the overall average nighttime density (FirstEnergy 2007). Lifestage diel periodicity data are provided in Table 4-15.

Table 4-14: Ichthyoplankton Density (Organisms/100m³) in the New Cumberland Pool by Month

Taxa	Lifestage	1980	1981	1982	1983	1984	1985	1987	1988	1989	1990	1991	1992	Average
April														
Percidae	Egg	0	0	0	0.81	0	0	0	0	0	0	0	0	0.07
Unidentified	Egg	0.25	0	0	0	0.32	0	0	0	0	0	0	0	0.05
Pike-perch sp.	Larvae	0	0	0	0	0	0	0	0.18	0	0	0.98	0.22	0.12
Unidentified	Larvae	0	0	0	0	0	0	0	0	0	0	0	0.22	0.02
Emerald shiner	Adult	0	0	0	137.97	0	0	0	0	0.29	0	0	0	0.03
Total		0.25	0	0	138.78	0.32	0	0	0.18	0.29	0	0.98	0.44	11.77
May														
Common carp	Egg	0	0	0	0	0	0	0.26	0	0	0	0	0	0.02
Cyprinidae sp.	Egg	0	0	2.67	0	0	0	0	0	0	0	0	0	0.22
Freshwater drum	Egg	0	0	0	0	0	0	3.19	0	0	0	6.49	26.58	3.02
Temperate Bass sp.	Egg	0	0	0	0	0	0	0	0	0.09	0	0	4.06	0.35
Unidentified	Egg	0.22	0	0	0	0.17	8.73	1.98	0	0.34	0	6.41	2.19	1.67
Common carp	Larvae	0	0	0.49	0	0	0.36	13.11	0	0	0.69	3.74	0.24	1.55
Crappie sp.	Larvae	0	0	0	0	0	0	0.43	0	0.34	0	0	0.08	0.07
Cyprinidae sp.	Larvae	0	0	1.46	0	0	0.18	0	0	0.09	0	5.57	0.49	0.65
Etheostoma sp.	Larvae	0	0	0	0	0	1.07	0.51	0	0.6	0.93	0.5	0	0.30
Freshwater drum	Larvae	0	0	0	0	0	0	0.17	0	0	0	0.41	0	0.05
Gizzard shad	Larvae	0	0	0.48	0	0	5.34	7.94	0	0	0.23	1.92	34.78	4.22
Golden shiner	Larvae	0	0	0	0	0	0	0.43	0	0	0	0	0	0.04
Percidae	Larvae	0	0	0	0	0	0	0.69	0	0	0	0	0.32	0.08
Pike-perch sp.	Larvae	0.45	0.25	0	0.18	0	0	0.09	1.12	1.2	0.46	0	0.16	0.33
Shiner sp.	Larvae	0	0	0	0	0	0	1.81	0	0	0	0	2.03	0.32
Sucker sp.	Larvae	0.67	0	0	0	0	0	0.09	0.09	0.6	0.54	0.08	0.24	0.19
Unidentified	Larvae	0	0	0.24	0	0	0	0.09	0	0	0	0	0	0.03
White bass	Larvae	0	0	0	0	0	0	2.59	0	0.26	0.08	0.17	11.7	1.23
Yellow perch	Larvae	0.89	0.5	0.24	0	0	0	1.04	0	0	1.16	0	0.16	0.33
Bluntnose minnow	Adult	0	0	0	0	0	0	0	0.17	0	0	0	0	0.01
Emerald shiner	Adult	0.67	0	0	0.54	0	0	0.09	0	0	0	0	0	0.11
Johnny darter	Adult	0	0	0	0	0	0	0.09	0	0	0	0	0	0.01
Sand shiner	Adult	0	0	0	0	0	0	0.09	0	0	0	0	0	0.01
Total		2.9	0.75	5.58	0.72	0.17	15.68	34.69	1.38	3.52	4.09	25.29	83.03	14.82

Taxa	Lifestage	1980	1981	1982	1983	1984	1985	1987	1988	1989	1990	1991	1992	Average
June														
Common carp	Egg	0	0.23	0	0	0	0	0	0	0	0	0	0	0.02
Cyprinidae sp.	Egg	0.21	0	11.52	3.22	3.4	0	0	0	0	0	0	0	1.53
Freshwater drum	Egg	0	4.08	0	0.86	0	2.23	0.97	8.11	0	0	0.46	14.75	2.62
Unidentified	Egg	11.47	6.12	0	0	0.16	0	0.19	2.08	1.41	0	0	9.39	2.57
Common carp	Larvae	0	0	0	3.87	0	3.56	2.53	5.47	7.64	42.07	0	0.5	5.47
Cyprinidae sp.	Larvae	4.04	17.69	1.99	3.22	0	0	0	0	0.28	0.48	0	2.01	2.48
Etheostoma sp.	Larvae	0	0	0	0	0	0	0.19	0.19	3.39	0.32	0	0	0.34
Freshwater drum	Larvae	0	0	0	0	0	1.93	6.04	5.47	0	0.48	0.23	5.37	1.63
Gizzard shad	Larvae	0.64	3.86	0	1.93	0	12.32	14.8	57.72	2.26	11.84	5.96	159.62	22.58
Percidae sp.	Larvae	0	0	0	0	0	0	0	0	0	0	0	0.17	0.01
Pimephales sp.	Larvae	0	0	0	0.21	0	0	0	0	0	0.48	0	0	0.06
Shiner sp.	Larvae	0	0	0	0.21	0.65	6.54	30.97	9.62	0	1.28	0.46	0	4.14
Smallmouth bass	Larvae	0	0	0	0	0	0	0	0	0.57	0	0	0	0.05
Sunfish sp.	Larvae	0.21	0	0	0	0	0	0	0	0	0	0	0	0.02
Unidentified	Larvae	0	0	0.2	0	0	0.59	0	0	0	0	0	0	0.07
White crappie	Larvae	0	0.23	0	0	0	0	0	0	0	0	0	0	0.02
Yellow perch	Larvae	0	2.72	0	0	0	0	0	0	0	0	0	0	0.23
Freshwater drum	Juvenile	0	0	0	0	0	0	0	0	0	0	0.46	0	0.04
Gizzard shad	Juvenile	0	0	0	0	0	0	0	0	0	0	0.46	0	0.04
Emerald shiner	Adult	0	0.68	0	0	0	0	0	0	0	0	0	0	0.06
Total		**16.57**	**35.61**	**13.71**	**13.52**	**4.21**	**27.17**	**55.69**	**88.66**	**15.55**	**56.95**	**8.03**	**191.81**	**43.96**
July														
Cyprinidae sp.	Egg	1.37	0.63	0.22	2.39	0	0	0	0	0	0	0	0	0.38
Freshwater drum	Egg	0	0	0	1.11	2	0	7.87	0	232.5	0	1.36	52.17	24.75
Unidentified	Egg	0	0	0	0	0	0	1.09	1.05	7.89	0.08	7.61	0.99	1.56
Banded killifish	Larvae	0.59	0	0	0	0	0	0	0	0	0	0	0	0.05
Common carp	Larvae	0	0	0	0	0	0	0.62	0.24	11.55	1.16	0	0.66	1.19
Crapple sp.	Larvae	0	0	0	0	0	0	0.62	0	0.08	0	0	0.58	0.11
Cyprinidae sp.	Larvae	84.15	34.68	28.04	0	2.5	1.13	0	0	2.6	15.72	0	0	14.07
Emerald shiner	Larvae	0	0	0	0	0	0	0	0	1.14	0.93	0	0	0.17
Etheostoma sp.	Larvae	0	0	0	0	0	3.01	0.08	0	0.57	0.23	0	0.16	0.34
Freshwater drum	Larvae	0	0	0.87	0.92	0.25	6.03	4.13	0	46.19	0	0	9.76	5.68
Gizzard shad	Larvae	7.65	0.84	0	10.32	7.25	206.14	1.4	0.73	135.82	0.31	0	34.72	33.77
Ictalurus sp.	Larvae	0	0	0	0	1	0	0	0	0	0	0	0	0.08

Taxa	Lifestage	1980	1981	1982	1983	1984	1985	1987	1988	1989	1990	1991	1992	Average
Percidae	Larvae	0	0	0	0	0.25	0	0	0	0	0.39	0	0	0.05
Pimephales sp.	Larvae	0	0	0	0	0.25	2.45	0.16	0	5.77	1.01	0.11	0	0.81
Shiner sp.	Larvae	0	0	0	23.02	2.5	16.76	55.67	0.08	40.26	0	0	0.08	11.53
Sunfish sp.	Larvae	0.78	1.67	0	0	0.5	1.13	0.16	0.08	0	0.54	0.34	0.25	0.45
Yellow perch	Larvae	0.59	0	0	0	0	0	0	0	0	0	0	0	0.05
White bass	Larvae	0	0	0	0	0	0	0	0	0.24	0	0	0	0.02
Unidentified	Larvae	0	0	0	0.18	0	0	2.18	0	1.55	0	0	0	0.33
Freshwater drum	Juvenile	0	0	0	0	0	0	0	0.16	0	0	0	0	0.01
Common carp	Juvenile	0	0	0	0	0.25	0	0	0	0	0	0	0	0.02
Emerald shiner	Juvenile	0	0	0	0	0	0.19	0	1.13	0	0.15	0	0	0.12
Shiner sp.	Juvenile	0	0	0	0	0	0	0	0	0	0	0.68	0	0.06
Sand shiner	Juvenile	0	0	0	0	0	0	0	0.32	0	0	0	0	0.03
Darter sp.	Juvenile	0	0	0	0.18	0	0	0	0	0	0	0	0	0.02
Gizzard shad	Juvenile	0	0	0	0	5.26	0.19	0.08	22.01	0	0.08	0.23	0.16	2.33
Pimephales sp.	Juvenile	0	0	0	0	0	0	0	0	0	0.08	0	0	0.01
Percina sp.	Juvenile	0	0	0	0	0	0	0	0	0	0	0.11	0	0.01
Bluntnose minnow	Juvenile	0	0	0	0.18	0	0	0	0	0	0	0	0	0.02
Redhorse sp.	Juvenile	0	0	0	0	0	0	0.08	0	0	0	0	0	0.01
Sunfish sp.	Juvenile	0	0	0	0	0	0	0.08	0.16	0	0	0	0	0.02
White catfish	Juvenile	0.2	0	0	0	0	0	0	0	0	0	0	0	0.02
Emerald shiner	Adult	0	0	0	0	0	0	0.23	0	0	0	0	0	0.02
Logperch	Adult	0	0	0	0	0	0	0	0	0	0	0.11	0	0.01
Total		95.33	37.82	29.13	38.3	22.01	237.03	74.45	25.96	486.16	20.68	10.55	99.53	98.08
August														
Freshwater drum	Egg		-	-	-	-	-	0	7.03	8.29	0	3.87	1.6	3.47
Unidentified	Egg		-	-	-	-	-	0	0	0.17	0	0	0	0.03
Common carp	Larvae		-	-	-	-	-	0.32	0	0	0.15	0	0	0.08
Crappie sp.	Larvae		-	-	-	-	-	0.32	0	0	0	0	0	0.05
Cyprinidae sp.	Larvae		-	-	-	-	-	0	0	0	0.91	0	0.8	0.29
Emerald shiner	Larvae		-	-	-	-	-	0	0	2.54	8.06	0	0	1.77
Etheostoma sp.	Larvae		-	-	-	-	-	0	0	0	0	0	0.16	0.03
Freshwater drum	Larvae							0.32	0.19	1.86	0.46	0	0.96	0.63
Gizzard shad	Larvae		-	-	-	-	-	1.61	0	0.17	0	0	0	0.30
Pimephales sp.	Larvae		-	-	-	-	-	0	0	0.68	6.08	0	0	1.13
Shiner sp.	Larvae		-	-	-	-	-	7.08	0	0	22.96	0	0	5.01

Taxa	Lifestage	1980	1981	1982	1983	1984	1985	1987	1988	1989	1990	1991	1992	Average
Unidentified	Larvae		-	-	-	-	-	0.16	0	0	0	0	0	0.03
Emerald shiner	Juvenile		-	-	-	-	-	0.48	0	0	0	0	0	0.08
Channel catfish	Juvenile		-	-	-	-	-	0.32	0	0	0	0	0	0.05
Total			-	-	-	-	-	10.61	7.22	13.71	38.62	3.87	3.52	12.93

Source: FirstEnergy (2007)

Table 4-15: Diel Periodicity of Ichthyoplankton Densities (Organisms/100m^3) in the New Cumberland Pool (May and July 1987-1992)

Year	Month	Period	Volume	Eggs		Larvae		Juvenile		Adults		Total	
				N	Density	N	Density	N	Density	N	Density	N	Density
1987	May	Day	592.8	12	2.02	108	18.22	0	0	0	0.00	120	20.24
		Night	566.4	51	9.00	228	40.25	0	0	3	0.53	282	49.79
	July	Day	670.6	8	1.19	708	105.58	0	0	0	0.00	716	106.77
		Night	612	107	17.48	126	20.59	3	0.49	3	0.49	239	39.05
1988	May	Day	598.4	0	0.00	1	0.17	0	0.00	0	0	1	0.17
		Night	572.2	0	0.00	13	2.27	0	0.00	2	0.35	15	2.62
	July	Day	564.3	0	0.00	3	0.53	2	0.35	0	0	5	0.89
		Night	675.8	13	1.92	11	1.63	293	43.36	0	0	317	46.91
1989	May	Day	592.5	2	0.34	14	2.36	0	0	0	0	16	2.70
		Night	575.6	3	0.52	22	3.82	0	0	0	0	25	4.34
	July	Day	643.8	72	11.18	1,407	218.55	0	0	0	0	1479	229.73
		Night	585.8	2,884	492.32	1,615	275.69	0	0	0	0	4499	768.01
1990	May	Day	633.1	0	0.00	2	0.32	0	0	0	0	2	0.32
		Night	659.1	0	0.00	51	7.74	0	0	0	0	51	7.74
	July	Day	621.5	1	0.16	116	18.66	0	0	0	0	117	18.83
		Night	669.2	0	0.00	146	21.82	3	0.45	0	0	149	22.27
1991	May	Day	597.2	50	8.37	31	5.19	0	0	0	0	81	13.56
		Night	604.4	105	17.37	118	19.52	0	0	0	0	223	36.90
	July	Day	458.4	11	2.40	4	0.87	0	0	0	0	15	3.27
		Night	421.6	68	16.13	0	0.00	9	2.13	1	0.24	78	18.50
1992	May	Day	604.6	30	4.96	215	35.56	0	0	0	0	245	40.52
		Night	625.9	374	59.75	403	64.39	0	0	0	0	777	124.14
	July	Day	606.7	12	1.98	77	12.69	0	0	0	0	89	14.67
		Night	602.7	631	104.70	482	79.97	2	0.33	0	0	1115	185.00

Year	Month	Period	Volume	Eggs		Larvae		Juvenile		Adults		Total	
				N	Density	N	Density	N	Density	N	Density	N	Density
May Average: Day				16	2.62	62	10.3	0	0	0	0	78	12.92
May Average: Night				89	14.44	139	23	0	0	1	0.15	229	37.59
July Average: Day				17	2.82	386	59.48	0	0.06	0	0	404	62.36
July Average: Night				617	105.43	397	66.62	52	7.79	1	0.12	1,066	179.96
Overall Average: Day				17	2.72	224	34.89	0	0.03	0	0	241	37.64
Overall Average: Night				353	59.93	268	44.81	26	3.9	1	0.13	648	108.77

Source: FirstEnergy (2007)

The most recent entrainment characterization study conducted at Sammis demonstrated temporal, diel, and spatial variability of ichthyoplankton collected in the area of influence at Sammis (EPRI 2017). Ichthyoplankton were first collected on April 27, 2015 and April 26, 2016. Ichthyoplankton were last collected on September 15, 2015 and during the final 2016 sample on August 29. 2015 sampling demonstrated generally low ichthyoplankton densities, with a peak during mid-May. This peak was the result of a large catch of Ictiobinae sp. larvae. Entrainment densities in 2016 were generally similar to those in 2015, but lacked the large peak in density that occurred in mid-May, 2015. Peak collections in 2016 were smaller in magnitude, but still demonstrated distinct peaks. Ictiobinae sp. and logperch type accounted for the peak in May, gizzard shad accounted for the peaks in June, and gizzard shad, *Pimephales* type, and Cyprinidae sp. accounted for the peak in early August.

In 2015, differences in diel densities were generally small, with the exception of large nighttime collections in the mid and late May samples, which demonstrated significantly higher densities at nighttime (EPRI 2017). Generally, nighttime densities were higher than daytime ichthyoplankton densities in 2015. In regards to taxa specific diel periodicity, Ictiobinae sp. were approximately 30 times more abundant at night than during the day; Cyprinidae sp. were 13 times more abundant at night, and freshwater drum were approximately three times more abundant at night. Remaining taxa did not demonstrate any significant diel variability in 2015. Nighttime densities were typically higher than daytime densities during 2016 sampling. Two events resulted in higher daytime densities, which occurred in early June and late August. Approximately 61% of ichthyoplankton were collected at night in 2016. Ictiobinae sp. were approximately five times more abundant at night, and most other common taxa were also more abundant at night, though differences were much less pronounced. However, logperch type was the only common taxa collected at higher densities during the day (EPRI 2017).

Daytime samples in 2015 were primarily collected at mid-depth, followed by near bottom samples. The highest density only occurred at the surface during the mid-July sampling event. These differences indicate that stratification occurred in the Ohio River to some extent during the day. Generally, nighttime collections in 2015 demonstrated no consistent spatial patterns of ichthyoplankton occurrence. The large ichthyoplankton collection of Ictiobinae sp. larvae during the mid-May sample demonstrated noticeably more abundant higher in the water column with densities of 76.3, 44.5, and 21.1/10m^3 for near-surface, mid-depth, and near-bottom samples, respectively at night.

In 2016, stratification of ichthyoplankton was evident in multiple daytime samples. Some events demonstrated near-bottom densities were to three to 21 times higher than mid-depth or near-surface densities, while others demonstrated substantially higher densities in mid-depth and/or near-surface samples than in near-bottom samples. There was no consistent pattern of stratified densities among events during the daytime. At night, higher densities were found in near-surface and mid-depth samples during early to mid-May, but the highest densities were consistently found at mid-depth and/or near-bottom in late May through August samples.

4.7 THREATENED, ENDANGERED, AND OTHER PROTECTED SPECIES

Regulatory requirement at §122.21(r)(4)(vi): "Identification of all threatened, endangered, and other protected species that might be susceptible to impingement and entrainment at your cooling water intake structures."

The Rule requires that the USEPA or state permitting authority transmit permit applications to the appropriate Field Office of the United State Fish and Wildlife Service (USFWS) and/or Regional Office of the National Marine Fisheries Service (NMFS) for review. The Services have the ability to recommend control measures, monitoring and reporting of take and other impacts to listed species and critical habitats. The Rule specifically addresses federally listed threatened and endangered (T&E) species; however, state-listed species are included for completeness. The federally and state-listed aquatic species that may be present near the intake were identified based on on-line reviews of the USFWS' Information for Planning and Consultation (IPaC) database and the Pennsylvania Natural Heritage Program's (PNHP) Pennsylvania Natural Diversity Inventory (PNDI) database.

USFWS (2018) reported no federally protected aquatic species or critical habitat occurring within the vicinity of the Beaver Valley CWIS (Attachment D). The PNDI receipt identified four mussel species that are considered Special Concern Species by the Pennsylvania Fish and Boat Commission (PFBC) – fragile papershell (*Leptodea fragilis*), threehorn wartyback (*Obliquaria reflexa*), mapleleaf (*Quadrula quadrula*), and fawnsfoot (*Truncilla donaciformis*) – and required further review by PFBC. PFBC responded in a letter dated March 2, 2018 stating that additional information would be required to more thoroughly evaluate protected freshwater mussel species and that a survey for the species of concern may be warranted (PFBC 2018) (Attachment D). Additional information was provided to PFBC via letter dated May 23, 2018. No response has been received from PFBC as of the writing of this report. No other state-listed species were identified (PNHP 2018).

Mussel species are typically only prone to impingement during their larval glochidia phase, when they attach to a host species of fish and the host species becomes impinged. The hosts for those four mussel species considered Species of Concern are provided in Table 4-3. Species of Concern are not under any level of state protection, but simply indicates a risk of being listed as threated or endangered on a state level. The PNDI receipt also included voluntary conservation measures from USFWS that would contribute to the conservation and recovery of T&E species through improved water quality, but did not identify any protected species (Attachment D).

The Pennsylvania Code Chapter 75 list of state threatened and endangered species was compared to fisheries data available near Beaver Valley (ORSANCO 2012, 2018; PFBC 2011; PNHP 2017b) to further identify aquatic species potentially vulnerable to impingement or entrainment. Four state-listed species were collected in the New Cumberland Pool near Beaver Valley: longear sunfish (endangered), black bullhead (endangered), river shiner (endangered), and spotted sucker (threatened). Two longear sunfish were collected during ORSANCO electrofishing during June and August of 2011, at RM 35.6 and RM 39.0 (ORSANCO 2018). Black bullhead were recorded historically near Beaver Valley, but have not been collected since at least 2011 (PNHP 2017b; FENOC 2012, 2013, 2014b, 2015, 2016, 2017). PFBC (2011) reports the occurrence of black bullhead, river shiner, and spotted sucker in the New Cumberland Pool in Pennsylvania, but does not indicate how recent those collections were (PNHP 2017b).

4.8 PUBLIC PARTICIPATION AND AGENCY CONSULTATION

Regulatory requirement at §122.21(r)(4)(vii): "Documentation of any public participation or consultation with Federal or State agencies undertaken in development of the plan."

A PNDI database search for state protected species and an IPaC database search for federally protected species and critical habitats were completed. Based on the results of the PNDI search, additional information was provided to PFBC. No other public consultation with Federal or State agencies related to Clean Water Act (CWA) § 316(b) was undertaken during the development of the §122.21(r) reports.

4.9 SUPPLEMENTAL FIELD STUDIES

Regulatory requirement at §122.21(r)(4)(viii): "If you supplement the information requested in paragraph (r)(4)(i) of this section with data collected using field studies, supporting documentation for the Source Water Baseline Biological Characterization must include a description of all methods and quality assurance procedures for sampling, and data analysis including a description of the study area; taxonomic identification of sampled and evaluated biological assemblages (including all life stages of fish and shellfish); and sampling and data analysis methods. The sampling and/or data analysis methods you use must be appropriate for a quantitative survey and based on consideration of methods used in other *biological studies performed within the same source water body. The study area should include, at a minimum, the area of influence of the cooling water intake structure."*

Not Applicable – No supplemental field studies have been performed, or are proposed, as part of this §122.21(r)(4) Source Water Baseline Biological Characterization report.

4.10 REGULATORY REQUIREMENT

Regulatory requirement at §122.21(r)(4)(ix): "In the case of the owner or operator of an existing facility or new unit at an existing facility, the Source Water Baseline Biological Characterization Data is the information in paragraphs (r)(4)(i) through (xii) of this section."

Regulatory requirement cited for informational purposes only. No response necessary.

4.11 PROTECTIVE MEASURES AND STABILIZATION ACTIVITIES NEAR THE INTAKE

Regulatory requirement at §122.21(r)(4)(x): "For the owner or operator of an existing facility, identification of protective measures and stabilization activities that have been implemented, and a description of how these measures and activities affected the baseline water condition in the vicinity of the intake."

The baseline water condition near Beaver Valley, as well as much of the Ohio River, is primarily affected by the Lock and Dam system within the river. These L/Ds were intended to maintain the water levels of each pool of the Ohio River in order to facilitate commerce. The L/Ds resulted in the "pools" of the Ohio River, and significantly affected the river's habitat. The Montgomery L/D is located approximately 3 miles upstream of Beaver Valley.

4.12 FRAGILE SPECIES

Regulatory requirement at §122.21(r)(4)(xi): "For the owner or operator of an existing facility, a list of fragile species, as defined at 40 CFR 125.92(m), at the facility. The applicant need only identify those species not already identified as fragile at 40 CFR 125.92(m). New units at an existing facility are not required to resubmit this information if the cooling water withdrawals for the operation of the new unit are from an existing intake."

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 traveling screens are in operation.*"

Fragile species listed in the Existing Facilities Rule include, but are not limited to: alewife, American shad, Atlantic herring, Atlantic long-finned squid, Atlantic menhaden, bay anchovy, blueback herring, bluefish, butterfish, gizzard shad, grey snapper, hickory shad, menhaden, rainbow smelt, round herring, and silver anchovy (79 FR 48432, August 15, 2014). The only fragile species from this list impinged at plants near Beaver Valley is gizzard shad.

The list of species likely to be impinged at Beaver Valley based on data from nearby facilities was compared to the USEPA (2014) list of "Non-Fragile" species. All species impinged at the nearby facilities are considered "Non-Fragile" because they are either listed explicitly or are closely related to a species included on the USEPA (2014) list.

4.13 INCIDENTAL TAKE EXEMPTION OR AUTHORIZATION

Regulatory requirement at §122.21(r)(4)(xii): "For the owner or operator of an existing facility that has obtained incidental take exemption or authorization for its cooling water intake structure(s) from the U.S.

Fish and Wildlife Service or the National Marine Fisheries Service, any information submitted in order to obtain that exemption or authorization may be used to satisfy the permit application information requirement of paragraph 40 CFR 125.95(f) if included in the application."

Beaver Valley has not obtained an incidental take exemption or authorization for its CWIS from the USFWS or NMFS. No response necessary.

5.0 §122.21(r)(5) - COOLING WATER SYSTEM DATA

5.1 NARRATIVE DESCRIPTION OF COOLING WATER SYSTEM

Regulatory requirement at §122.21(r)(5)(i): "A narrative description of the operation of the cooling water system and its relationship to cooling water intake structures; the proportion of the design intake flow that is used in the system; the number of days of the year the cooling water system is in operation and seasonal changes in the operation of the system, if applicable; the proportion of design intake flow for contact cooling, non-contact cooling, and process uses; a distribution of water reuse to include cooling water reused as process water, process water reused for cooling, and the use of gray water for cooling; a description of reductions in total water withdrawals including cooling water intake flow reductions already achieved through minimized process water withdrawals; a description of any cooling water that is used in a manufacturing process either before or after it is used for cooling, including other recycled process water flows; the proportion of the source waterbody withdrawn (on a monthly basis)"

Each unit's cooling water system at Beaver Valley consists of:

- One Circulating Water System;
- One Makeup Water System; and
- One Blowdown System

Section 3.0 of this report describes the CWIS from the point-of-entry of the water up to and including the intake pumps, while this section of the report includes a description of the balance of the Cooling Water System.

Most of the water withdrawn from the Ohio River through the CWIS is used as makeup to the circulating water system; to replace consumptive losses due to evaporation and drift from the cooling towers; and to maintain dissolved solids at design conditions. A small portion of the water withdrawn through the CWIS is used for production of demineralized water and other purposes. Some makeup water to the circulating water systems is directed back to the Ohio River as blowdown to maintain dissolved solids at design conditions. The cooling water system components are described in further detail below.

5.1.1 *CIRCULATING WATER SYSTEM*

Closed-cycle cooling systems, one per unit, are used at Beaver Valley to remove heat from each unit's condenser. Beaver Valley utilizes two hyperbolic, natural draft cooling towers with reinforced concrete shells that are approximately 500 feet high, one for each unit, to dissipate heat from the condenser steam cycle as part of the Unit 1 and Unit 2 circulating water systems (FENOC 2014a; USNRC 2007). The operation of the cooling towers enables cooling water intake flow reductions, achieved through minimized makeup water withdrawals when compared to plant circulating water flow.

The natural draft cooling towers have a combined circulating flow of 1,461 MGD (1,014,800 gpm) and an estimated maximum combined drift and evaporative loss of 15.5 MGD (10,754 gpm) and 15.2 MGD (10,566 gpm) for Unit 1 and Unit 2, respectively (FENOC 2014a, FENOC 2018). These drift and evaporative losses are replaced by river water from the Unit 1 River Water system and the Unit 2 Service Water system. Refer to Section 10, Attachment C – Drawings and Schematics.

5.1.2 *MAKEUP WATER SYSTEM*

The Makeup Water System is supplied from the CWIS (described in Section 3.0) and the associated systems, including Unit 1 River Water Systems and Unit 2 Service Water System, which convey cooling water to the Unit 1 and Unit 2 circulating systems. The Unit 1 River Water System, consisting of the

Turbine Plant River Water System and the Reactor Plant River Water System, supplies cooling water to other plant components before it discharges to the Unit 1 circulating system. The Unit 2 Service Water system also serves as cooling water for various plant components before it discharges into the Unit 2 circulating system; Unit 2 also discharges to an emergency outfall structure at a design rate of 8,400 gpm to reduce silt accumulation in that system. The Makeup Water System is required to provide a design maximum intake flow of approximately 92.2 MGD.

5.1.3 Blowdown System

The Blowdown System is provided to control the dissolved solids concentration in the circulating water. As the makeup water system supplies water to the basins of each cooling tower, the excess makeup flow causes water to overflow a weir in each basin; the flows over these weirs constitute the facility's blowdown flow. All blowdown is directed back to the Ohio River through the discharge structure, with the exception of periods of high river water temperatures when the second Unit 1 river water pump is operating. During these months, typically July through October, approximately one-third of the Unit 1 blowdown flow is discharged to the Ohio River through the Unit 1 emergency cooling tower overflow.

The cooling towers have an estimated maximum monthly average combined blowdown flow of 61.2 MGD (42,500 gpm), in order to control the solids build-up and to minimize scale formation in the system (USNRC 2007). Actual maximum monthly average blowdown flows are typically lower, at approximately 35 MGD (24,300 gpm) (FENOC 2018).

5.1.4 Cooling Water System Operation

Beaver Valley is a base load nuclear-power facility that operates two units at all times of the year with no seasonal changes, except in the case of scheduled maintenance. Typically, the units are on separate, alternating outage schedules where one unit is shut down every 18 months for approximately 26 days. The CWIS operates to provide a continuous supply of water for makeup water to Beaver Valley's cooling system to replace consumptive and non-consumptive losses. In general, the cooling water system operates to support electrical generation. AIFs for 2015 through 2017 are provided in Section 3.0.

Of the design intake flow withdrawn from the Ohio River, approximately 97% of this is used in the system as makeup water for non-contact cooling purposes. Therefore, approximately 3% of intake water is used for other process uses and no volume of intake water is used for contact cooling. Cooling water is recirculated for use in the cooling towers. Thus, no amount of cooling water is recycled for use in plant processes or manufacturing (and no "process water" or gray water is recycled for use in cooling.)

Since the intake water is used for cooling purposes as part of closed-cycle cooling and not as process water, the water withdrawal from the Ohio River is minimized. A description and calculations regarding the percent reduction in cooling water intake flow achieved with closed-cycle cooling are discussed in Section 5.2.3.

5.2 Design and Engineering Calculations

Regulatory requirement at §122.21(r)(5)(ii): "Design and engineering calculations prepared by a qualified professional and supporting data to support the description required by paragraph (r)(5)(i) of this section"

5.2.1 Design Intake Flow

The DIF is provided in Section 3.3.

5.2.2 *THROUGH-SCREEN VELOCITY*

The through-screen velocity of the traveling water screens was calculated under normal and low water elevations under DIF and maximum AIF conditions.

Table 5-1: Calculated Through-screen Velocities

		Normal Water Elevation	Low Water Elevation
Water Elevation		664'-6" MSL	654'-0" MSL
Screenhouse Floor Elevation		646'-0" MSL	646'-0" MSL
Water Depth		18'-6"	8'-0"
Through-Screen Velocity	**DIF**	**0.26 FPS**	**0.59 FPS**
	Maximum AIF	**0.23 FPS**	**0.53 FPS**

Calculations of the Through-screen Velocity are provided in Section 10 – see Attachment B.

5.2.3 *PERCENT REDUCTION IN COOLING WATER*

Beaver Valley utilizes two hyperbolic, natural draft cooling towers, one for each unit, as part of the circulating water system (FENOC 2014a). Due to the operation of the cooling towers, cooling water intake flow reductions are achieved through minimized makeup water withdrawals when compared to plant circulating water flow. Additional flow reduction is recognized during plant outages and planned maintenance activities. The Unit 1 cooling tower is typically operated at 1.8 cycles of concentration, and the Unit 2 cooling tower is typically operated at 2.6 cycles of concentration (FirstEnergy 2018). The percent of flow reduction is listed in Table 5-2.

Table 5-2: Percent Reduction in Flow

Cooling Water Intake Flows	Percent Flow Reduction
Plant Circulating Flow– 1,461 MGD	
DIF – 92.2 MGD	93.7%
AIF – 82.2 MGD	94.4%

Percent reduction in flow calculations are provided in Attachment B - Calculations.

5.2.4 *PROPORTION OF THE SOURCE WATERBODY WITHDRAWN*

Table 5-3 shows the proportion of the source water body withdrawn on an average monthly basis. The maximum percentage of the waterbody withdrawn (1.28%) occurs in September.

Table 5-3: Average Monthly Proportion of Source Waterbody Withdrawn

	Mean Streamflow[1]	Average Intake Flow[2]		Proportion of Stream Flow Withdrawn
Month	cfs	MGD	cfs	%
January	37,220	66.59	103.0	0.28%
February	53,539	61.19	94.7	0.18%
March	70,764	63.66	98.5	0.14%
April	52,097	57.92	89.6	0.17%
May	31,487	56.76	87.8	0.28%
June	42,851	66.23	102.5	0.24%
July	29,947	69.19	107.0	0.36%
August	10,513	79.07	122.3	1.16%
September	9,309	76.98	119.1	1.28%
October	20,299	53.99	83.5	0.41%
November	23,514	68.00	105.2	0.45%
December	46,379	55.85	86.4	0.19%

[1] 2015 – 2016 Average Ohio River Flow from USGS (2018d)

[2] Source: Monthly average intake flow at Beaver Valley for 2015-2016 (FirstEnergy 2018)

5.3 EXISTING IMPINGEMENT AND ENTRAINMENT TECHNOLOGIES

Regulatory requirement at §122.21(r)(5)(ii): "Description of existing impingement and entrainment technologies or operational measures and a summary of their performance, including but not limited to reductions in impingement mortality and entrainment due to intake location and reductions in total water withdrawals and usage"

Beaver Valley operates a closed-cycle cooling system as defined at §125.92 to minimize makeup and blowdown flows from the Ohio River to support non-contact cooling water uses at the facility. As such, Beaver Valley meets best technology available (BTA) standards for impingement mortality at §125.94(c)(1) and BTA for entrainment under Best Professional Judgment. Use of the cooling towers provides up to a 94.4% reduction in AIFs required for the facility. In addition to the operation of the closed-cycle recirculating system, the Beaver Valley CWIS has a through-screen velocity of less than 0.5 fps at normal river water elevation at both DIF and maximum AIF.

6.0 §122.21(r)(6) - CHOSEN METHOD OF COMPLIANCE WITH IMPINGEMENT MORTALITY STANDARD

Regulatory requirement at §122.21(r)(6) requires FirstEnergy to discuss the chosen method of compliance with the impingement mortality standard for Beaver Valley. Facilities must either select one of the seven alternatives at 125.95(c)(1) through (7) unless the facilities qualifies for an exemption or less stringent standards. The owner/operator must identify the chosen compliance method for the entire facility; alternatively, the applicant must identify the chosen compliance method for each cooling water intake structure at its facility.

Beaver Valley utilizes two hyperbolic, natural draft cooling towers, one for each unit, as part of the circulating water system (FENOC 2014a). Due to the operation of the cooling towers, cooling water intake flow reductions are achieved through minimized makeup water withdrawals when compared to plant circulating water flow. The percent reduction in flow, assuming a total design flow of 1,014,800 GPM (1,461 MGD) (FENOC 2014a; 2018) is approximately 93.7% for DIF and 94.4% for AIF. The Unit 1 cooling tower is typically operated at 1.8 cycles of concentration, and the Unit 2 cooling tower is typically operated at 2.6 cycles of concentration (FirstEnergy 2018). Given that Beaver Valley operates a closed-cycle cooling system as defined at §125.92, it meets BTA standards for impingement mortality at §125.94(c)(1) and BTA for entrainment under Best Professional Judgment.

In addition to the operation of the closed-cycle recirculating system, the Beaver Valley CWIS has a through-screen velocity of less than 0.5 fps at normal river water elevation at both DIF and maximum AIF.

Additionally, compliance may be met by retirement, as FirstEnergy has announced potential plans to retire the Beaver Valley facility in 2021. If this were to occur, no further impingement mortality reductions would be required.

7.0 §122.21(r)(7) - ENTRAINMENT PERFORMANCE STUDIES

Regulatory requirement at §122.21(r)(7): "The owner or operator of an existing facility must submit any previously conducted studies or studies obtained from other facilities addressing technology efficacy, through-facility entrainment survival, and other entrainment studies. Any such submittals must include a description of each study, together with underlying data, and a summary of any conclusions or results. Any studies conducted at other locations must include an explanation as to why the data from other locations are relevant and representative of conditions at your facility. In the case of studies more than 10 years old, the applicant must explain why the data are still relevant and representative of conditions at the facility and explain how the data should be interpreted using the definition of entrainment at 40 CFR 125.92(h)."

No previously conducted studies or studies from other nearby facilities addressing technology efficacy, through-facility entrainment survival, or other entrainment studies applicable to Beaver Valley are available. Beaver Valley uses cooling towers, which are part of closed-cycle recirculating systems as defined in 40 CFR 125.83. The withdrawn CWA § 316(b) Phase II Rule for existing facilities stated that closed-cycle recirculating systems were deemed to have met the applicable performance standards for both impingement mortality and entrainment and were not required to demonstrate further the achievement of performance standards. Facilities with closed-cycle recirculating systems were not required to submit a Proposal for Information Collection or a Comprehensive Demonstration Study.

8.0 §122.21(r)(8) - OPERATIONAL STATUS

8.1 NARRATIVE DESCRIPTION OF POWER PRODUCTION

Regulatory requirement at §122.21(r)(8)(i): "For power production or steam generation, descriptions of individual unit operating status including age of each unit, capacity utilization rate (or equivalent) for the previous 5 years, including any extended or unusual outages that significantly affect current data for flow, impingement, entrainment, or other factors, including identification of any operating unit with a capacity utilization rate of less than 8 percent averaged over a 24-month block contiguous period, and any major upgrades completed within the last 15 years, including but not limited to boiler replacement, condenser replacement, turbine replacement, or changes to fuel type"

Beaver Valley's two nuclear-powered generating units, Unit 1 and Unit 2, have been licensed since 1976 and 1987, respectively (FirstEnergy Generation 2016). Beaver Valley is a load following plant that normally operates year-round to produce electrical power, except for scheduled outages (FirstEnergy 2018). Typically, the units are on separate, alternating outage schedules where one unit is shut down every 18 months for approximately 26 days. Based on annual operations from 2013 through 2017, Beaver Valley's average net facility capacity utilization rate was 94.5%. In general, the surface water withdrawal system operates to support electrical generation with no seasonal changes (FirstEnergy 2018).

Beaver Valley unit capacity factors are in listed in Table 8-1 for the last five years (FirstEnergy 2018). These values are based on gross electrical generation as a ratio of actual generation produced divided by the rated generation value at Beaver Valley's average annual ambient conditions.

Table 8-1: Capacity Utilization Factors

Year	Capacity Utilization Factor (%)	
	Unit 1	Unit 2
2013	89.11	100.85
2014	95.69	91.83
2015	91.86	91.52
2016	92.47	98.98
2017	100.9	92.24
Average	**94.01**	**95.08**

The following major upgrades (i.e., to boilers, condensers, turbines, fuel type, etc.) have been completed at Beaver Valley within the previous 15 years (FirstEnergy 2018):

- October 2006 – Beaver Valley Unit 1 Steam Generator Replacement 28 MWe
- December 2012 – Beaver Valley Unit 2 Low Pressure Turbine Rotor Replacement 33 MWe (effective in Jan. 2014)
- December 2013 – Beaver Valley Unit 1 Low Pressure Turbine Rotor Replacements 39 MWe (effective in Jan. 2015)

8.2 DESCRIPTIONS OF UPRATES AND USNRC RELICENSING

Regulatory requirement at §122.21(r)(8)(ii): "Descriptions of completed, approved, or scheduled uprates and Nuclear Regulatory Commission relicensing status of each unit at nuclear facilities"

The following uprates have occurred in the past 15 years (FirstEnergy 2018):

- 2002 – Measurement Uncertainty Recapture (MUR) Power Uprate Beaver Valley Unit 1 and Beaver Valley Unit 2 (Leading Edge Flow Meter [LEFM] Appendix K Uprate)
- 2006 – Beaver Valley Unit 1: 5% Extended Power Uprate (effective in Jan. 2007 MOR)
- 2008 – Beaver Valley Unit 2: 5% Extended Power Uprate (effective in Jan. 2009 MOR)

Both Units 1 and 2 have been approved to maintain USNRC licensing for an additional 20 years past their original licenses. Unit 1 license ends Jan. 29, 2036. Unit 2 license ends May 27, 2047.

8.3 NEW UNIT PLANS AND SCHEDULES

Regulatory requirement at §122.21(r)(8)(v): "Descriptions of plans or schedules for any new units planned within the next 5 years"

There are no plans or schedules for new units at Beaver Valley within the next five years.

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10.0 ATTACHMENTS

Attachment A – Locational Maps

- **Site Map**; USNRC. 2007.
- **Aerial View Satellite Image**; Source: Google Maps. 2018.
- **Ohio River Navigation Chart No. 214**; USACE 2003.
- **Mussel Survey Transect and Bottom Characterization Maps**; EnviroScience. 2013.

Attachment B – Calculations

- **Through-Screen Velocity – DIF and Maximum AIF**. AECOM. 2018.
- **Percent Flow Reduction Calculation**. AECOM. 2018.

Attachment C – Drawings and Schematics

- **Drawing No. AA8700-RM-27F Rev. 14, Waste Water Flow Diagram**; FirstEnergy Nuclear Operating Company. 1995.
- **Drawing No. 02.075-0009, 14' x 60' 4-Post Traveling Water Screen General Arrangement**; Atlas Manufacturing Co. 2017.
- **Drawing No. 08700-02.075-0004 Rev. D, Traveling Water Screens General Arrangement**; Rex Chainbelt Inc. 1996.
- **Aquatic Monitoring, Intake Structure**. Beaver Valley Power Station, Procedure Number BVBP-ENV-001.

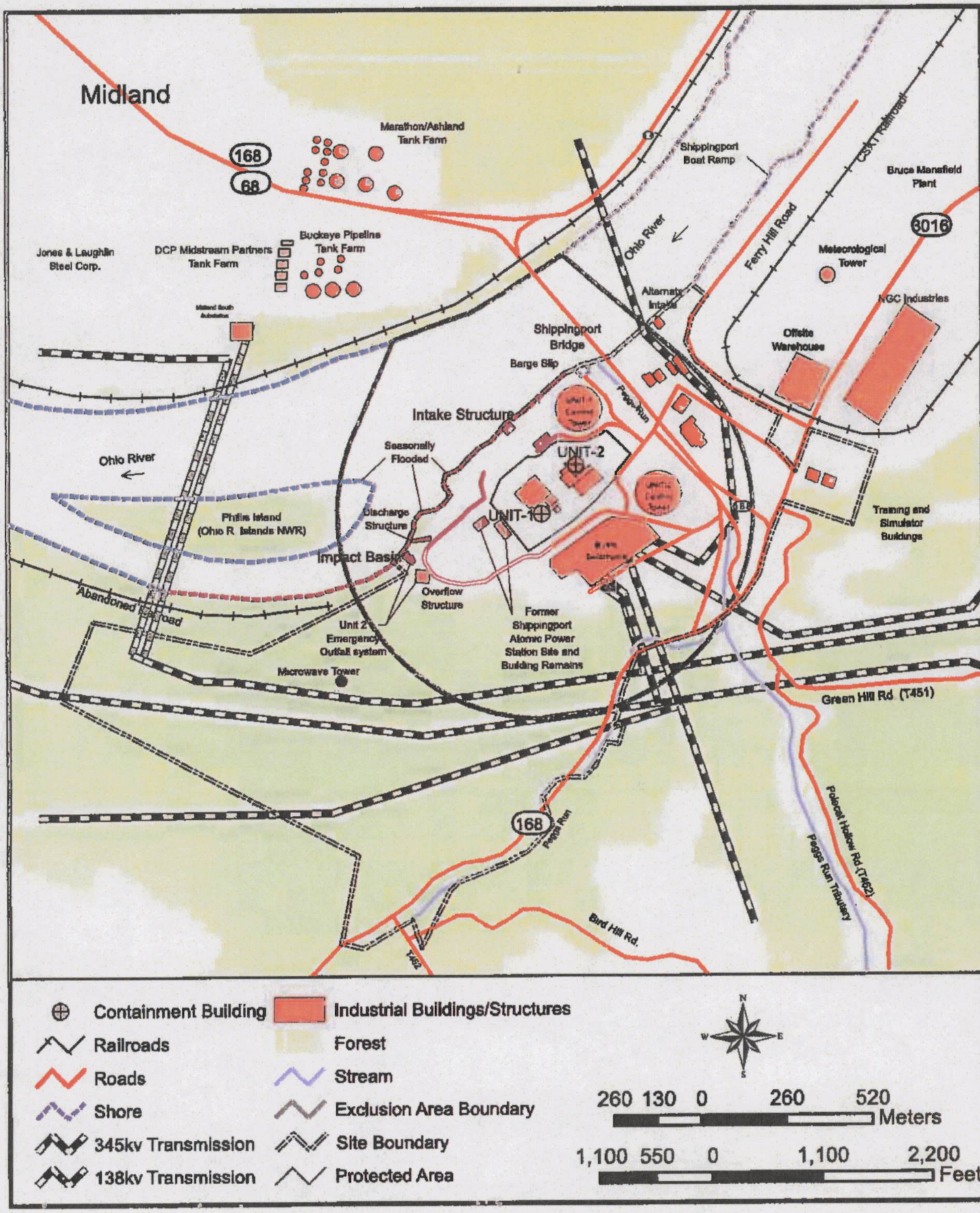
Attachment D – Threatened and Endangered Species Information

- **USFWS Consultation Letter** dated May 22, 2018.
- **Pennsylvania Natural Diversity Inventory (PNDI) Receipt. PNDI-657834.** Pennsylvania Department of Conservation and Natural Resources, Pennsylvania Natural Heritage Program. May 23, 2018.
- **AECOM Request Letter to Pennsylvania Fish and Boat Commission.** Dated May 23, 2018, re: PNDI-657834.

ATTACHMENT A
LOCATION MAPS

FIGURE 2.1-3

SITE MAP



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Prepared by: Marie Tarnowski

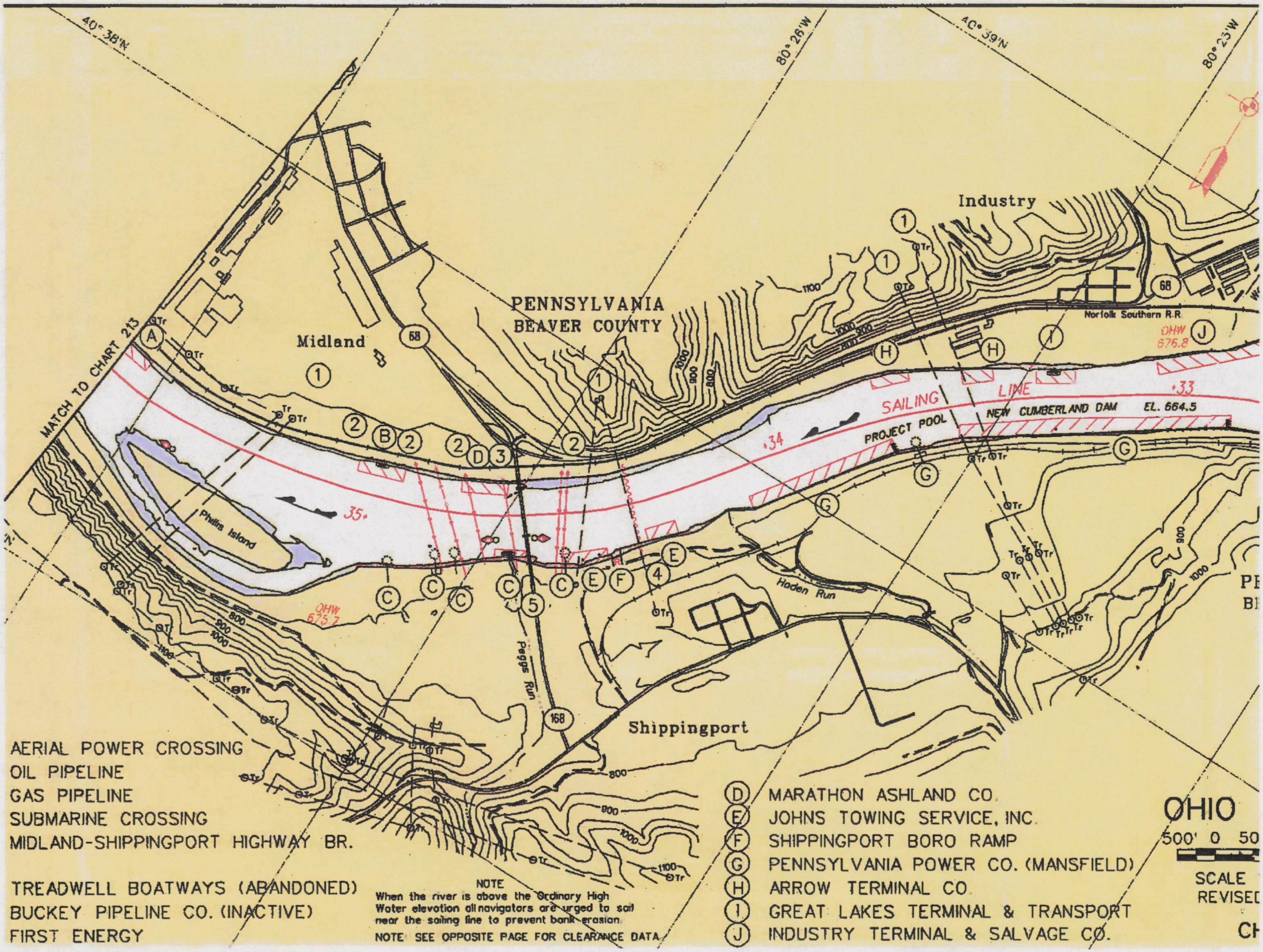
Checked by:

Date: 5/25/2018

Beaver Valley Power Station
Cooling Water Intake Structure Location

820 410 0 820 Feet

1 inch = 667 feet



40° 38'N
80° 26'W
40° 39'N
80° 23'W
MATCH TO CHART 213
PENNSYLVANIA
BEAVER COUNTY
Midland
Industry
Shippingport
Norfolk Southern R.R.
Phillis Island
Haden Run
Pegps Run
SAILING LINE
PROJECT POOL
NEW CUMBERLAND DAM EL. 664.5
OHW 675.7
OHW 676.8
AERIAL POWER CROSSING
OIL PIPELINE
GAS PIPELINE
SUBMARINE CROSSING
MIDLAND-SHIPPINGPORT HIGHWAY BR.
TREADWELL BOATWAYS (ABANDONED)
BUCKEY PIPELINE CO. (INACTIVE)
FIRST ENERGY
NOTE
When the river is above the Ordinary High Water elevation all navigators are urged to sail near the sailing line to prevent bank erosion.
NOTE: SEE OPPOSITE PAGE FOR CLEARANCE DATA.
D MARATHON ASHLAND CO.
E JOHNS TOWING SERVICE, INC.
F SHIPPINGPORT BORO RAMP
G PENNSYLVANIA POWER CO. (MANSFIELD)
H ARROW TERMINAL CO.
I GREAT LAKES TERMINAL & TRANSPORT
J INDUSTRY TERMINAL & SALVAGE CO.
OHIO
SCALE
REVISED


Ohio River
This section permit
Ferry Hill Rd
Kerona Rd
N
1
2
3
4
5
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7
8
10
11
12
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21
0
68

ATTACHMENT B
CALCULATIONS

AECOM
Conshohocken, PA

FirstEnergy
Beaver Valley Power Station
CWA 316(b)

THROUGH-SCREEN VELOCITY

PREPARED FOR

First Energy
Beaver Valley Power Station

Prepared By:	**Date:**
Susan Ambler, PE Project Engineer	6/26/2018
Reviewed By:	**Date:**
Tom Kaley Staff Engineer	7/6/2018
Approved By:	**Date:**
Joella Posey, PE Principal Engineer	7/10/2018

Rev.	Date	Prepared by	Reviewed by	Approved by
0	7/10/2018	SEA	TK	JP

CWA 316 (b) Project

THROUGH-SCREEN VELOCITY

Calculation Purpose:

1. Calculate the design and actual through-screen velocities for the cooling water intake structure.
2. Determine if CWA 316(b) performance standards for impingement mortality are met.

Calculation Objectives:

1. Identify the screen physical parameters and intake flow rates.
2. Calculate the proportion of open screen area to screen surface area.
3. Calculate the design and actual through-screen velocities.

System Description:

Water is withdrawn from the Ohio River and used primarily for cooling. Water enters the structure via four intake bays oriented parallel to the riverbank. The entrance to each bay consists of a 15.3-foot wide by 13.5-foot high opening to the river, extending from the floor of the bay at elevation 646.0 feet NGVD to elevation 659.5 feet NGVD, 5 feet below normal pool elevation to prevent entry by floating objects. In each intake bay, water passes through trash racks constructed of steeply sloped steel bars spaced horizontally at 3.5-inch intervals to prevent entry of coarse debris, then through vertical 0.375-inch mesh traveling screens (50 percent open space) for removal of finer debris.

Calculation Methodology:

The through-screen velocity will be calculated using the following formulas adapted from Pankrantz, 1988.

V = Q / WD * OA * TW * K **(Formula 1)**

where:

Q = flow rate in gallons per minute (gpm)
V = through-screen velocity in feet per second (fps)
WD = water depth in feet (ft)
OA = proportion of screen open area to total screen area
TW = nominal screen tray width in ft
K = constant = 396 for through-flow screen, or 740 for dual-flow screen

and OA = (W x L) / ((W + D) * (L + d)) **(Formula 2)**

where:

d = screen horizontal (shute) wire diameter in inches (in)
D = screen vertical (warp) wire diameter (in)
W = width of screen opening (in)
L = vertical length of screen opening (in)

Impingement mortality standard will be met if the through-screen velocity is equal to or less than 0.5 feet per second.

CWA 316 (b) Project

THROUGH-SCREEN VELOCITY

Design Inputs:

1. a. Design Intake Flow

Design Water Withdrawal Rate	92.2	MGD	64,000	GPM	
River Water Pumps	13	MGD	9,000	GPM	(Ref 1)
River Water Pumps	13	MGD	9,000	GPM	(Ref 1)
Raw Water Pumps	23	MGD	16,000	GPM	(Ref 1)
Service Water Pumps	22	MGD	15,000	GPM	(Ref 1)
Service Water Pumps	22	MGD	15,000	GPM	(Ref 1)
Total	92.2	MGD	64,000	GPM	
	142.6	CFS			

1. b. Actual Intake Flow

Maximum Actual Intake Flow	82.2	MGD	57,092	GPM	(Ref 2)
	127.2	CFS			

2. Number of screens	4		(Ref 1)
3a. Design Water Withdrawal Rate (per screen)	16,000	GPM	
3b. Actual Water Withdrawal Rate (per screen)	14,273	GPM	
4. Screen Width	14.0	feet	(Ref 4)
5. Screenhouse Floor Elevation	646.0	feet	(Ref 1)
6. Pool Elevation -normal	664.5	feet	(Ref 1)
Pool Elevation -minimum	654.0	feet	(Ref 1)
Pool Elevation -top of skimmer wall	659.5	feet	(Ref 1)
7. Water Height (Depth) -normal	18.5	feet	
Water Height (Depth) -low	8.0	feet	
Water Height (Depth) -top of skimmer wall normal WL	13.5	feet	
Water Height (Depth) -top of skimmer wall minimum WL	8.0	feet	
8. Mesh Size (Square)	0.375	inch	(Ref 1)
9. Wire Size - shute and warp	12	Gauge W&M	(Ref 4)
10. Wire Width	0.1055	inch	(Ref 4)
11. Intake Width	61.2	feet	(Ref 5)
12. TWS Port Width	15.3	feet	(Ref 5)

Assumptions:

1. No changes to as-built configuration after dates of references used.
2. All intake screens are normally in service.
3. The constant for Formula 1 includes units conversion (gpm to cfs) and screen efficiency factors.
4. The design flow is conservative assuming that all pumps are operating 24 hours per day.
5. The actual intake flow is based on average flow from the references.
6. The wire size is Washburn & Moen gauge.
7. Approach velocity is equal to port velocity and is just outside of trash racks in body of water.
8. Intake, screen, and TWS port widths are estimated from the references.

References Used:

1) U.S. Nuclear Regulatory Commission (USNRC). 2007. Beaver Valley Power Station Units 1 and 2 License Renewal Application Appendix E – Environmental Report.

2) 2015 - 2017 Monthly Cooling Water Intake Volumes for completion of U.S. Depatment of Energy Power Plant Operations Report Forms, provided by FirstEnergy 2017/2018.

3) Rex Chainbelt Inc. 1960. Drawing No. H65704-1. Rev 3. Traveling Water Screens General Arrangement. Duquesne Light Company. Beaver Valley Power Station.

4) Atlas Manufacturing Co. 2017. Drawing No. SP17-485. Rev 5. Traveling Water Screen General Arrangement. First Energy Nuclear Operating Company. Beaver Valley Power Station. October 2, 2017.

5) Beaver Valley Power Station, Procedure No. BVBP-ENV-001, Page 24, Attachment E - Intake Structure.

CWA 316 (b) Project

THROUGH-SCREEN VELOCITY

Summary and Conclusions:

Design Intake Flow:

1. The calculated design through-screen velocity for the CWIS is	**0.26 fps**	(Normal WL)
	0.59 fps	(Minimum WL)
2. The calculated velocity at the face of the intake structure (for area of influence evaluation) is	**0.13 fps**	(Normal WL)
	0.29 fps	(Minimum WL)
3. The calculated velocity at the face of the bar racks (for area of influence evaluation) is	**0.13 fps**	(Normal WL)
	0.29 fps	(Minimum WL)
4. The calculated velocity in each TWS port is	**0.13 fps**	(Normal WL)
	0.29 fps	(Minimum WL)

Actual Intake Flow:

1. The calculated actual through-screen velocity for the CWIS is	**0.23 fps**	(Normal WL)
	0.53 fps	(Minimum WL)
2. The calculated velocity at the face of the intake structure (for area of influence evaluation) is	**0.11 fps**	(Normal WL)
	0.26 fps	(Minimum WL)
3. The calculated velocity at the face of the bar racks (for area of influence evaluation) is	**0.11 fps**	(Normal WL)
	0.26 fps	(Minimum WL)
4. The calculated velocity in each TWS port is	**0.11 fps**	(Normal WL)
	0.26 fps	(Minimum WL)

CWA 316 (b) Project

THROUGH-SCREEN VELOCITY

Calculations:

1. Screen Physical Parameters and Intake Flow Rates

Formulas Used:
none

Given:

	DIF		AIF	
Q=	16,000	GPM per screen	14,273	GPM per screen
D=d=	0.1055	in	0.1055	in
W=L=	0.375	in	0.375	in
high WD=	18.5	ft	18.5	ft
low WD=	8.0	ft	8.0	ft
K=	396		396	
TW=	14.0	ft	14.0	ft

Calculate:
N/A

2. Proportion of Open Screen Area to Total Screen Area

Formulas Used:
Formula 2

Given:
screen parameters as above

Calculate:

OA = (W x L) / ((W + D) * (L + d)) = **0.6091**

3. Through-screen Velocities

Formulas Used:
Formula 1

Given:
screen parameters as above and calculated screen open area proportion

Calculate:

V = Q / WD * OA * TW * K =

DIF			AIF		
0.26	fps	normal WL	**0.23**	fps	normal WL
0.59	fps	min WL	**0.53**	fps	min WL

CWA 316 (b) Project

THROUGH-SCREEN VELOCITY

Calculations:

4. Velocity at Face of Intake Structure

Formulas Used:

Area at Face of Intake Structure = (Intake Width) x (Water Depth)

Velocity = (Withdrawal Rate) / (Area at Face of Intake Structure)

Given:

parameters as in input section

Calculate:

	DIF			AIF		
Area of Intake Structure =	1132	ft^2	normal WL	1132	ft^2	normal WL
Velocity =	0.13	fps		0.11	fps	
	489	ft^2	min WL	489	ft^2	min WL
	0.29	fps		0.26	fps	

5. Velocity at Face of Bar Rack

Formulas Used:

Area at Face of Bar Rack = (Bar Rack Width) x (Water Depth)

Velocity = (Withdrawal Rate) / (Area at Face of Bar Rack)

Given:

parameters as in input section

Calculate:

	DIF			AIF		
Area of Bar Rack =	1132	ft^2	normal WL	1132	ft^2	normal WL
Velocity =	0.13	fps		0.11	fps	
	489	ft^2	min WL	489	ft^2	min WL
	0.29	fps		0.26	fps	

6. Velocity in Traveling Water Screen Port

Formulas Used:

Area of TWS Port = (TWS Port Width) x (Water Depth)

Velocity = (Withdrawal Rate) / (Area of TWS Port)

Given:

parameters as in input section

Calculate:

	DIF			AIF		
Area of TWS Port =	283	ft^2	normal WL	283	ft^2	normal WL
Velocity =	0.13	fps		0.11	fps	
	122	ft^2	min WL	122	ft^2	min WL
	0.29	fps		0.26	fps	

FirstEnergy
Beaver Valley Power Station

Percent Flow Reduction Calculation

Design Inputs:

Plant Circulating Water (CW) Flow:	1,461	MGD	Design	(Ref 1)
	1,014,800	gpm	Average Circ. Water Flow	(Ref 1)
Total Withdrawal:	92.2	MGD	Design Intake Flow	(Ref 2)
	82.2	MGD	Maximum Actual Intake Flow	(Ref 3)

Assumptions:

1. All pumps, screens, and ports are in continuous service and function similarly.
2. Flow rates are pump design maximum and are most conservative.
3. Plant CW Flow and DIF includes screen wash water, but not backup water use.

References:

1. Unit 2 - Chapter 10 of the Unit 2 Updated Final Safety Analysis Report; Unit 1 - Communication with FirstEnergy 2018.
2. U.S. Nuclear Regulatory Commission (USNRC). 2007. Beaver Valley Power Station Units 1 and 2 License Renewal Application Appendix E – Environmental Report.
3. 2015 - 2017 Monthly Cooling Water Intake Volumes for completion of U.S. Department of Energy Power Plant Operations Report Forms, provided by FirstEnergy 2017/2018.

Calculation:

Withdrawal as a Percent of Plant CW = (Total Withdrawal / Plant CW) X 100

Percent Reduction = 100% - Withdrawal as a Percent of Plant CW

Design Intake Flow

Withdrawal as a Percent of Plant CW:	6.3%
Percent Reduction:	**93.7%**

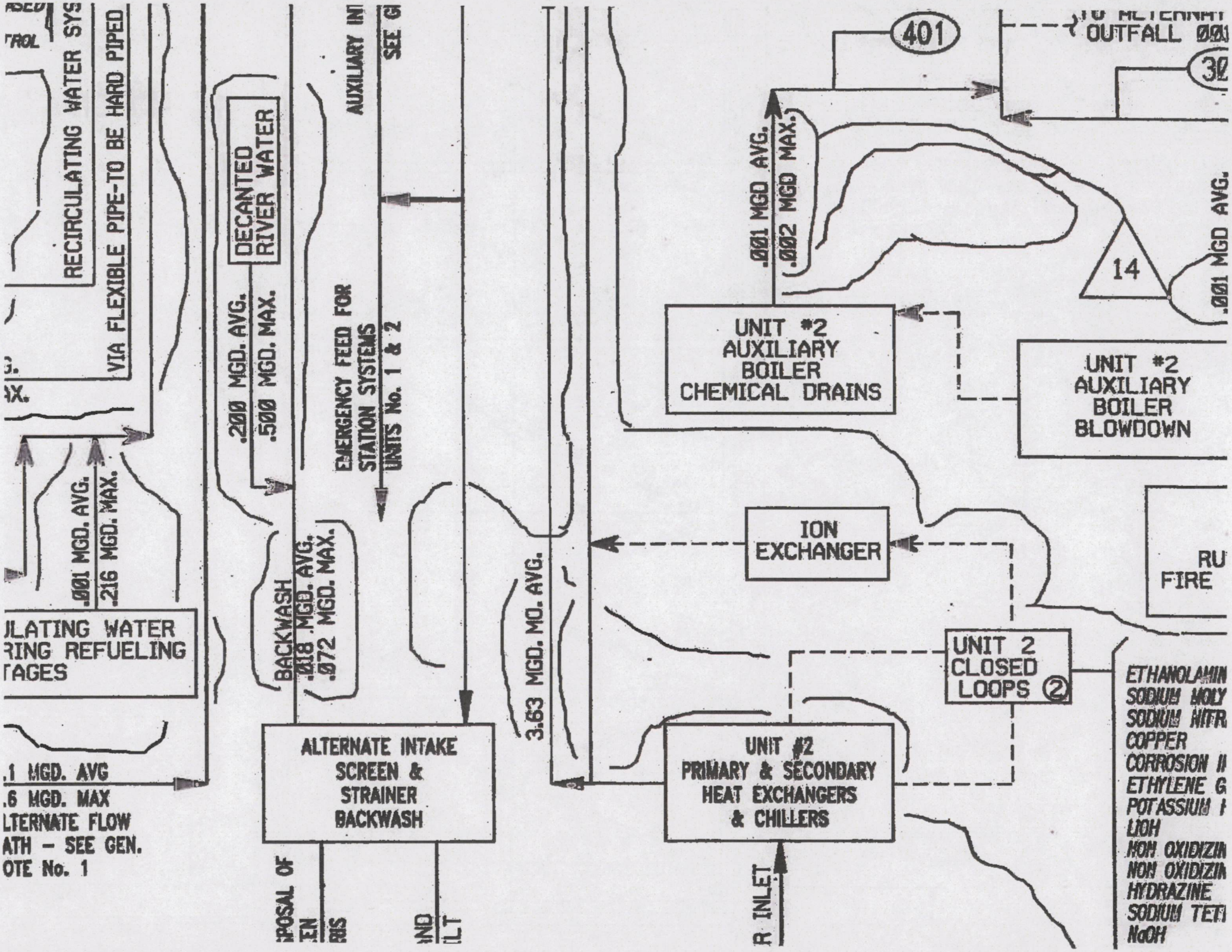
Actual Intake Flow

Actual Withdrawal as a Percent of Plant CW:	5.6%
Percent Reduction:	**94.4%**

Prepared By:

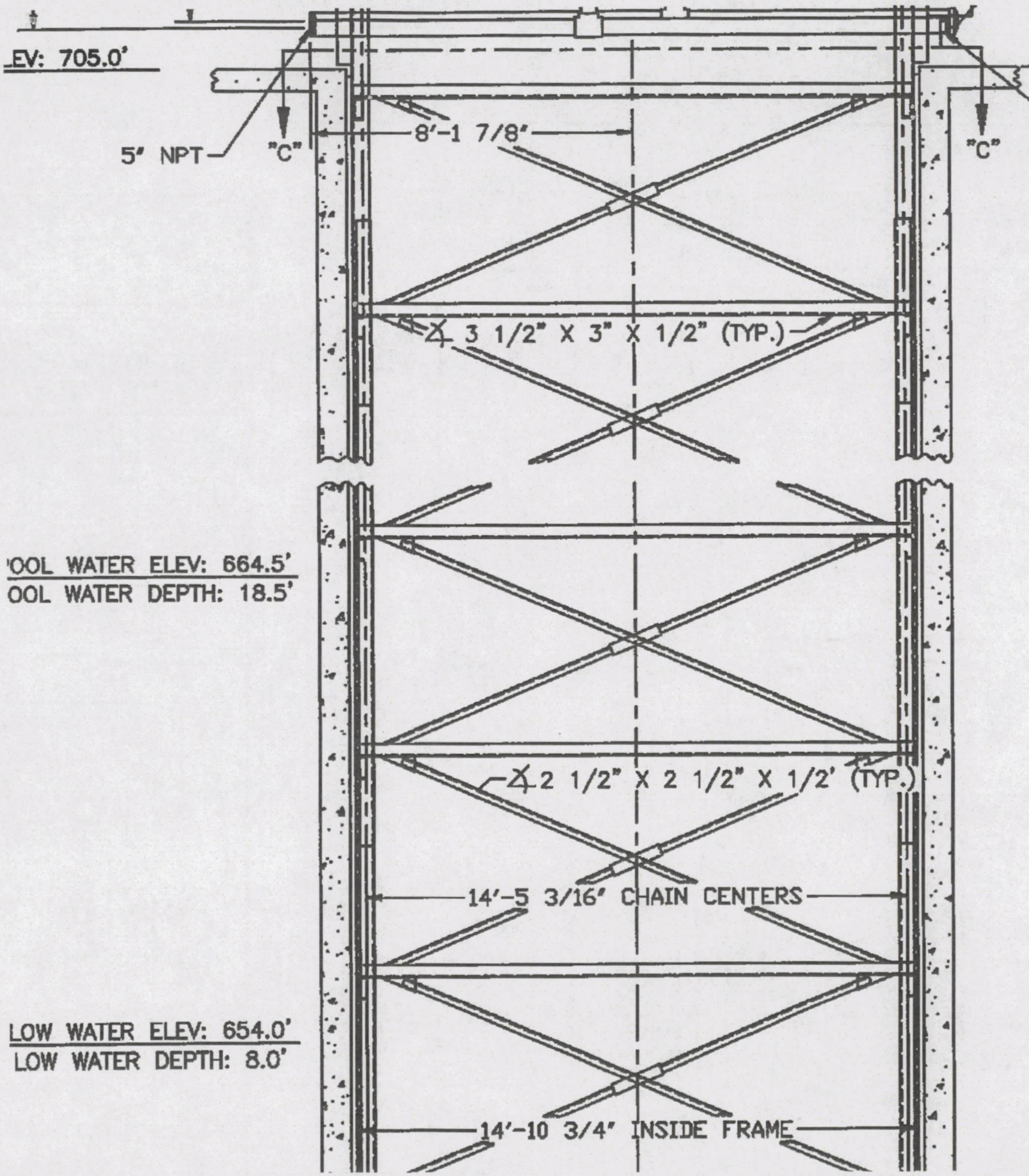
AECOM
Conshohocken, PA
September 2018

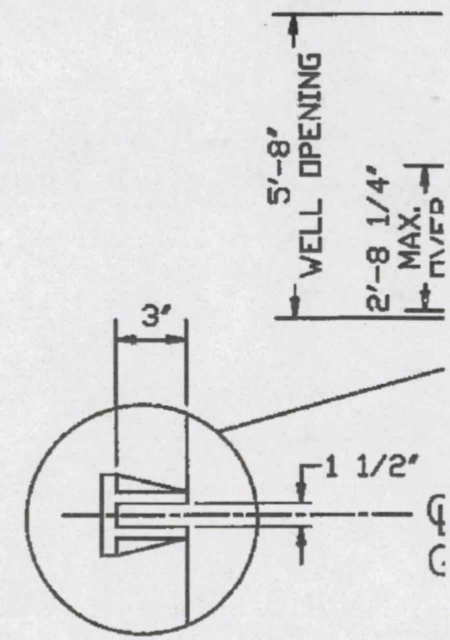
ATTACHMENT C
DRAWINGS AND SCHEMATICS


RECIRCULATING WATER SYS
VIA FLEXIBLE PIPE-TO BE HARD PIPED
DECANTED RIVER WATER
.200 MGD. AVG.
.500 MGD. MAX.
AUXILIARY IN
SEE G
EMERGENCY FEED FOR STATION SYSTEMS UNITS No. 1 & 2
401
TO ALTERNAT
OUTFALL 001
.001 MGD AVG.
.002 MGD MAX.
14
.001 MGD AVG.
UNIT #2 AUXILIARY BOILER CHEMICAL DRAINS
UNIT #2 AUXILIARY BOILER BLOWDOWN
.001 MGD. AVG.
.216 MGD. MAX.
ULATING WATER
RING REFUELING
TAGES
BACKWASH
.018 MGD. AVG.
.072 MGD. MAX.
3.63 MGD. MO. AVG.
ION EXCHANGER
RU
FIRE
UNIT 2 CLOSED LOOPS 2
ETHANOLAMIN
SODIUM MOLY
SODIUM NITR
COPPER
CORROSION I
ETHYLENE G
POTASSIUM
LIOH
NON OXIDIZIN
NON OXIDIZIN
HYDRAZINE
SODIUM TETI
NaOH
.1 MGD. AVG
.6 MGD. MAX
LTERNATE FLOW
ATH - SEE GEN.
OTE No. 1
ALTERNATE INTAKE SCREEN & STRAINER BACKWASH
UNIT #2 PRIMARY & SECONDARY HEAT EXCHANGERS & CHILLERS
R INLET

SPRAY W

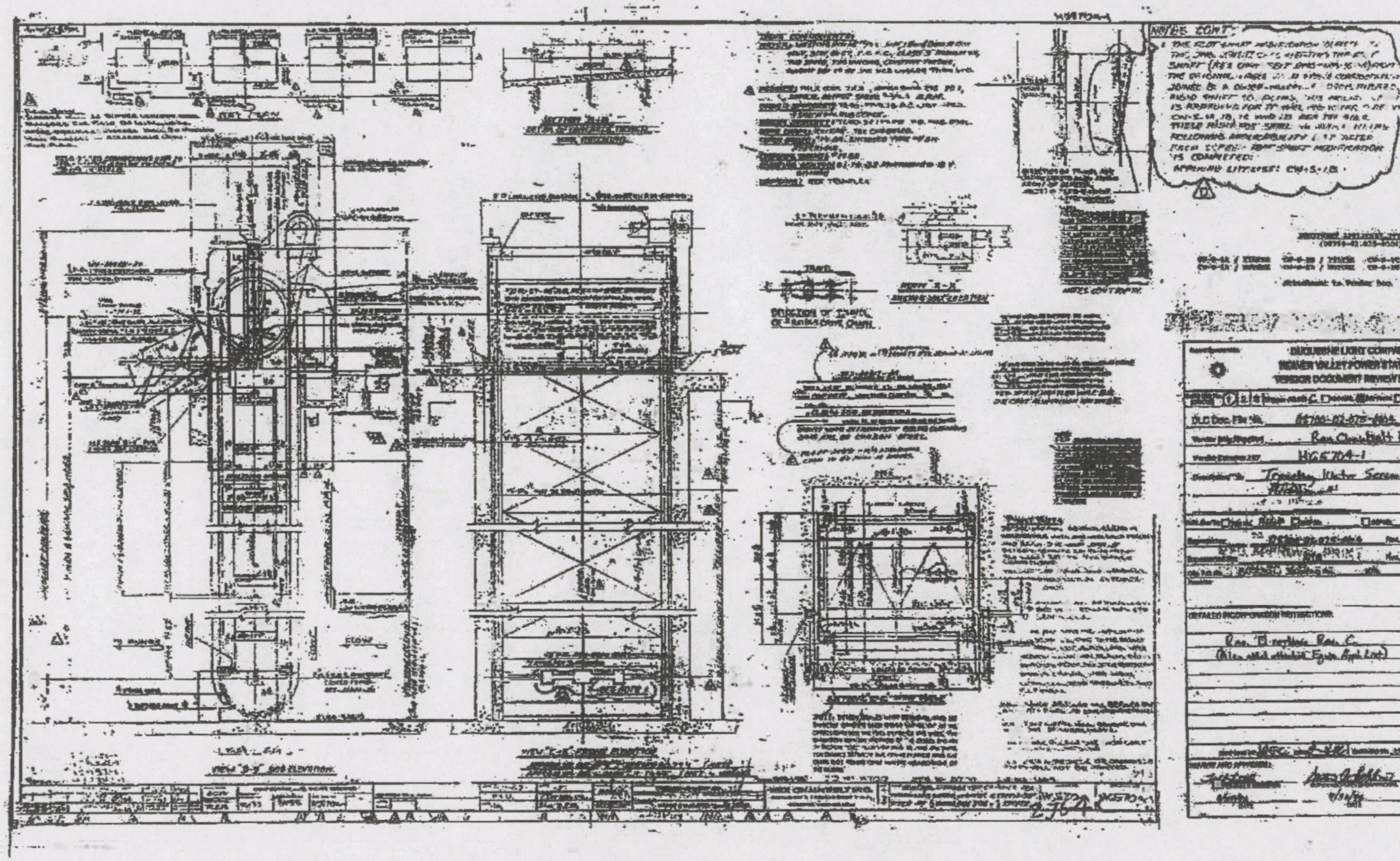
(FLOW RE





NOTES:

1. SCREEN WILL PASS APPROX. 126,500 GP NORMAL POOL WATER DEPTH OF 18.5 FT 100% CLEAN SCREEN AT A VELOCITY OF
2. SCREEN WILL PASS APPROX. 126,500 GP EXTREME LOW WATER DEPTH OF 8.0 FT. 100% CLEAN SCREEN AT A VELOCITY OF
3. MAIN FRAME IS A36 CARBON STEEL.



DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION
VENDOR DOCUMENT REVIEW FORM

Page 1

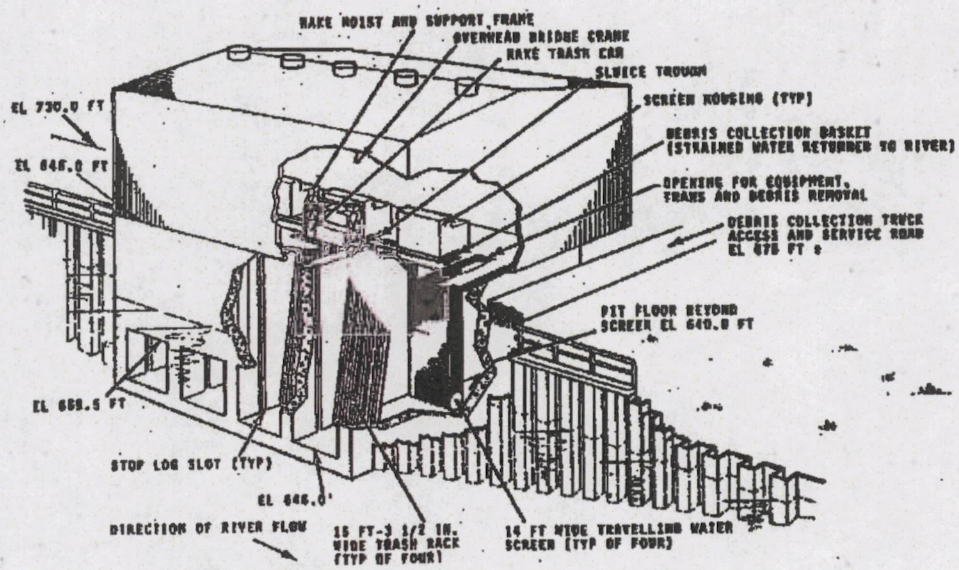
DLC Doc. File No.	05700-02-075-0104 — Revision D
Vendor	Rex Chainbelt Inc.
Vendor Document	HG5704-1 — Rev. 3
Description	Traveling Water Screens, General

Supersedes: 05700-02-075-0104 Rev. C

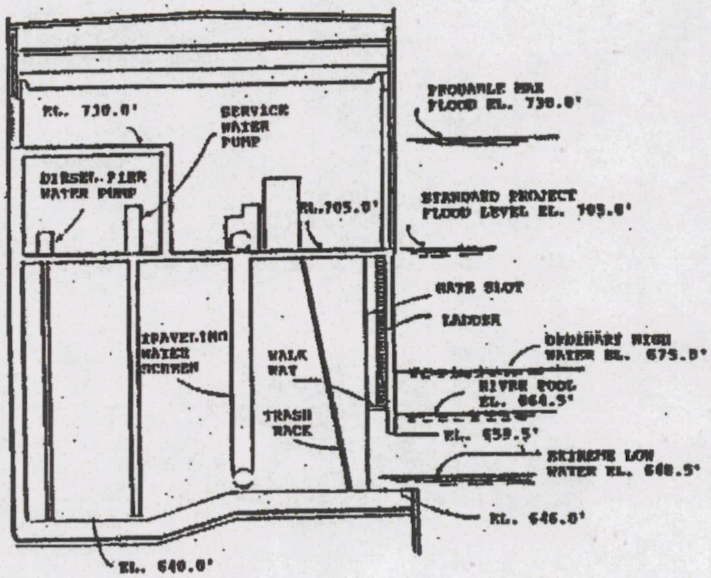
DETAILED INCORPORATION INSTRUCTIONS:

Rev. D replaces Rev. C
(Also add attached Equip. Appl. List)

ATTACHMENT E
Page 1 of 1
INTAKE STRUCTURE



(Three dimensional: Cutaway View)



(Two dimensional: Side View)

ATTACHMENT D
THREATENED AND ENDANGERED SPECIES INFORMATION

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pennsylvania Ecological Services Field Office
110 Radnor Road Suite 101
State College, PA 16801-7987
Phone: (814) 234-4090 Fax: (814) 234-0748
http://www.fws.gov/northeast/pafo/

In Reply Refer To: May 22, 2018
Consultation Code: 05E2PA00-2018-SLI-1049
Event Code: 05E2PA00-2018-E-04587
Project Name: Beaver Valley Power Plant 316(b) Compliance

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

Any activity proposed on National Wildlife Refuge lands must undergo a "Compatibility Determination' conducted by the Refuge. Please contact the individual Refuge to discuss any questions or concerns.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List
- USFWS National Wildlife Refuges and Fish Hatcheries

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Pennsylvania Ecological Services Field Office
110 Radnor Road Suite 101
State College, PA 16801-7987
(814) 234-4090

Project Summary

Consultation Code: 05E2PA00-2018-SLI-1049

Event Code: 05E2PA00-2018-E-04587

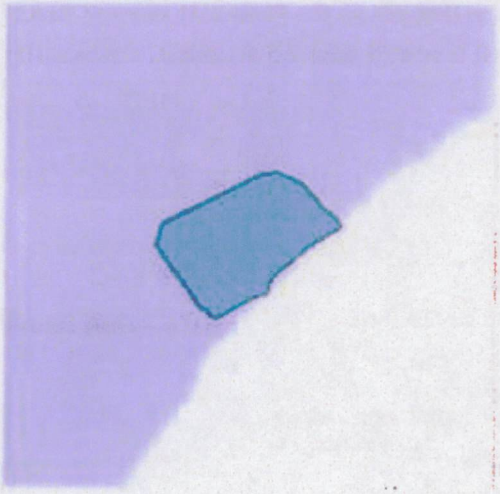
Project Name: Beaver Valley Power Plant 316(b) Compliance

Project Type: POWER GENERATION

Project Description: To determine the risk of impingement or entrainment of federally protected species at the Beaver Valley Power Plant

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/40.624498599024506N80.43534865715333W



Counties: Beaver, PA

Endangered Species Act Species

There is a total of 2 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

---

1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Indiana Bat *Myotis sodalis* **There is final critical habitat for this species. Your location is outside the critical habitat.** **Species profile:** https://ecos.fws.gov/ecp/species/5949	Endangered
Northern Long-eared Bat *Myotis septentrionalis* **No critical habitat has been designated for this species.** **Species profile:** https://ecos.fws.gov/ecp/species/9045	Threatened

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

USFWS National Wildlife Refuge Lands And Fish Hatcheries

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

REFUGE INFORMATION WAS NOT AVAILABLE WHEN THIS SPECIES LIST WAS GENERATED. PLEASE CONTACT THE FIELD OFFICE FOR FURTHER INFORMATION.

1. PROJECT INFORMATION

Project Name: **Beaver Valley Nuclear Power Station**
Date of Review: **5/23/2018 01:21:10 PM**
Project Category: **Energy Storage, Production, and Transfer, Energy Production (generation), Nuclear Power Plant -- maintenance, modification, or expansion**
Project Area: **2.19 acres**
County(s): **Beaver**
Township/Municipality(s): **SHIPPINGPORT**
ZIP Code: **15050**
Quadrangle Name(s): **HOOKSTOWN; MIDLAND**
Watersheds HUC 8: **Upper Ohio**
Watersheds HUC 12: **Sixmile Run-Ohio River**
Decimal Degrees: **40.624573, -80.435100**
Degrees Minutes Seconds: **40° 37' 28.4621" N, 80° 26' 6.3594" W**

2. SEARCH RESULTS

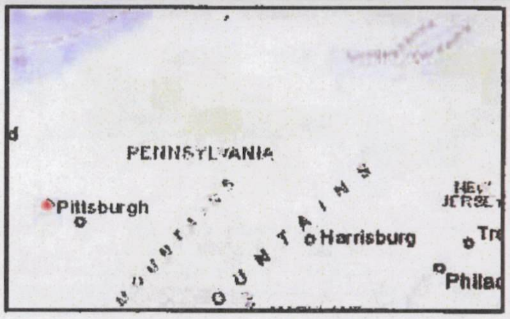
Agency	Results	Response
PA Game Commission	No Known Impact	No Further Review Required
PA Department of Conservation and Natural Resources	No Known Impact	No Further Review Required
PA Fish and Boat Commission	**Potential Impact**	**FURTHER REVIEW IS REQUIRED, See Agency Response**
U.S. Fish and Wildlife Service	**Conservation Measure**	**No Further Review Required, See Agency Comments**

As summarized above, Pennsylvania Natural Diversity Inventory (PNDI) records indicate there may be potential impacts to threatened and endangered and/or special concern species and resources within the project area. If the response above indicates "No Further Review Required" no additional communication with the respective agency is required. If the response is "Further Review Required" or "See Agency Response," refer to the appropriate agency comments below. Please see the DEP Information Section of this receipt if a PA Department of Environmental Protection Permit is required.

Beaver Valley Nuclear Power Station

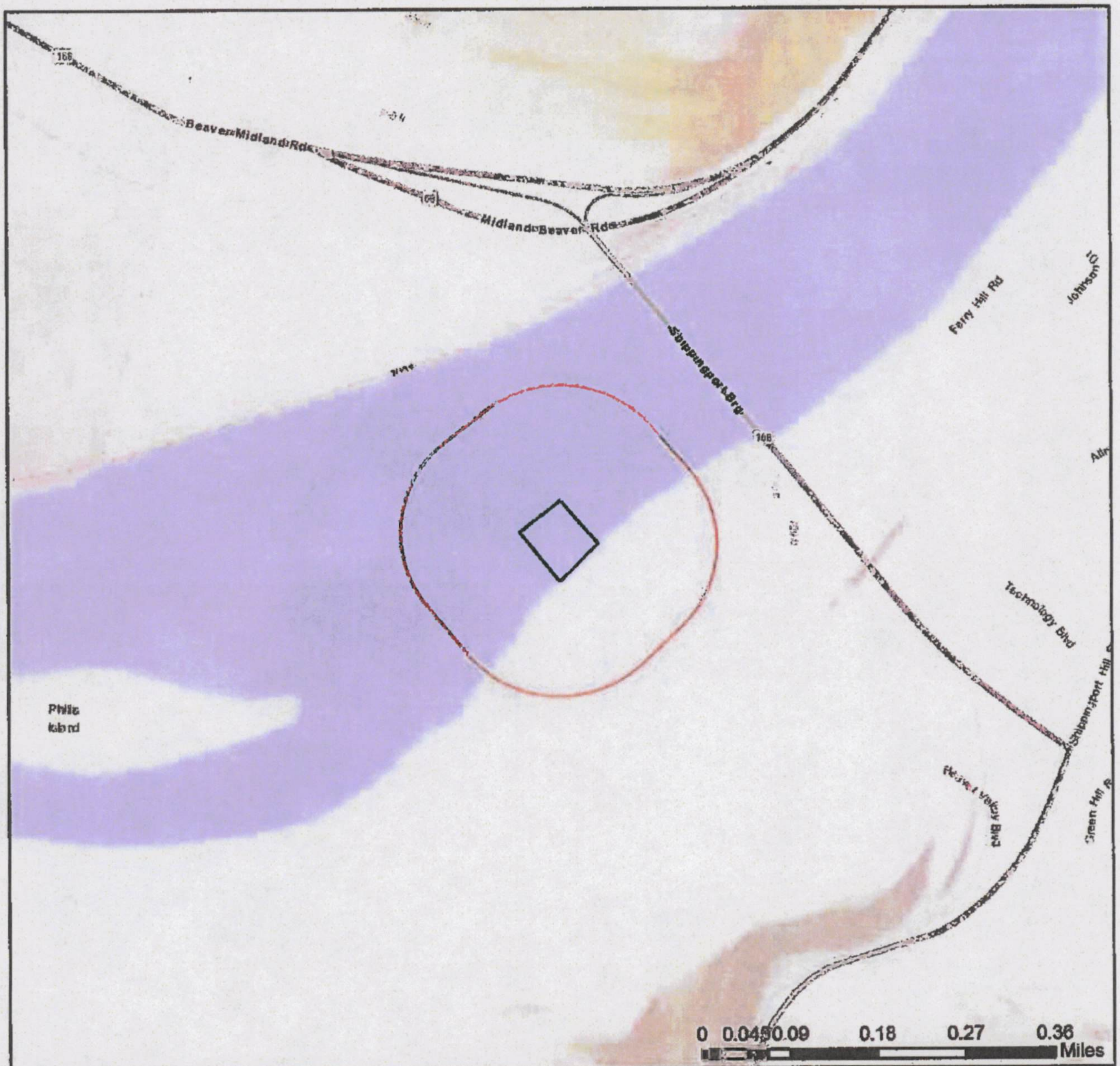
Project Boundary

Buffered Project Boundary



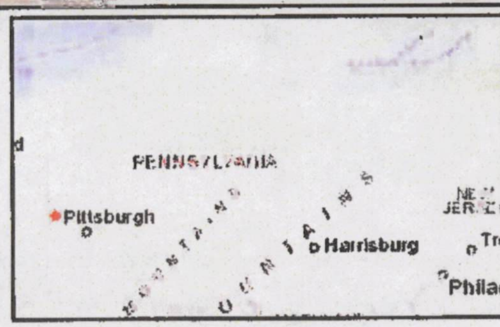
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

Beaver Valley Nuclear Power Station



Project Boundary

Buffered Project Boundary



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS,

3. AGENCY COMMENTS

Regardless of whether a DEP permit is necessary for this proposed project, any potential impacts to threatened and endangered species and/or special concern species and resources must be resolved with the appropriate jurisdictional agency. In some cases, a permit or authorization from the jurisdictional agency may be needed if adverse impacts to these species and habitats cannot be avoided.

These agency determinations and responses are **valid for two years** (from the date of the review), and are based on the project information that was provided, including the exact project location; the project type, description, and features; and any responses to questions that were generated during this search. If any of the following change: 1) project location, 2) project size or configuration, 3) project type, or 4) responses to the questions that were asked during the online review, the results of this review are not valid, and the review must be searched again via the PNDI Environmental Review Tool and resubmitted to the jurisdictional agencies. The PNDI tool is a primary screening tool, and a desktop review may reveal more or fewer impacts than what is listed on this PNDI receipt. The jursidictional agencies **strongly advise against** conducting surveys for the species listed on the receipt prior to consultation with the agencies.

PA Game Commission
RESPONSE:
No Impact is anticipated to threatened and endangered species and/or special concern species and resources.

PA Department of Conservation and Natural Resources
RESPONSE:
No Impact is anticipated to threatened and endangered species and/or special concern species and resources.

PA Fish and Boat Commission
RESPONSE:
Further review of this project is necessary to resolve the potential impact(s). Please send project information to this agency for review (see WHAT TO SEND).

PFBC Species: (Note: The Pennsylvania Conservation Explorer tool is a primary screening tool, and a desktop review may reveal more or fewer species than what is listed below.)

Scientific Name	Common Name	Current Status
Leptodea fragilis	Fragile Papershell	Special Concern Species*
Obliquaria reflexa	Threehorn Wartyback	Special Concern Species*
Quadrula quadrula	Mapleleaf	Special Concern Species*
Truncilla donaciformis	Fawnsfoot	Special Concern Species*

U.S. Fish and Wildlife Service
RESPONSE:
Conservation Measure: Voluntary implementation of the following recommendations will contribute to the conservation and recovery of endangered and threatened species. – In order to maintain or improve water quality for endangered aquatic species, retain (or restore, if not already present) a 100- to 300-foot wide buffer on each side of the waterway (river, stream, creek) or waterbody (lake). Avoid construction, earth disturbance, and chemical application in this buffer. The buffer should be vegetated with native plant species. When adequately vegetated, this upland buffer will act to stabilize the streambanks (preventing or minimizing erosion), and filter pollutants (e.g., sediment, fertilizers, pesticides, road salt, oil). Where streambanks have become badly eroded (e.g., due to removal of native riparian vegetation), streambank fencing and/or bioengineering restoration techniques are recommended (geotextile, root wads, vegetative stabilization), rather than riprapping the streambanks; removing gravel bars; or attempting to dredge, ditch, channelize, or widen the stream.

* Special Concern Species or Resource - Plant or animal species classified as rare, tentatively undetermined or candidate as well as other taxa of conservation concern, significant natural communities, special concern populations (plants or animals) and unique geologic features.
** Sensitive Species - Species identified by the jurisdictional agency as collectible, having economic value, or being susceptible to decline as a result of visitation.

WHAT TO SEND TO JURISDICTIONAL AGENCIES

If project information was requested by one or more of the agencies above, upload* or email* the following information to the agency(s). Instructions for uploading project materials can be found here. This option provides the applicant with the convenience of sending project materials to a single location accessible to all three state agencies. Alternatively, applicants may email or mail their project materials (see AGENCY CONTACT INFORMATION).
***Note:** U.S.Fish and Wildlife Service requires applicants to mail project materials to the USFWS PA field office (see AGENCY CONTACT INFORMATION). USFWS will not accept project materials submitted electronically (by upload or email).

Check-list of Minimum Materials to be submitted:
____Project narrative with a description of the overall project, the work to be performed, current physical characteristics of the site and acreage to be impacted.
____A map with the project boundary and/or a basic site plan(particularly showing the relationship of the project to the physical features such as wetlands, streams, ponds, rock outcrops, etc.)
In addition to the materials listed above, USFWS REQUIRES the following
____**SIGNED** copy of a Final Project Environmental Review Receipt

The inclusion of the following information may expedite the review process.
____Color photos keyed to the basic site plan (i.e. showing on the site plan where and in what direction each photo was taken and the date of the photos)
____Information about the presence and location of wetlands in the project area, and how this was determined (e.g., by a qualified wetlands biologist), if wetlands are present in the project area, provide project plans showing the location of all project features, as well as wetlands and streams.

4. DEP INFORMATION

The Pa Department of Environmental Protection (DEP) requires that a signed copy of this receipt, along with any required documentation from jurisdictional agencies concerning resolution of potential impacts, be submitted with applications for permits requiring PNDI review. Two review options are available to permit applicants for handling PNDI coordination in conjunction with DEP's permit review process involving either T&E Species or species of special concern. Under sequential review, the permit applicant performs a PNDI screening and completes all coordination with the appropriate jurisdictional agencies prior to submitting the permit application. The applicant will include with its application, both a PNDI receipt and/or a clearance letter from the jurisdictional agency if the PNDI Receipt shows a Potential Impact to a species or the applicant chooses to obtain letters directly from the jurisdictional agencies. Under concurrent review, DEP, where feasible, will allow technical review of the permit to occur concurrently with the T&E species consultation with the jurisdictional agency. The applicant must still supply a copy of the PNDI Receipt with its permit application. The PNDI Receipt should also be submitted to the appropriate agency according to directions on the PNDI Receipt. The applicant and the jurisdictional agency will work together to resolve the potential impact(s). See the DEP PNDI policy at https://conservationexplorer.dcnr.pa.gov/content/resources.

5. ADDITIONAL INFORMATION

The PNDI environmental review website is a preliminary screening tool. There are often delays in updating species status classifications. Because the proposed status represents the best available information regarding the conservation status of the species, state jurisdictional agency staff give the proposed statuses at least the same consideration as the current legal status. If surveys or further information reveal that a threatened and endangered and/or special concern species and resources exist in your project area, contact the appropriate jurisdictional agency/agencies immediately to identify and resolve any impacts.

For a list of species known to occur in the county where your project is located, please see the species lists by county found on the PA Natural Heritage Program (PNHP) home page (www.naturalheritage.state.pa.us). Also note that the PNDI Environmental Review Tool only contains information about species occurrences that have actually been reported to the PNHP.

6. AGENCY CONTACT INFORMATION

PA Department of Conservation and Natural Resources
Bureau of Forestry, Ecological Services Section
400 Market Street, PO Box 8552
Harrisburg, PA 17105-8552
Email: RA-HeritageReview@pa.gov

U.S. Fish and Wildlife Service
Pennsylvania Field Office
Endangered Species Section
110 Radnor Rd; Suite 101
State College, PA 16801
NO Faxes Please

PA Fish and Boat Commission
Division of Environmental Services
595 E. Rolling Ridge Dr., Bellefonte, PA 16823
Email: RA-FBPACENOTIFY@pa.gov

PA Game Commission
Bureau of Wildlife Habitat Management
Division of Environmental Planning and Habitat Protection
2001 Elmerton Avenue, Harrisburg, PA 17110-9797
Email: RA-PGC_PNDI@pa.gov
NO Faxes Please

7. PROJECT CONTACT INFORMATION

Name: Kevin M. DeCristofer
Company/Business Name: AECOM
Address: 625 West Ridge Pike, Suite E-100
City, State, Zip: Conshohocken,PA 19428
Phone:(610) 832-7362 Fax:(610) 832-3501
Email: kevin.decristofer@aecom.com

8. CERTIFICATION

I certify that ALL of the project information contained in this receipt (including project location, project size/configuration, project type, answers to questions) is true, accurate and complete. In addition, if the project type, location, size or configuration changes, or if the answers to any questions that were asked during this online review change, I agree to re-do the online environmental review.

Kevin M. DeCristofer — applicant/project proponent signature

05/23/2018 — date

AECOM
Built to deliver a better world

May 23, 2018

Kevin DeCristofer, Aquatic Ecologist
AECOM
625 West Ridge Pike
Suite E-100
Conshohocken, PA 19428

USA Re: PNDI (PNDI-657834) Project Narrative

To Whom It May Concern,

This letter is in response to the Pennsylvania Fish and Boat Commission (PFBC) request for further review to determine potential impacts following AECOM's submittal of a Pennsylvania Natural Diversity Inventory (PNDI) Project Review. The PNDI was generated in order to determine whether any state protected aquatic species are known to, or may occur within the vicinity of the cooling water intake structure of the Beaver Valley Nuclear Power Station in Shippingport, Pennsylvania and may be subject to impingement or entrainment under 316(b) of the Clean Water Act (CWA). Cooling water from the Beaver Valley Nuclear Power Station is utilized from the Ohio River at approximately Ohio River Mile 34.8. Approval of CWA 316(b) CWA measures are authorized and regulated by the Pennsylvania Department of Environmental Protection (PADEP) under NPDES permit No. PA0025615. This letter is intended to satisfy the project narrative requirement required by PFBC to continue further review.

AECOM is currently in the process of preparing a Clean Water Act (CWA) §316(b) 122.21(r)(4) Report. This report will be submitted to PADEP in the future as a part of the Beaver Valley Nuclear Power Station NPDES permit renewal application. As a part of that (r)(4) report, the risk of impingement or entrainment to any federally or state protected species must be evaluated and addressed. The purposes of the PNDI request are to determine the risk, if any, of impingement or entrainment to any protected species that may occur within the vicinity of the Beaver Valley Nuclear Power Stations Cooling Water intake Structure.

If there are any further questions regarding the purpose of the PNDI request or the project descriptions, please contact me with the information provided below. A project map is provided below.

Kevin DeCristofer, Aquatic Ecologist
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Beaver Valley Nuclear Power Station Cooling Water Intake Location Ohio River Mile 34.8