FACT SHEET

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 3
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

NPDES Permit No. DC0000248

The United States Environmental Protection Agency (EPA) Proposed the Reissuance of a National Pollutant Discharge Elimination System (NPDES) Permit to Discharge Pollutants Pursuant to the Provisions of the Clean Water Act (CWA) For:

The John F. Kennedy Center for the Performing Arts
2700 F Street, NW
Washington, D.C. 20566

RECEIVING WATER:
Potomac River

ACTION TO BE TAKEN:

EPA is finalizing the reissuance of the NPDES permit for the John F. Kennedy Center for the Performing Arts. EPA published a draft permit for a 30-day public notice and comment period on September 23, 2021 and accepted comments until October 25, 2021 because October 23, 2021 fell on a weekend (see 40 C.F.R. 124.20(c)). EPA did not receive public comments on the draft permit during or after the public notice period.

The final permit is intended to replace the 2013 permit which was administratively continued past its June 5, 2013 expiration date. The effective date of this reissued permit is March 1, 2022.

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1.0 Facility Description

The John F. Kennedy Center for the Performing Arts ("The Kennedy Center" or "Permittee") is located adjacent to the Potomac River in Washington, D.C. The Kennedy Center is a public/private partnership facility serving a dual role as a presidential memorial and a performing arts center. The Kennedy Center withdraws raw water from the Potomac River to provide non-contact cooling water for the condensers to operate the facility's air conditioning system. The Kennedy Center's air conditioning system consists of four chillers that provide cool air (i.e. air conditioning) during various times of the year when hot temperatures outside cause the building's inside temperature to rise above ambient. Heat is generated in the chillers requiring the use of a coolant to bring temperatures down. The water withdrawn from the Potomac River functions as "cooling water" which gets circulated through the system to reduce the high temperatures generated by the chillers. Because the raw Potomac River water (aka cooling water) is circulated through pipes and does not come into contact with raw materials, products, or other wastes, it is referred to as "non-contact cooling water."

In 2019, The Kennedy Center completed construction of an expansion to their existing building which provided 60,000 square feet of additional space for classrooms, rehearsal rooms, event spaces, and offices adjacent to The Kennedy Center. This new addition is called the "The REACH." In order to provide heating and cooling to the REACH facilities, connections to the chilled and heating hot water systems were made at the existing central plant in the Refrigeration Room. The connections were supplemented by a geothermal heat exchanger via connection to a modular water-to-water heat pump system in order to reduce the environmental impact on the Potomac River. This system allows the heat absorbed from the new REACH facilities to be rejected into several geothermal wells located within the new landscape. Each well has a depth of 500 feet and rejects heat into the ground. As a result, this new system reduces the need to increase the influent flow requirements from the Potomac River because the geothermal heat exchanger recirculates and reuses the water after the heat is transferred out of the water and into the ground.

The following is a list of changes from the previous permit:

1. Added detailed reporting requirements to clarify how data should be reported on the Discharge Monitoring Reports (DMRs).
2. Added requirements to satisfy the federal regulations for existing facilities with cooling water intake structures, consistent with section 316(b) of the Clean Water Act, 33 U.S.C. § 1326(b).
3. Removed temperature limits based on the results of the reasonable potential (RP) analysis.

2.0 Discharge Description

The Kennedy Center withdraws water from the Potomac River to provide non-contact cooling water to operate the facility's once through, single use cooling system. Raw river water enters a sump in the condenser pump room via a 60-inch diameter intake pipe. The water travels through a series of screens and basket strainers where debris is removed prior to distribution of the water to and from the chillers. After the water is used for cooling, heat is transferred from four condensers where it exits the condenser pump room via a 24-inch pipe and returned to Potomac River through Outfall 001. Depending on the time of year, the water may be recirculated and sent to a holding tank to allow the water temperature to cool before discharging. The average annual effluent flow during the previous permit cycle was 5 million gallons per day (MGD), however, the facility generally does not discharge during the winter months since operating the cooling system is not necessary. The discharge occurs primarily between May-October.

Parameters of concern identified in the discharge are temperature and pH. Since biofouling[1] has not been a problem at the facility, the permittee does not treat raw water (the influent) with additives.

Table 1. Discharge location

OUTFALL NO.	LATITUDE	LONGITUDE	RECEIVING WATER	DESIGNATED USES
001	**N38º 53' 52.8"**	**W77º 03' 28.8"**	**Potomac River**	**A, B, C, D, E**

Classifications of the District's Waters, Defined:
Class A – Primary Contact Recreation
Class B – Secondary Contact Recreation
Class C – Protection and propagation fish, shellfish and wildlife
Class D – Protection of human health related to consumption of fish and shellfish
Class E – Navigation

3.0 Special Conditions in the 2013 Permit

3.1 Thermal Plume Study

The previous permit required the permittee to conduct a thermal plume study after the cooling system was updated to determine how the thermal discharge mixes with the ambient receiving waters, including a characterization of the horizontal and vertical extent of the thermal discharge plume. The permittee conducted the study in August 2013 to capture conditions when the receiving waters were expected to be the hottest. The study accounted for tidal influence of the ambient river, including current speed and direction, salinity, density, and temperature. Measurements were taken during three time periods: during peak flood tide, slack water, and peak ebb tide. Thirty-two vertical profile measurements were collected through the full depth of the Potomac River water column, taken at distances ranging horizontally from 4 ft to 523 ft from the outfall. The results of the study indicated that the discharge has a limited thermal footprint with a return to background temperature within a horizontal distance of 50 ft from the outfall. In other words, the river water was well mixed and indistinct from background within 50 ft of the outfall. For perspective, the full width of the Potomac River from Outfall 001 to the edge of the Theodore Roosevelt Island, which is across the river from the Kennedy Center, is 816 ft wide. There was no vertical plume observed, with the exception of one location within 5 ft of the discharge, where elevated water temperatures were observed in the upper 5-10 ft of the water column.

4.0 Special Conditions in the current permit

4.1 Part III.A Cooling Water Intake Structure Best Technology Available (BTA)

This special condition includes requirements that must be in all permits subject to section 316(b) of the Clean Water Act as well as site specific requirements for the Kennedy Center.

4.2 Part III.B Additional Monitoring for Entrainment

The permittee currently conducts monthly visual inspections of the non-contact cooling water intake structure (CWIS) and has stated that no impingement or entrainment of fish or shellfish has occurred.

[1] Biofouling is the degradation of pipes caused by microorganisms, plants, and algae.

However, the permittee lacks a formal monitoring program that characterizes the potential for entrainment of fish, larvae, or eggs. This special condition requires the permittee to conduct a formal evaluation of the entrainment potential to determine if entrainment of fish, larvae or eggs occurs during normal operating conditions. The monitoring must be conducted over the next permit term. The Permittee must submit Biological Monitoring Reports at the end of each calendar year. It should be noted that entrainment studies are not required by 40 C.F.R. § 122.21(r) for facilities like the Kennedy Center that withdraw <125 mgd, however, the permittee has not properly and adequately documented entrainment of organisms during the last permit term. As such EPA believes a formal evaluation is necessary to ensure that entrainment is not occurring.

4.2 Part III. C. Application Requirements for Cooling Water Intake Structures

In 2014, EPA finalized regulations that established requirements for cooling water intake structures at existing facilities that are designed to withdraw more than 2 million gallons per day of water from waters of the United States. These regulations established national requirements applicable to the location, design, construction, and capacity of cooling water intake structures at existing facilities that reflect the BTA for minimizing the adverse environmental impact for impingement and entrainment associated with the use of these structures. The revised regulations at 40 C.F.R § 122.21(r)(1)(ii)(A) and § 125.95(a), require all existing facilities to submit the information required under 40 C.F.R § 122.21 (r)(2) – (r)(3) as well as (r)(4) – (8) if applicable. 40 C.F.R § 122.21 (r)(2) – (r)(8) are sections that apply to this facility. EPA requested this new information to be submitted as supplemental information with their 2017 permit application for this permit reissuance. The BTA determinations were based on this information which is the best available information at this time. EPA added the special condition in Part III Section B of the permit to ensure that the information required in 40 C.F.R § 122.21 is provided with the next permit reissuance.

5.0 CWA Section 316(b)

5.1 Applicability of CWA Section 316(b)

Section 316(b) of the Clean Water Act and its implementing regulations found at 40 C.F.R. Part 125 Subpart J require existing facilities' cooling water intake structures to reflect best technology available (BTA) for minimizing adverse environmental impacts. The 316(b) implementing regulations were revised and became effective on October 14, 2014. The revised rule established national requirements applicable to the location, design, construction, and capacity of cooling water intake structures at existing facilities that reflect the BTA for minimizing the adverse environmental impact for impingement and entrainment associated with the use of these structures. According to 40 C.F.R § 125.91(a), existing facilities are subject to applicable requirements at sections 125.94 through 125.99 if the facility is (1) a point source, (2) uses or proposes to use one or more cooling water intake structures with a cumulative design intake flow (DIF) of greater than 2 mgd to withdraw water from waters of the United States and (3) twenty-five percent or more of the water the facility withdraws on an actual intake flow (AIF) basis is used exclusively for cooling purposes. All facilities subject to this rule must submit basic information describing the facility, source water physical data, source water biological characterization data, and cooling water intake system data. The Kennedy Center is an existing facility as defined in 40 C.F.R. § 125.92(k) and meets the aforementioned three criteria, making it subject to 40 C.F.R § 125.94 through § 125.99.

5.2 Cooling Water Intake Structure Description

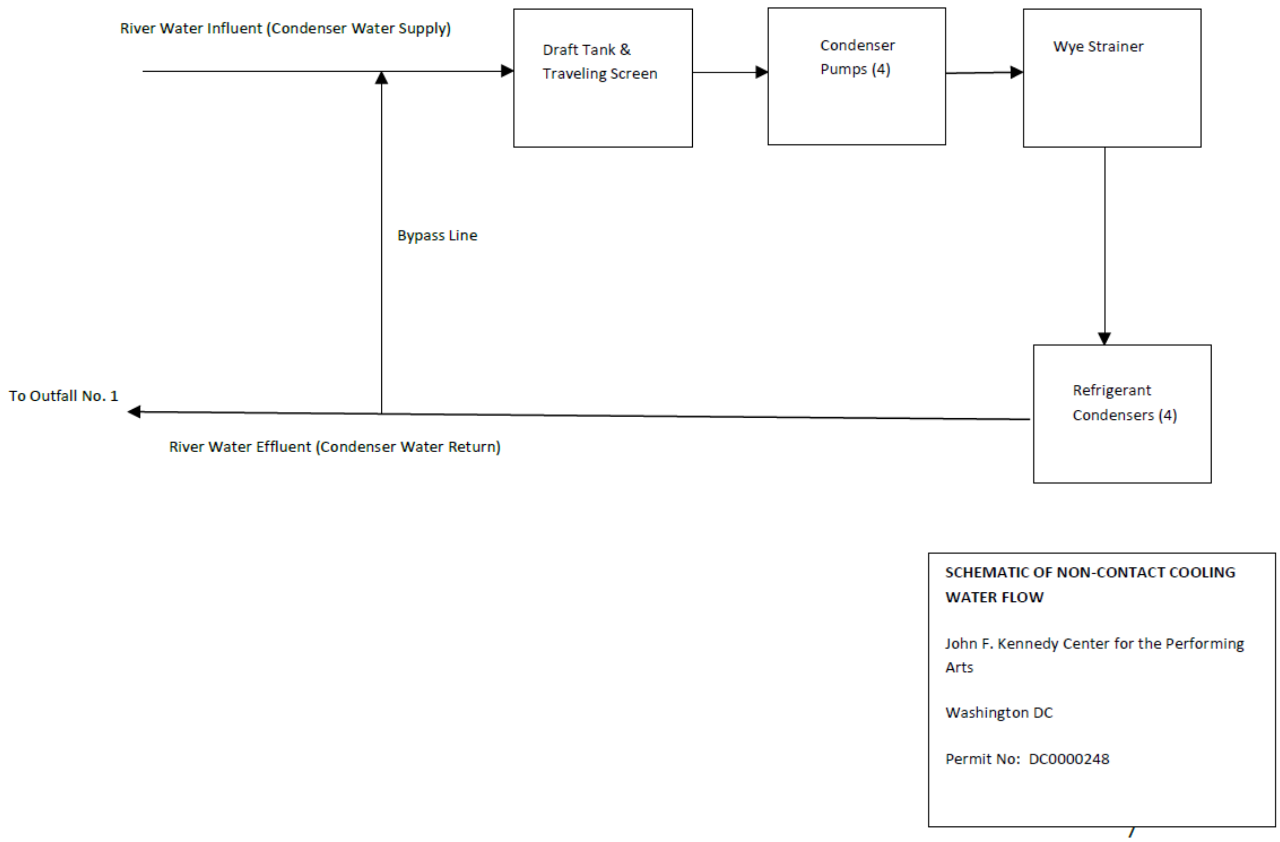
Raw water from the Potomac River enters a sump in the condenser pump room via a 60-inch diameter intake pipe that extends 37 feet from the shoreline. At the mouth of this 60-inch intake pipe there is a grid arrangement of ¾-inch monel rods spaced 6 inches on center and welded at the crossing joints. The approximate location of the cooling water intake pipe is North 38.894943 degrees latitude and West 77.056738 degrees longitude. The 60-inch pipe enters into the draft tank located on level C of the garage and within the Condenser Pump Room. The draft tank has a depth of about 26 feet and the intake pipe has an invert elevation of -11.61 feet at the point of intake. Influent then travels through a parallel set of traveling screen filters containing a mesh hardware cloth approximately 1/4 inch thick and then to the draft tank section.

The river water then travels to a basin where a bar grid strainer is located. This bar grid strainer has an opening of 0.29 square feet. The grid strainer is composed of metal bars that are 3/16 inches thick arranged to form a 1-inch deep grid with openings approximately 1 inch wide by 4 inches high. The total length of this bar grid is approximately 12 feet.

The influent is drawn from the draft tank through 20-inch foot valves, into the primary condenser water pumps, through a 24-inch Wye strainer for additional filtration. The Wye strainer has a fabricated carbon steel body and a 1/8 inch perforated stainless steel screen. The water then travels through 24-inch pipe supply water to the chiller plant. A 14-inch diameter pipe allows effluent water to be recirculated into the draft tank, so that the water used in the chillers does not fall below the chiller manufacturer's recommended minimum temperature of 73 degrees F. Two automatic butterfly valves (one in the 24-inch pipe and one in the 14-inch pipe) are utilized to regulate the amount of by-pass water. After having the debris removed from the water via traveling screens and strainers, four condenser water pumps (each rated for 4,000 gallons per minute or) are utilized to distribute the water to and from the chillers located within the Refrigeration Room on level C of the Kennedy Center premises. One condenser water pump supplies water to one chiller, if two chillers are needed then two water pumps will be operating to pump water to the two chillers. The effluent water travels back to the Condenser Pump Room where it exits the Condenser Pump Room via a 24-inch diameter pipe and is pumped to Outfall Number 001 to the Potomac River.

The design intake flow rate of condenser water supply (influent) that is needed for a single chiller is 3.6 MGD. Since there are four chillers, the maximum design intake flow rate equates to 14.4 MGD if all four chillers need to be in full operation at once; the facility does not typically operate at its maximum design flow intake rate, however. The actual average intake flow is 2.2 MGD, which is only 15% of the capacity of the condenser pumps. The average intake velocity is 0.22 feet per second (fps). The daily hours of operation are 18 hours/day from May to October. From November to April the use of the chillers is typically not needed.

Below is a flow distribution and water balance diagram of the source water, recirculating flows, and discharges provided by The Kennedy Center. The raw water intake pipe that leads to the draft tank has an invert elevation of -11.61 feet which is not depicted in the flow diagram below:



5.3 Source water physical data as it relates the intake structure

The section of the Potomac where the intake is located consists of tidal fresh water with marginal increases in salinity with depth from 0.172 to 0.177 (using the Practical Salinity Scale or PSS). Salinity at the outfall was measured at 0.173 within normal freshwater range for the Potomac River.[2] The water column in the vicinity of the intake is approximately 40 feet deep. The Thermal Plume study submitted by the permittee contains temperature regime graphics that depict steady surface temperatures across the study area with the temperature varying within a half degree of 80°F, indicating a uniform background temperature.

5.4 Potomac River (source water) baseline characterization data as it relates to the intake structure

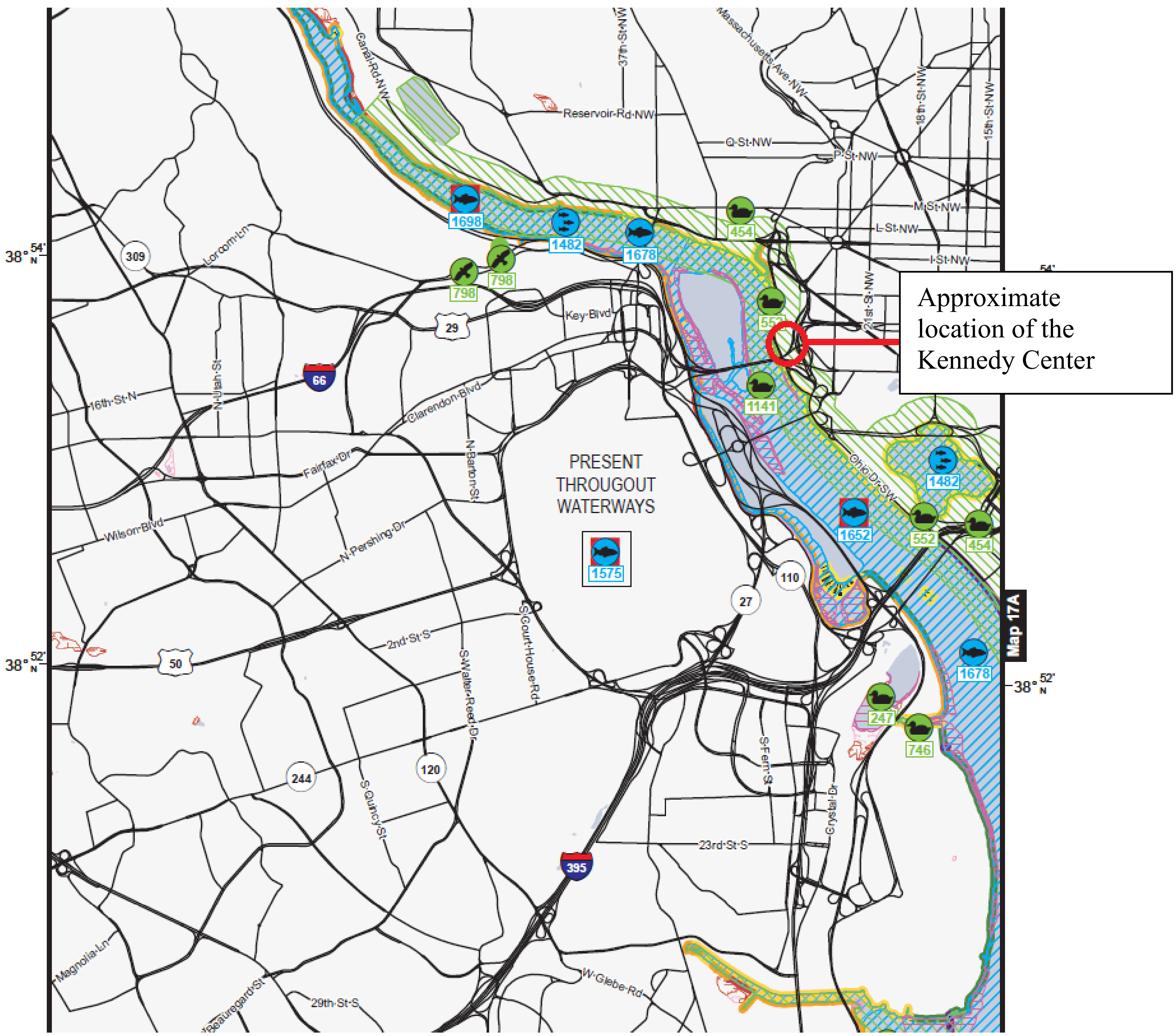
The permittee was required to submit information to characterize the biological community in the vicinity of the cooling water intake structure (CWIS). To satisfy this requirement, the permittee submitted a study that was published in September 2016 by the National Oceanic Atmospheric Administration's Office of Response and Restoration (NOAA study) titled "Environmental Sensitivity Index Atlas, A guide to Coastal Resources at Risk to Spilled Oil." The Environmental Sensitivity Index Atlas was developed for the marine and coastal areas of the Chesapeake Bay and the outer coasts of Maryland and Virginia.[3] The data provided in the NOAA study summarizes the resources (shoreline

[2] Page 2 of the Thermal Plume Study
[3] Page IV (introduction) of the NOAA study

habitat, sensitive biological resources, and human-use resources) that may be particularly vulnerable to spilled oil; in other words, it is not a comprehensive listing of the species present in the Potomac River area near the intake structure. However, EPA believes the study provides enough information to adequately characterize the biological community within the vicinity of the intake structure.

The NOAA study maps the geographic distribution of species in different area segments. Each map includes a tabular report that summarizes the species found in that area. The presence of a species was recorded on the map if the species occurred with a 10% frequency or higher in a given month for a given sampling region.

The Kennedy Center is located in the area included in Map 17B, Chesapeake Bay West which is presented below. The figure below was taken from the NOAA study and shows the mapped area that includes the Kennedy center and its cooling water intake structure.



According to this map, there are seven (7) fish species present in the Potomac River that may be in the general vicinity of the Kennedy Center's cooling water intake structure; the following table lists those seven (7) fish species. Most notably, the list includes the Atlantic and Shortnose Sturgeons, which are federally protected species under the Endangered Species Act. This list and the lists included in Appendix A are excerpts from the NOAA study. A full list of the biological community can be found on page 496 of the NOAA study, which can also be found in Appendix A of this fact sheet.

FISH

Map ID	Subelement	Species	Mapping Qualifier	MD/VA S	F	Concentration	Monthly Presence J F M A M J J A S O N D	Spawn	Eggs	Larvae	Juveniles	Adults
1482	Estuarine Nursery	White perch	Spawning Area			-		Mar-May	Mar-May	Apr-Jun	-	Mar-May
1575	Diadromous	Atlantic sturgeon	General Distribution	-/E	E	-		-	-	-	-	Jan-Dec
	Diadromous	Shortnose sturgeon	General Distribution	E/E	E	-		-	-	-	Jan-Dec	Jan-Dec
1652	Diadromous	Shortnose sturgeon	Migration	E/E	E	-		-	-	-	-	Mar-Jun
1678	Diadromous	Alewife	Nursery Area			Moderate Run		-	-	Feb-Apr	Apr-Oct	Feb-Apr
	Diadromous	American shad	Nursery Area			Strong Run		-	-	May-Jul	May-Oct	-
	Diadromous	American shad	Spawning Area			Strong Run		Apr-Jun	Apr-Jun	-	-	Mar-Jun
	Diadromous	Blueback herring	Nursery Area			Moderate Run		-	-	May-Jul	May-Oct	Feb-Jun
	Diadromous	Hickory shad	Nursery Area			Moderate Run		-	-	Apr-Jun	Apr-Oct	Feb-Jun
1698	Diadromous	Shortnose sturgeon	Spawning Area	E/E	E	Potential Spawning		Apr-May	Apr-May	-	-	Apr-May

The 2013 permit's administrative record included a Biological Opinion (BO) from the National Marine Fisheries Service (NMFS or NOAA Fisheries), which is a division of the National Oceanic and Atmospheric Administration (NOAA). The 2013 BO evaluated the Kennedy Center's intake and discharge as it relates to the Atlantic and Shortnose Sturgeon. The 2013 BO indicated that no spawning of Atlantic or Shortnose Sturgeon in the Potomac River had been confirmed. However, a Shortnose Sturgeon sighting in the Potomac River near Chain Bridge was reported to and confirmed by the U.S. Fish and Wildlife Service in April 2021[4]. Chain Bridge is located approximately 4 miles upstream from the Kennedy Center. The 2013 BO also stated that if Atlantic or Shortnose Sturgeon larvae were to move this far downstream (to the location of the Kennedy Center) they would be at least 20mm in length and would be able to avoid the intake velocity of 0.5 fps. According to the 2013 BO, all life stages are thought to be able to avoid intake velocities of 0.5 fps and larger life stages such as juvenile, subadult, and adult of both species have been demonstrated to avoid impingement and entrainment at intakes with velocities as high as 3.0 fps. Based on this information and the fact that the permittee has not observed impinged or entrained fish in their non-contact CWIS, EPA believes the existing technologies employed at the Kennedy Center are adequate to protect fish species of varying life stages, including the sturgeon. EPA will be submitting a new biological evaluation to the NMFS for the reissuance of this permit.

The following table lists the species that are "generally distributed" in the mapped area shown above. According to the NOAA study, this qualifier is used for "broad, general distributions of species that are often mapped to landscape or habitat scale features." In other words, the species listed below may not be located within the immediate area of the intake but are located in area of the Potomac depicted in the map above.

[4] This Shortnose Sturgeon sighting was reported by the local CBS news station in D.C. called WUSA9. The article was published on the CBS WUSA9 website and saved in the permit's administrative record. See document number 56.

FISH

Subelement	Species	Spawn	Eggs	Larvae	Juveniles	Adults
Diadromous	Alewife	Feb-Apr	Feb-Apr	Feb-Apr	Apr-Oct	Feb-Apr
	Alewife	Mar-May	Mar-May	Apr-Jun	Apr-Oct	Mar-May
	American eel	-	-	-	Jan-May	Jan-Dec
	American shad	Apr-Jun	Apr-Jun	May-Jul	May-Oct	Mar-Jun
	Blueback herring	Apr-Jun	Apr-Jun	May-Jul	May-Oct	Feb-Jun
	Blueback herring	Mar-Jun	Mar-Jun	Apr-Jun	May-Oct	Mar-Jun
	Gizzard shad	Mar-Jun	-	-	Jan-Dec	Jan-Dec
	Striped bass	-	-	-	Jan-Dec	Jan-Dec
Estuarine Nursery	White perch	-	-	-	Jan-Dec	Jan-Dec
Estuarine Resident	Silversides	Mar-Jul	Mar-Jul	Apr-Sep	Jan-Dec	Jan-Dec
Freshwater	Black crappie	Mar-Jul	-	-	Jan-Dec	-
	Bullhead catfish	Apr-Jun	-	-	-	Jan-Dec
	Chain pickerel	Feb-Apr	-	-	-	Jan-Dec
	Channel catfish	May-Jun	-	-	Jan-Dec	Jan-Dec
	Common carp	May-Jun	-	-	-	Jan-Dec
	Golden shiner	Apr-Aug	-	-	Jan-Dec	Jan-Dec

Chesapeake West: Map 17B

5.4.1 Conclusion of the baseline characterization data as it relates to the intake structure

EPA evaluated the geographic distribution of species in the NOAA study along with the facility's current control technology and site specific impingement and entrainment information. The Kennedy Center's intake flow is 2.2 MGD and the 7Q10 (low flow) of the Potomac River is 741 MGD; that is a 0.3% withdrawal rate of the Potomac River. Likewise, the Kennedy Center uses only 15% of their design intake flow which is an 85% reduction from the design capacity of the system. Having a low intake flow minimizes the impacts of the CWIS on the aquatic community. Lastly, data collected by EPA shows that 96% of studied fish can avoid an intake structure when the intake velocity is 0.5 ft/sec or less[5]. The permittee's actual intake velocity is 0.22 ft/sec and the permittee reports that it has not observed impingement or entrainment of fish or shellfish in its CWIS. Based on this information, EPA does not expect there to be adverse effects on the species listed above.

5.5 BTA Standard for Impingement Mortality, 40 C.F.R. § 125.94(c)

According to 40 C.F.R § 125.98(b)(2), any permit issued after July 14, 2018 must include, at a minimum, conditions to implement and ensure compliance with the impingement mortality[6] standard at § 125.94(c). The Kennedy Center's chosen method of compliance is maintaining 0.5 feet per second through screen actual velocity which is the BTA standard for impingement mortality found at 40 C.F.R § 125.94(c)(3). EPA calculated an average monthly flow limit of 2.2 MGD, which establishes a flow reduction of 85% from the design flow. Additionally, a maximum flow limit of 6.3 MGD will ensure the facility will not exceed the 0.5 fps velocity at the intake. Therefore, average monthly and daily maximum flow limits of 2.2 MGD and 6.3 MGD, respectively, were imposed in the permit and will ensure that the 0.5 fps through screen velocity standard is met. The facility's average intake velocity is 0.22 feet per second[7], therefore, EPA believes the facility can achieve this standard by using the current technology in place. This BTA determination may be revised upon submission of additional

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[5] See Chapter 9.1.2 of EPA's "Technical Development Document for the Final Section 316(b) Existing Facilities Rule, May 2014." This document can be found the permit's administrative record, document number 67.

[6] "Impingement mortality" is defined as "death as a result of impingement." 40 C.F.R § 125.92(o). "Impingement," in turn, is defined as "the entrapment of any life stages of fish and shellfish on the outer part of an intake structure or against a screening device during periods of intake water withdrawal." 40 C.F.R § 125.92(n). This includes those organisms collected or retained on a sieve with maximum distance in the opening of 0.56 inches and excludes those organisms that pass through the sieve. It may also include organisms removed from their natural ecosystem and lacking the ability to escape the cooling water intake system and thus subject to mortality.

[7] See Appendix B for calculations.

information by the permittee. Revisions to the BTA determination shall be effective through a permit modification or renewal of the permit.

5.6 BTA Standard for Entrainment For Existing Facilities, 40 C.F.R § 125.94(d)

According to 40 C.F.R § 125.98(b)(2), any permit issued after July 14, 2018 must include, at a minimum, conditions to implement and ensure compliance with the entrainment standard at § 125.94(d). The 2014 rule established the national BTA standard for entrainment at existing units at existing facilities at 40 C.F.R. § 125.94(d). This rule, however, did not promulgate uniform national requirements for entrainment for existing facilities. Instead, the rule requires that the permitting authority establish BTA entrainment requirements for a facility on a site-specific basis in accordance with the requirements at 40 C.F.R. § 125.98(f).

The permittee states that it has never observed fish and/or shellfish[8] impingement on the traveling screens or entrainment in the system. Monthly visual inspections of the inlet tank pit and river pump room are performed where the condition of the pit, traveling screens, and water levels are checked. These visual inspections have never revealed fish impingement or entrainment. The high efficiency chillers at the Kennedy Center and the existing traveling screen and wye strainer technologies reflect the best technology available for minimizing environmental impacts for this type of facility, including impingement and/or entrainment of aquatic organisms. EPA has reviewed all the information submitted with the permit application in 2017 and in the supplemental information submitted in 2019 and has determined that the Kennedy Center's existing non-contact CWIS continues to meet the BTA standard for entrainment for existing facilities at 40 C.F.R § 125.94(d) based on the low intake flow volume of the CWIS. EPA included flow limits in the permit to ensure the facility maintains its low intake flow, which will comply with the BTA entrainment standard.

EPA reviewed the candidate flow reduction technologies for entrainment mortality control including closed-cycle recirculating systems, variable speed pumps, and seasonal flow reduction practices. A closed cycle recirculating system can reduce water withdrawals by at least 95 percent compared to once through cooling systems[9] like the Kennedy Center's system. However, closed cycle systems are not only a significant capital expense but are not realistic for the Kennedy Center because the Kennedy Center currently withdraws only 0.3% of the Potomac River water even at low-flow conditions. The design intake flow of the CWIS is 14.4 MGD, but the actual intake flow average is 2.2 MGD, which is only 15% of the system's design capacity. In other words, the Kennedy Center already operates its system at a reduced flow so utilizing different control reduction technologies such as a closed cycle system, variable speed pumps, or seasonal flow reductions is not needed at this time.

EPA reviewed candidate screening technologies for entrainment mortality control such as fine mesh traveling screens, conventional traveling screens, and modified coarse mesh traveling screens. The Kennedy Center's current screen mesh sizes have not exhibited impingement or entrainment of organisms, and the facility does not withdraw Potomac River water year-round. In addition, it would not be feasible to retrofit the existing traveling screens with a smaller mesh size without increasing the

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[8] 40 C.F.R. § 125.90 defines "All life stages of fish and shellfish" as "eggs, larvae, juveniles, and adults. It does not include members of the infraclass Cirripedia in the subphylum Crustacea, (barnacles), green mussels (*Perna viridis*), or zebra mussels (*Dreissena polymorpha*).

[9] See EPA's Final rule establishing requirements under 316(b) of the Clean Water Act which can be found in the permit's administrative record.

traveling screen velocity. An increase in the traveling screen velocity would negatively impact the aquatic community.

Based on review of other flow reduction and screening technologies, EPA determined that additional entrainment control technologies are not needed at this time and that maintaining the average monthly and daily maximum flow limits will ensure the BTA for entrainment standard is met. This determination was based on the information provided to EPA in addition to considering the factors under 40 C.F.R § 125.98(f)(2). EPA may revise this BTA determination upon submission of additional information by the permittee. Revisions to the BTA determination shall be made through a permit modification or renewal of the permit. Additional entrainment sampling will be required over the next permit term in accordance with 125.98(b) to determine what impacts the low intake flow may have on the aquatic community.

5.7 Transmission of permit application to U.S. Fish and Wildlife Services and National Marine Fisheries Service in accordance with 40 C.F.R § 125.98(h)

Concurrent with publishing of the draft permit and fact sheet for public notice and comment, EPA submitted the permit application, draft permit, and draft fact sheet to the U.S. Fish and Wildlife Services' Chesapeake Bay Field Office and the National Marine Fisheries Service Mid-Atlantic Field Office (collectively the Services). The Services had sixty (60) days to review the permit package and provide comments to EPA. EPA received a Biological Opinion from the National Marine Fisheries Service (aka NOAA Fisheries) on October 12, 2021 that completed consultation. This letter is document no. 80 the permit's Administrative Record. EPA did not receive a response from the U.S. Fish and Wildlife Service.

6.0 Receiving Water Characterization

The Kennedy Center discharges to the Middle Potomac River – segment 2. Based on the District's 2020 Integrated Report (submitted pursuant to sections 303(d) and 305(b) of the Clean Water Act), the Middle Potomac River – segment 2 is not on the District's 303(d) list of impaired waters but it does have TMDLs for *E.coli*, polychlorinated biphenyls (PCBs), Total Nitrogen (TN), Total Phosphorus (TP), and Total Suspended Solids (TSS). The TN, TP, and TSS TMDLs in the 2010 Chesapeake Bay TMDL address the pH impairments of this portion of the Potomac River. (See Bay TMDL document, Section 6.8).

6.1 Total Maximum Daily Loads (TMDLs)

According to 40 C.F.R. § 122.44 (d)(1)(vii)(B), the effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, must be consistent with the assumptions and requirements of any available wasteload allocation for the discharge in a TMDL established or approved by EPA pursuant to 40 C.F.R. § 130.7.

The Kennedy Center was not identified in the TMDLs listed above. The facility's effluent consists of non-contact cooling water which is raw Potomac river water being discharged back to the Potomac River. The permittee does not apply chemical additives to the cooling water.

7.0 Basis for Effluent Limitations

In general, the Clean Water Act (Act) requires compliance with all applicable statutory and regulatory requirements, including effluent limitations based on the capabilities of technologies available to control pollutants (i.e., technology-based effluent limits) and limitations that are protective of the water quality standards of the receiving water (i.e., water quality-based effluent limits). Typically, technology-based effluent limitations (TBELs) are developed for all applicable pollutants of concern and water quality-based effluent limitations (WQBELs) are developed where TBELs are not adequate to meet applicable water quality standards (WQS) in the receiving water. The final effluent limitations will ensure that all applicable District of Columbia WQS are achieved.

8.0 Technology-Based Effluent Limitations (TBELs)

Federal regulations at 40 C.F.R. § 122.44(a) and § 125.3 require that permits include conditions requiring dischargers to meet applicable TBELs. When EPA has not promulgated effluent limitation guidelines (ELG) for an industry, permit limitations may be based on best professional judgment (BPJ). (40 C.F.R. § 125.3(c)). The cooling water intake structure requirements are TBELs to meet BTA requirements and the District's water quality standards.

9.0 Water Quality-Based Effluent Limitations (WQBELs)

Water quality-based effluent limitations, or WQBELs, are developed where TBELs are not adequate to meet water quality standards in the receiving water (§122.44(d)). 40 C.F.R. § 122.44(d)(1)(i) requires limitations to be established in permits to control all pollutants or pollutant parameters that are or may be discharged at a level that *cause*, have the *reasonable potential (RP) to cause*, or *contribute* to an excursion above any state water quality standard (WQS), including state narrative water quality criteria. The RP analysis conducted for this permit is described in Section 10 below. The WQBELs in this permit will be as stringent as necessary to achieve applicable WQS.

9.1 pH

The pH effluent limits in the permit are WQBELs designed to meet the District's WQS for pH. Specifically, EPA includes the District's WQS for pH as the WQBEL for this permit. Therefore, no RP analysis is needed for this parameter. The WQBEL for pH is 6.0 to 8.5 as specified in Section 21-1104.8 of the District of Columbia Municipal Regulations, Water Quality Standards.

10.0 Reasonable Potential (RP) Analysis

EPA conducted a reasonable potential (RP) analysis for temperature on the effluent[10] using DMR data and data submitted by the permittee to determine if the discharge shows the potential to exceed in-stream water quality criteria for temperature. The District has two WQS for temperature, both of which must be met: a maximum allowable temperature of 32.2°C and a maximum change above ambient of 2.8°C. The maximum effluent temperature reported during the previous permit cycle (38.4°C) was evaluated against the maximum ambient temperature of the Potomac River (27.7°C) during the peak summer months (May-Oct) and winter months (Nov-Apr).

EPA applied dilution to the RP analysis to evaluate to what extent the maximum effluent temperature increased the Potomac River water temperature after complete mixing of the discharge occurs. The

[10] This is different from the analysis conducted for I & E in sections 5.5 and 5.6 above which is based on the facility's influent or intake flow.

results showed that the Potomac River temperature reached 28.2°C when it was mixed with the Kennedy Center's discharge of 38.4°C. This is consistent with the Thermal Plume study which showed that the Potomac River water returns to ambient temperature within 50 feet of the outfall.

The dilution factor was calculated based on the maximum discharge flow and the 7Q10 stream flow of the Potomac River. EPA followed a conservative approach to the calculation by using 1/3 of the 7Q10 flow of the Potomac River[11]. The USGS calculated the 7Q10 of the Potomac River to be 1,150 cfs[12].

Therefore, 1,150 cfs x 33% = 380 cfs is the 7Q10 stream flow of the Potomac River which is used for the purposes of calculating the dilution factors.

Dilution Factor Calculation is:

(Max effluent flow + stream flow) / Max effluent flow

(20.05 cfs + 380cfs)/20.05cfs = **20**

Dilution Factor Calculations and Receiving Water Critical Conditions

Facility Name	JFK Center For Performing Arts (DC0000248)
Receiving Water	Potomac River
Water Body Type	Freshwater

	Annual Average	**Max Monthly Average**
Facility Flow, MGD	5.1	12.96
Facility Flow, cfs (calculated)	7.89	20.05

	Condition	**Receiving water Flow, MGD**	**Receiving Water Flow, cfs**	**Allowable % of river flow is 33%**	**Max Dilution Factor Allowed**
1Q10	1Q10	741.75	1150	380	**20**
7Q10	7Q10	741.75	1150	380	**20**

To determine the maximum river temperature and the temperature rise EPA assumed complete mixing of the effluent with the river water based on the results of the thermal study described in Section 3.1 above and the low instream waste concentration of 0.05%.

The basic equations used for the calculation of river temperature rise are as follows:

$Q_{plant} = C_p m_p \Delta T_p$

$Q_{river} = C_p m_r \Delta T_r$

$C_p m_p \Delta T_p = C_p m_r \Delta T_r$

$\Delta T_r = m_p / m_r \times \Delta T_p$

Where

[11] This approach was based on Chapter 21 section 1105.7(f) of the DC WQS regulations which does not allow a discharge's mixing zone to occupy more than one third (1/3) of the width of the waterway.

[12] 7Q10 flow was calculated manually by a hydrologist at USGS Maryland-Delaware-District of Columbia Water Science Center in Baltimore, Maryland. This can be found in the permit's administrative record.

Q_{plant} = heat load discharged from facility (btu)
C_p = heat capacity of water = 1.0 btu/lb°C
m_p = max effluent flow (mgd)
ΔT_p = change in temperature, effluent – influent, °C
m_r = 7Q10 of receiving waterbody mgd
ΔT_r = change in river temperature, °C

Temperature Reasonable Potential and Limit Calculation	Peak Summer Months	Winter Months
INPUT	May - Oct	Nov - Apr
1. Chronic Dilution Factor at Mixing Zone Boundary	20	20
2. Max Ambient Stream Temperature	27.7 °C	7.1 °C
3. Max Effluent Temperature	38.4 °C	38.4 °C
4. Aquatic Life Temperature WQ Criterion in Fresh Water	32.2 °C	32.2 °C
OUTPUT		
5. Stream temperature at Chronic Mixing Zone Boundary:	28.2 °C	8.7 °C
6. Stream temperature Increase or decrease:	0.57 °C	0.22 °C
7. Maximum Allowable Temperature Increase above ambient:	2.8 °C	2.8 °C
8. Maximum Allowable Temperature at Mixing Zone Boundary:	30.5 °C	9.9 °C
CRITERIA ASSESSMENT		
9. Does the discharge cause an exceedance of the maximum temperature criterion of 32.2°C?	**NO**	**NO**
10. Does the discharge cause an exceedance of the maximum temperature change of 2.8°C at the mixing zone boundary?	**NO**	**NO**
11. Temperature Limit, if Required:	**NO LIMIT REQUIRED**	**NO LIMIT REQUIRED**

Evaluation of the 2.8°C temperature rise water quality standard

EPA determined that the Kennedy Center's maximum effluent temperature of 38.4°C increased the Potomac River water temperature by 0.57 °C, which is below the District's standard of 2.8°C above ambient. Therefore, the Kennedy Center's discharge shows no reasonable potential to cause or contribute to an excursion of the District's temperature rise standard of 2.8°C.

ΔT_p = change in temperature = effluent – influent (°C)

ΔT_P = max effluent temp – influent (average ambient stream temp) = 38.4°C − 27.7°C = 10.7°C

ΔT_r = change in river temperature (°C)

$$\Delta Tr = \frac{mp}{mr} * \Delta Tp \ \ °C$$

$$\Delta Tr = \frac{12.96 \text{ mgd}}{245 \text{ mgd}} * 10.7\ °C$$

$\Delta T_r = 0.57$ °C

Evaluation of the maximum temperature standard of 32.2°C :

EPA evaluated to what extent the maximum effluent temperature increased the Potomac River water temperature. The results showed that the Potomac River temperature reached 28.2°C when it was mixed with the Kennedy Center's discharge of 38.4°C. Because the Potomac River water did not exceed the District's maximum temperature standard of 32.2°C, EPA determined there is no reasonable potential to cause or contribute to an exceedance of the District's maximum temperature standard of 32.2°C.

Max Ambient Stream Temperature + Maximum Allowable Temperature Increase above ambient

27.7 °C + 2.8 °C = 30.5 °C

11.0 Endangered species and Essential Fish Habitat Protection

Endangered Species Act

Per the requirements under Section 7 of the Endangered Species Act (50 C.F.R. Part 402; 16 U.S.C. § 1536(c)), EPA submitted a Biological Evaluation to NMFS. EPA determined that all effects on endangered species under the jurisdiction of NMFS are insignificant or discountable and that the discharges from the Kennedy Center may affect, but are not likely to adversely affect listed species or critical habitat. EPA received a Biological Opinion from the NMFS on October 12, 2021 that completed consultation. This letter is document no. 80 in the permit's Administrative Record.

Magnuson-Stevens Act

The Magnuson-Stevens Act (16 U.S.C. §§ 1801 et seq.) gives NMFS the authority to minimize adverse effects on Essential Fish Habitat (EFH) from fishing and other activities. EPA has determined that the reissuance of this permit will not adversely affect EFH in the Potomac River in the vicinity of the intake. On November 10, 2021, EPA received an email from the NMFS Essential Fish Habitat Division expressing concerns over the Kennedy Center's intake structure and its vicinity to essential fish habitat for Alosines. EPA participated in a call with NMFS on November 16, 2021 to discuss their concerns. NMFS determined that it did not have any EFH conservation recommendations that would affect permit reauthorization at this time. Email communications between EPA and NMFS are included in the permit's Administrative Record document no. 95.

12.0 National Historic Preservation Act

The National Historic Preservation Act of 1966. and implementing regulations (36 C.F.R. Part 800) requires federal agencies to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation, or designee, the opportunity to comment on such undertakings. See Section 106, 54 U.S.C. § 306108. EPA will notify the DC State Historic Preservation Officer (DC SHPO) of its proposed reissuance of the permit and that it had determined that the permit does not have the potential to affect historic properties in D.C. See 36 C.F.R. § 800.3(1).

13.0 Anti-Backsliding Provision

Section 402(o) of the CWA and 40 C.F.R. § 122.44(l) prohibit the renewal, reissuance or modification of an existing NPDES permit that contains effluent limits, permit conditions, or standards that are less stringent than those established in the existing permit, unless certain exceptions are met. The 2013 permit contained Water Quality Based Effluent Limits (WQBELs) at Outfall 001 for temperature. These WQBELs are not included in the current permit based on the results of the RP analysis. Therefore, EPA conducted an anti-backsliding analysis in accordance with CWA Section 402(o)(1). Where the effluent limitation under consideration is water quality-based, Section 401(o)(1) states that such backsliding may occur only in compliance with the requirements of Section 303(d)(4) of the CWA.

CWA Section 303(d)(4) addresses relaxation of water quality-based effluent limits under two circumstances: where the receiving water is not attaining the applicable water quality standards (WQS) (CWA Section 303(d)(4)(A)) and where the receiving water is attaining the applicable WQS (CWA Section 303(d)(4)(B)). The current permit contains less stringent effluent limits for temperature where the water quality standard is being attained triggering an anti-backsliding review under CWA Section 303(d)(4)(B).

CWA Section 303(d)(4)(B) Standard attained

The WQBEL for temperature from the 2013 permit was removed because the reasonable potential analysis did not show a reasonable potential to cause or contribute to an exceedance of the applicable WQS for this pollutant. Because the standard for temperature is being attained, the relaxation of the WQBELs is consistent with the exception to the prohibition against backsliding found at CWA Section 303(d)(4)(B) provided it is also consistent with the District's antidegradation policy. The Potomac River is a Tier 1 designated waterbody. The District of Columbia's Municipal Regulations Title 21 Section 21-1102.1 define a Tier 1 designation as "Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected." The relaxation of the temperature effluent limit is consistent with the District's Tier 1 antidegradation policy because the discharge is meeting the water quality standards for temperature thereby maintaining the designated water uses of the Potomac River. Because the discharge is meeting water quality standards for temperature and the District's antidegradation policy is being met, the removal of these limits is consistent with the exception to the prohibition to backsliding found at CWA Section 303(d)(4)(B).

14.0 Antidegradation Statement

The Potomac River is a Tier 1 designated waterbody. The District of Columbia's Municipal Regulations Title 21 Section 21-1102.1 define a Tier 1 designation as "Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected." The final permit contains WQBELs that will ensure compliance with the DC water quality standards and the antidegradation policy.

15.0 CWA Section 401 Certification

In accordance with CWA Section 401(a)(1), EPA requested a water quality certification from the District of Columbia, via DOEE, to ensure compliance with the District's WQS. DOEE provided their 401 certification of the permit with three conditions that were incorporated into Part III Section E of the final permit.

401 certification request emailed to DOEE: September 23, 2021.
401 certification request received from DOEE: November 9, 2021.

Pursuant to CWA Section 401(a)(2), EPA determined that discharges from the Kennedy Center will not affect the quality of the waters of any neighboring jurisdiction.

APPENDIX A

Approximate location of the Kennedy Center
PRESENT THROUGOUT WATERWAYS
Reservoir Rd NW
Q St NW
P St NW
M St NW
L St NW
I St NW
Massachusetts Ave NW
Canal Rd NW
37th St NW
18th St NW
15th St NW
21st St NW
Key Blvd
Lorcom Ln
16th St N
N Utah St
Clarendon Blvd
N Barton St
Fairfax Dr
Wilson Blvd
N Pershing Dr
Ohio Dr SW
2nd St S
S Walter Reed Dr
S Court House Rd
S Fern St
Crystal Dr
S Quincy St
23rd St S
W Glebe Rd
Magnolia Ln
29th St S
Map 17A

Species that occur in the mapped area, which includes the Kennedy Center. Screen shots taken from the2016 NOAA study.

Map 17B
Chesapeake West

BIOLOGICAL RESOURCES

Note: An asterisk (*) indicates that life stage occurs in this range but not in all months included

DISPLAYED ON MAP

BENTHIC

	Subelement	Species	Mapping Qualifier	MD/VA S	MD/VA F	Concentration	Monthly Presence J F M A M J J A S O N D					
	SAV	Submerged aquatic veg	High Ecological Value			Ephemeral		-	-	-	-	-
	SAV	Submerged aquatic veg	High Ecological Value			High		-	-	-	-	-
	SAV	Submerged aquatic veg	High Ecological Value			Low		-	-	-	-	-

BIRDS

Map ID	Subelement	Species	Mapping Qualifier	MD/VA S	MD/VA F	Concentration	Monthly Presence J F M A M J J A S O N D	Nest	Mig.(S)	Mig.(F)	Molt	
247	Waterfowl	American black duck	Wintering			100S		-	-	-	-	-
	Waterfowl	American coot	Wintering			1,000S		-	-	-	-	-
	Waterfowl	Canada goose	Nesting			Present		Mar-Aug	-	-	Jun-Jul	-
	Waterfowl	Canada goose	Wintering			1,000S		-	-	-	-	-
	Waterfowl	Gadwall	Wintering			100S		-	-	-	-	-
	Waterfowl	Mallard	Nesting			Present		Mar-Aug	-	-	Jul-Aug	-
	Waterfowl	Mallard	Wintering			100S		-	-	-	-	-
	Waterfowl	Northern pintail	Wintering			10S		-	-	-	-	-
	Waterfowl	Tundra swan	Wintering			100S		-	-	-	-	-
454	Waterfowl	American black duck	Nesting			Low		Mar-Aug	-	-	Jul-Aug	-
	Waterfowl	Canada goose	Nesting			Moderate-High		Mar-Jun	-	-	Jul-Aug	-
	Waterfowl	Mallard	Nesting			Moderate-High		Mar-Aug	-	-	Jul-Aug	-
	Waterfowl	Wood duck	Nesting			Moderate-High		Mar-Jun	-	-	Jul-Aug	-
552	Waterfowl	American black duck	Wintering			1,000S		-	-	-	-	-
	Waterfowl	American coot	Wintering			1,000S		-	-	-	-	-
	Waterfowl	American wigeon	Wintering			Present		-	-	-	-	-
	Waterfowl	Gadwall	Wintering			1,000S		-	-	-	-	-
	Waterfowl	Green-winged teal	Wintering			100S		-	-	-	-	-
	Waterfowl	Mallard	Wintering			1,000S		-	-	-	-	-
	Waterfowl	Northern pintail	Wintering			100S		-	-	-	-	-
746	Waterfowl	American black duck	Wintering			100S		-	-	-	-	-
	Waterfowl	American coot	Wintering			1,000S		-	-	-	-	-
	Waterfowl	Canada goose	Wintering			1,000S		-	-	-	-	-
	Waterfowl	Gadwall	Wintering			100S		-	-	-	-	-
	Waterfowl	Mallard	Wintering			100S		-	-	-	-	-
	Waterfowl	Northern pintail	Wintering			10S		-	-	-	-	-
	Waterfowl	Tundra swan	Wintering			100S		-	-	-	-	-
798	Raptor	Bald eagle	Nesting			1 Nest		Dec-Jun	-	-	-	-
1141	Waterfowl	Bufflehead	Wintering			10S		-	-	-	-	-
	Waterfowl	Common goldeneye	Wintering			10S		-	-	-	-	-

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Chesapeake West: Map 17B

BIRDS (continued)

Map ID	Subelement	Species	Mapping Qualifier	MD/VA S	MD/VA F	Concentration	Monthly Presence J F M A M J J A S O N D	Nest	Mig.(S)	Mig.(F)	Molt	
	Waterfowl	Mergansers	Wintering			10S		-	-	-	-	-
	Waterfowl	Redhead	Wintering			10S		-	-	-	-	-
	Waterfowl	Ring-necked duck	Wintering			10S		-	-	-	-	-

FISH

Map ID	Subelement	Species	Mapping Qualifier	MD/VA S	MD/VA F	Concentration	Monthly Presence J F M A M J J A S O N D	Spawn	Eggs	Larvae	Juveniles	Adults
1482	Estuarine Nursery	White perch	Spawning Area			-		Mar-May	Mar-May	Apr-Jun	-	Mar-May
1575	Diadromous	Atlantic sturgeon	General Distribution	-/E	E	-		-	-	-	-	Jan-Dec
	Diadromous	Shortnose sturgeon	General Distribution	E/E	E	-		-	-	-	Jan-Dec	Jan-Dec
1652	Diadromous	Shortnose sturgeon	Migration	E/E	E	-		-	-	-	-	Mar-Jun
1678	Diadromous	Alewife	Nursery Area			Moderate Run		-	-	Feb-Apr	Apr-Oct	Feb-Apr
	Diadromous	American shad	Nursery Area			Strong Run		-	-	May-Jul	May-Oct	-
	Diadromous	American shad	Spawning Area			Strong Run		Apr-Jun	Apr-Jun	-	-	Mar-Jun
	Diadromous	Blueback herring	Nursery Area			Moderate Run		-	-	May-Jul	May-Oct	Feb-Jun
	Diadromous	Hickory shad	Nursery Area			Moderate Run		-	-	Apr-Jun	Apr-Oct	Feb-Jun
1698	Diadromous	Shortnose sturgeon	Spawning Area	E/E	E	Potential Spawning		Apr-May	Apr-May	-	-	Apr-May

ALSO PRESENT IN MAPPED AREA (GENERAL DISTRIBUTION)

BIRDS

Subelement	Species	Monthly Presence J F M A M J J A S O N D	Nest	Mig.(S)	Mig.(F)	Molt	
Waterfowl	Wood duck		Apr-Jul	-	-	Jul-Aug	-

FISH

Subelement	Species	Monthly Presence J F M A M J J A S O N D	Spawn	Eggs	Larvae	Juveniles	Adults
Diadromous	Alewife		Feb-Apr	Feb-Apr	Feb-Apr	Apr-Oct	Feb-Apr
	Alewife		Mar-May	Mar-May	Apr-Jun	Apr-Oct	Mar-May
	American eel		-	-	-	Jan-May	Jan-Dec
	American shad		Apr-Jun	Apr-Jun	May-Jul	May-Oct	Mar-Jun
	Blueback herring		Apr-Jun	Apr-Jun	May-Jul	May-Oct	Feb-Jun
	Blueback herring		Mar-Jun	Mar-Jun	Apr-Jun	May-Oct	Mar-Jun
	Gizzard shad		Mar-Jun	-	-	Jan-Dec	Jan-Dec
	Striped bass		-	-	-	Jan-Dec	Jan-Dec
Estuarine Nursery	White perch		-	-	-	Jan-Dec	Jan-Dec
Estuarine Resident	Silversides		Mar-Jul	Mar-Jul	Apr-Sep	Jan-Dec	Jan-Dec
Freshwater	Black crappie		Mar-Jul	-	-	Jan-Dec	-
	Bullhead catfish		Apr-Jun	-	-	-	Jan-Dec
	Chain pickerel		Feb-Apr	-	-	-	Jan-Dec
	Channel catfish		May-Jun	-	-	Jan-Dec	Jan-Dec
	Common carp		May-Jun	-	-	-	Jan-Dec
	Golden shiner		Apr-Aug	-	-	Jan-Dec	Jan-Dec

FISH (continued)

Subelement	Species	Monthly Presence J F M A M J J A S O N D	Spawn	Eggs	Larvae	Juveniles	Adults
	Largemouth bass		Mar-May	-	-	-	Jan-Dec
	Longnose gar		May-Jun	-	-	Jan-Dec	Jan-Dec
	Redfin pickerel		Feb-Mar	-	-	Jan-Dec	Jan-Dec
	Shorthead redhorse		Mar-Jun	-	-	-	Jan-Dec
	Spotfin shiner		Jun-Aug	-	-	-	Jan-Dec
	Spottail shiner		May-Aug	-	-	-	Jan-Dec
	Sunfish		Mar-Jul	-	-	-	Jan-Dec
	Tessellated darter		Apr-Jun	-	-	-	Jan-Dec
	Yellow perch		-	-	-	Jan-Dec	Jan-Dec

INVERTEBRATES

Subelement	Species	Monthly Presence J F M A M J J A S O N D	Spawn	Eggs	Larvae	Juveniles	Adults
Crab	Blue crab		-	-	-	Jan-Dec	Jan-Dec

For additional information about species locations and extent, reference the underlying GIS data available from response.restoration.noaa.gov

SHORELINE RESOURCES

ESI POLYGON HABITAT TYPES

ESI Rank	Habitat Classification	Area (Acres)	Area (Sq. Miles)
10B	Freshwater Marshes	28.15	0.04
10C	Swamps	54.39	0.08
10D	Scrub and Shrub Wetlands	5.94	0.01

ESI SHORELINE HABITAT TYPES

ESI Rank	Shoreline Habitat Classification	Length (Meters)	Length (Miles)	% of ESI Shoreline
10B	Freshwater Marshes	721.03	0.45	1%
10C	Swamps	3,297.46	2.05	6%
10D	Scrub and Shrub Wetlands	427.25	0.27	1%
9A	Sheltered Tidal Flats	2,764.31	1.72	5%
9B	Vegetated Low Banks	14,534.27	9.03	25%
8B	Sheltered, Solid Man-Made Structures	10,766.03	6.69	19%
8C	Sheltered Riprap	8,982.57	5.58	15%
8D	Sheltered, Rocky, Rubble Shores	841.04	0.52	1%
6B	Riprap	6,021.12	3.74	10%
6D	Boulder Rubble	7,853.90	4.88	14%
1B	Exposed, Solid Man-Made Structures	1,826.12	1.13	3%
	Total ESI Shoreline:	58,035.09	Total ESI Shoreline: 36.06	
	Total Shoreline:	41,803.70	Total Shoreline: 25.98	

Note: A shoreline segment may include multiple shoreline habitats. If any segments include multiple habitats, the combined length of all habitats may exceed the length of the mapped shoreline, and the percent of ESI shoreline values will sum to greater than 100%

All underlying GIS data can be obtained from response.restoration.noaa.gov

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Chesapeake West: Map 17B

APPENDIX B

Calculations related to the Cooling Water Intake Structure

<u>The Kennedy Center's Through Screen Velocity</u>: 0.22 fps

ft^3/s	Cubic feet per second
ft^2	Squared feet
ft/s	Feet per second (fps)
in^2	Squared inches

The through screen velocity was calculated by using the percent open area of the grate (mesh) in front of the pipe. The percent open area is calculated using the size of the bars and the spacing between the bars. The Kennedy Center's intake pipe consists of ¾ inch bars with 6 inch spacing.

Percent Open Area = $[\text{opening}/\text{opening}+\text{mesh})]^2$

Percent Open Area = $(6/6.75)^2 = 0.79$ or 79%

Through Screen Velocity is then calculated by taking the intake flow and dividing by the area of the pipe, however, here we will use the percent open area of the pipe to be more accurate:

V= Q/A

V = velocity
Q = flow (ft^3/s)
A = area of pipe (ft^2)

Open area of pipe: (area of pipe x percent open area)

or ($19.6\ ft^2 \times 0.79) = 15.48\ ft^2$

Through Screen Velocity (V) =Average intake flow(Q)/open area of pipe (A) = through screen velocity

or $3.433 ft^3/s$ / $15.48\ ft^2$ = **0.22 fps**

Averge intake flow (Q): 1,541 gal/min = **3.433 ft^3/s**
Area of Pipe (A): A=Лr^2
diameter = 60 inches
radius = 30 inches
Л = 3.14
A = 2,827 in^2 or **19.6 ft^2**