DELAWARE RIVERKEEPER NETWORK

July 8, 2016

Office of Legal Affairs
Attention: Adjudicatory Hearing Requests
Department of Environmental Protection
PO Box 402
Trenton, New Jersey 08625-0402

RECEIVED
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NJDEP-OFFICE OF LEGAL AFFAIRS

Re: Adjudicatory Hearing Request and Request for Party Status

Dear Office of Legal Affairs,

Enclosed please find the Delaware Riverkeeper Network's and the Delaware Riverkeeper's (collectively "DRN") request for an adjudicatory hearing and request for party status challenging the New Jersey Department of Environmental Protection's issuance of NJPDES Permit NJ0005622 to PSEG Nuclear LLC Salem Nuclear Generating Station. DRN's requests for an adjudicatory hearing and party status include the following enclosed documents:

a. Adjudicatory Hearing Request Checklist and Tracking Form for Individual NJPDES Permits ("AHR Tracking Form");
b. DRN's response satisfying Part IV.B. of the AHR Tracking Form;
c. DRN's September 18, 2015 public comment on the 2015 Draft Salem NJPDES Permit, DRN's Index of Attachment to its public comment, and the Carpenter Environmental Associates, Inc. Report DRN commissioned and submitted as a part of its public comment. Each is included as Attachment 1-3, respectively; and
d. A certified mail receipt demonstrating that DRN's requests for an adjudicatory hearing and party status have been mailed to the permittee, PSEG Nuclear LLC Salem Nuclear Generating Station. The certified mail receipt is included as Attachment 4.

Respectfully submitted,

Nicholas Patton, Staff Attorney
Delaware Riverkeeper Network
925 Canal St., Suite 3701
Bristol, PA 19007
(215) 369-1188

Counsel for Delaware Riverkeeper Network
and the Delaware Riverkeeper

cc:

PSEG Nuclear, LLC
P.O. Box 236
Hancocks Bridge, NJ 08038

John F. Perry, Vice President Salem
PSEG Nuclear LLC
80 Park Plaza
Newark, NJ 07101

Pilar Patterson, Chief
Mail Code 401-02B
Bureau of Surface Water Permitting
Department of Environmental Protection
401 East State Street, P.O. Box 420
Trenton, NJ 08625-0420

ADJUDICATORY HEARING REQUEST CHECKLIST AND TRACKING FORM FOR INDIVIDUAL NJPDES PERMITS

I. Permit Being Appealed:

Facility Name: PSEG Nuclear LLC - Salem Generating Station

NJEMS Masterfile # (if available): ____________ NJEMS PI # (if available): ____________

Issuance Date of Final Permit Decision: 06/10/2016 NJPDES Permit #: NJ0005622

Permitting Bureau (checkone):

☐ Chief
Mail Code 401-02B
Bureau of Nonpoint Pollution Control
Department of Environmental Protection
401 East State Street, P.O. Box 420
Trenton, NJ 08625-0420

☐ James Murphy, Acting Chief
Mail Code 401-02B
Bureau of Pretreatment and Residuals
Department of Environmental Protection
401 East State Street, P.O. Box 420
Trenton, NJ 08625-0420

☒ Pilar Patterson, Chief
Mail Code 401-02B
Bureau of Surface Water Permitting
Department of Environmental Protection
401 East State Street, P.O. Box 420
Trenton, NJ 08625-0420

Permit Writer: Pilar Patterson

II. Person Requesting Hearing:

Name/Organization	Name of Attorney (if applicable)	
Maya K. van Rossum, the Delaware Riverkeeper	Nicholas Patton	Stuart Lieberman and Michael Sinkevich
Delaware Riverkeeper Network	Delaware Riverkeeper Network	Lieberman & Blecher, P.C.
925 Canal Street, Suite 3701	925 Canal St., Ste. 3701	10 Jefferson Plaza
Bristol, PA 19007	Bristol, PA 19007	Princeton, NJ 08540
Address	Address of Attorney	
215-369-1188	215-369-1188	732-355-1311
Telephone Number	Telephone Number of Attorney	

III. Status of Person Requesting Hearing (Check One):

☐ Permittee under the permit number identified above.
Complete A. and C. through I. of Section IV. below.

☑ Person seeking consideration as a party to the action.
Complete B. through I. of Section IV. below.

IV. Include the following information as part of your request:

A. If you are a <u>permittee under the permit number identified above</u>:
1. For the Office of Legal Affairs only, a copy of the permit clearly indicating the permit number and issuance date;
2. A list of the specific contested permit condition(s) and the legal or factual question(s) at issue for each condition, including the basis of any objection;
3. The relevance of the legal and/or factual issues to the permit decision;

* For NJPDES permits, the procedures for requesting an adjudicatory hearing on a final permit decision and for the Department's evaluation and processing of such requests are set forth in N.J.A.C. 7:14A-17.

4. Suggested revised or alternative permit conditions and how they meet the requirements of the State or Federal Act; and

5. Information supporting the request or other written documents relied upon to support the request, unless this information is already in the administrative record (in which case, such information shall be specifically referenced in the request).

B. If you are a person seeking consideration as a party to the action:
   1. A statement setting forth each legal or factual question alleged to be at issue;
   2. A statement setting forth the relevance of the legal or factual issue to the permit decision, together with a designation of the specific factual areas to be adjudicated;
   3. A clear and concise factual statement of the nature and scope of your interest which meets the criteria set forth at N.J.A.C. 7:14A-17.3(c)4;
   4. A statement that, upon motion by any party granted by the administrative law judge, or upon order of the administrative law judge's initiative, you shall make yourself, all persons you represent, and all of your officers, directors, employees, consultants, and agents available to appear and testify at the administrative hearing, if granted;
   5. Specific references to the contested permit conditions, as well as suggested revised or alternative permit conditions, including permit denials, which, in your judgment, would be required to implement the purposes of the State Act;
   6. Identification of the basis for any objection to the application of control or treatment technologies, if identified in the basis or fact sheets, and the alternative technologies or combination of technologies which, in your judgment, are necessary to satisfy the requirements of the State Act;

C. The date you received notification of the final permit decision;

D. The names and addresses of all persons whom you represent;

E. A statement as to whether you raised each legal and factual issue during the public comment period in accordance with N.J.A.C. 7:14A-15.13;

F. An estimate of the amount of time required for the hearing;

G. A request, if necessary, for a barrier-free hearing location for disabled persons;

H. A clear indication of any willingness to negotiate a settlement with the Department prior to the Department's processing of your hearing request to the Office of Administrative Law; and

I. This form, completed, signed and dated with all of the information listed above, including attachments, to:
   1. Office of Legal Affairs
      ATTENTION: Adjudicatory Hearing Requests
      Department of Environmental Protection
      401 East State Street
      PO Box 402, Trenton, New Jersey 08625-0402
   2. The permitting bureau at the address identified in Section I above.
   3. Any other person named on the permit (if you are a permittee under that permit).
   4. The permittee(s) (if you are a person seeking consideration as a party to the action). You must submit evidence that a copy of the request has been delivered to the applicant for which the permit is the subject of your hearing request (e.g. certified mail receipt).

V. Signature: Claire W. Biehl for Maya K. van Rossum Date: 7/8/2016

*For NJPDES permits, the procedures for requesting an adjudicatory hearing on a final permit decision and for the Department's evaluation and processing of such requests are set forth in N.J.A.C. 7:14A-17.

July 8, 2016

Office of Legal Affairs
Attention: Adjudicatory Hearing Requests
Department of Environmental Protection
PO Box 402
Trenton, New Jersey 08625-0402

Re: Adjudicatory Hearing Request and Request for Party Status in Satisfaction of Part IV.B. of the Tracking Form

Dear Office of Legal Affairs,

The Delaware Riverkeeper Network and the Delaware Riverkeeper (collectively "DRN") hereby submit this request for an adjudicatory hearing, along with a request to be considered a party for said hearing, contesting the New Jersey Department of Environmental Protection's ("NJDEP" or "Department") final decision to issue a renewed NJPDES Permit to Salem Nuclear Generating Station. DRN is making these requests pursuant to N.J.A.C. 7:14A-17.2 and 17.3; N.J.S.A. 58:10A-7d and e.

In order to be considered a party to the action for purposes of requesting an adjudicatory hearing under N.J.A.C. 7:14A-17.2, a person shall submit a request in accordance with the requirements in subsection (f) within 30 days following receipt of the Department's notification of the final permit decision. In accordance with N.J.A.C. 7:14A-17.2(f) and Part IV.B. of the adjudicatory hearing checklist and tracking form for individual NJPDES permits, DRN provides the following basis for its request for party status and its request for an administrative hearing.

B. Person seeking consideration as a party to the action

1.& 2. The legal and factual issues at issue, their relevance to the permit decision, and a designation of the specific factual areas to be adjudicated

i. NJDEP's 316(b) determination is illegal as it requires restoration, mitigation, and other Special Conditions to be utilized

NJDEP's 316(b) determination, issued as a part of NJDEP's final NJPDES Permit NJ0005622 ("2016 Permit") to PSEG Nuclear LLC Salem Generating Station ("Salem"), is legally deficient because it allows Salem to comply with Section 316(b)[1] of the Clean Water Act through

[1] Section 316(b) of the Clean Water Act (CWA), 33 U.S.C. 1326(b), requires facilities like Salem to use the best technology available (BTA) on the design, location, construction and capacity of their cooling water intake

application of a series of "Special Conditions" including wetlands restoration, construction/maintenance of fish ladders and associated fish stocking and Delaware Bay abundance analysis. These measures are being required in lieu of further reductions to Salem's entrainment and impingement impacts.

Salem withdraws up to 3.024 billion gallons per day of water from the Delaware River via its once through cooling ("OTC") system to cool its nuclear generating station operations. Salem's OTC system kills more than 14 billion fish at varying life stages annually via impingement and entrainment. Impingement takes place when organisms are trapped against intake screens by the force of the water passing through the cooling water intake system ("CWIS"). Entrainment occurs when organisms are drawn through the CWIS into the cooling system.

Salem first applied for a permit to discharge pollutants in 1970. In 1975, EPA granted Salem its first NPDES permit, which imposed a schedule for compliance with technology-based effluent limitations for thermal discharges. Salem submitted its first demonstration regarding thermal discharges to NJDEP in 1984.[2]

In October 1990, NJDEP issued a draft permit to Salem that denied the thermal variance sought by Salem, which required thermal discharge limits that could not have been met with the existing OTC system, and which would have required PSEG to install a "closed-cycle cooling" ("CCC") system to achieve reductions in impingement and entrainment. A CCC system reuses cooling water rather than immediately discharging it back to the original water source and would reduce water intakes at Salem by 95% and also reduce fish kills via impingement and entrainment by 95%.

In 1993, PSEG filed a Permit Renewal Application Supplement that proposed that it engage in certain "Special Conditions" in lieu of retrofitting Salem with a CCC system.[3] The Special Conditions included a wetlands restoration program, intake flow limitations, modifications to intake screens, the construction of fish ladders, and a biological monitoring program. In 1993, NJDEP backed away from its original draft permit requiring a CCC system and instead issued a draft permit accepting Salem's proposal to engage in Special Conditions and continue to operate with an OTC system.

NJDEP's own Fact Sheet to the 1993 Draft Permit confirms that NJDEP required the Special Conditions to comply with its CWA section 316(b) duties. Specifically, the Department stated it

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structures to minimize their adverse environmental impact. NJDEP is required to make a 316(b) determination as a part of its final NJPDES Permit action.

[2] PSEG Nuclear, Salem NJPDES Permit Renewal Application, Permit No. NJ0005622, Section 1 (2006) ("Salem 2006 Permit Application"), at 8-10.

[3] Salem admits as much in its 2006 NJPDES Permit Renewal Application at 11 ("In March 1993, PSEG filed a Permit Renewal Application Supplement which proposed that NJDEP, in lieu of requiring a retrofit of Salem to closed cycle cooling, issue a revised draft permit for the Station containing a number of Special Conditions to address NJDEP's concern about the potential for long-term impacts associated with the operation of Salem's intake.")

accepted the Special Conditions "for the resolution of . . . the Department's Section 316(b) BTA determination."[4]

Shortly thereafter, in 1994, NJDEP issued a final permit that contained the various Special Conditions including a requirement that PSEG attempt to restore 8,000 acres of wetlands and 6,000 acres of upland buffers, a project referred to as the Estuary Enhancement Program ("EEP"), fish ladders and a biological monitoring program.[5] As PSEG has acknowledged, "the EEP was an integral part of NJDEP's 1994 Permit determinations."[6]

In March 1999, PSEG submitted an application for renewal of the 1994 permit, asserting that it had complied with the existing permit. On December 8, 2000, NJDEP issued a draft permit providing for continued restoration efforts and expanded biological monitoring. On June 29, 2001 NJDEP issued a final permit identifying that wetland restoration and enhancement efforts, along with the other Special Conditions, were "Section 316 Special Conditions."[7]

With NJDEP's current issuance of a final NJPDES Permit to Salem, NJDEP has continued these Special Conditions in lieu of requiring greater reductions to impingement and entrainment at Salem and has failed to perform its obligations under section 316(b). Specifically, NJDEP has retained the wetland restoration and enhancement, fish ladder, and biological monitoring program requirements.[8]

NJDEP's 316(b) determination, and Salem's compliance with Section 316(b), is clearly based on its restoration efforts and other Special Conditions. However, the United States Court of Appeals for the Second Circuit ruled in 2007 that "restoration measures contradict the unambiguous language of section 316(b)." Riverkeeper, Inc. v. U.S. Envtl. Prot. Agency, 475 F.3d 83, 110 (2d Cir. 2007), rev'd on other grounds, Entergy Corp. v. Riverkeeper, Inc., 556 U.S. 208 (2009). The Second Circuit further held that "restoration measures are not part of the location, design, construction, or capacity of cooling water intake structures, and a rule permitting compliance with the statute through restoration measures allows facilities to avoid adopting any cooling water intake structure technology at all, in contravention of the Act's clear language as well as its technology-forcing principle." Id. In response to the Second Circuit's decision, EPA suspended its 316(b) rule for existing facilities and began a seven year process of promulgating new regulations to implement section 316(b).[9] When EPA promulgated its new section 316(b) rule in 2014 it no longer allowed compliance with 316(b) through restoration measures.[10] Thus, as NJDEP has allowed Salem to continue to comply with section 316(b)

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[4] NJDEP's June 24, 1993 Fact Sheet to the 1993 Draft Permit, at p.125 of 152 ("As part of the Company's 1993 Application Supplement, [Salem] submitted a Technical Appendix *which provides* the scientific and technical basis for the proposed Special Conditions to the Draft Permit for resolution of . . . the Department's Section 316(b) BTA determination) (emphasis added); See also generally, p.125-134 of 152.
[5] Salem 2006 Permit Application, at 11-14.
[6] Supplemental Brief of Plaintiffs PSEG Fossil LLC and PSEG Nuclear LLC in Support of Restoration Provisions of Final Rule, Case No. 04-6692-ag(L), U.S. Court of Appeals for the Second Circuit, at 13.
[7] 2001 Final NJPDES Permit issued to Salem, at 6-13 of 16.
[8] 2016 Permit, Part IV.G.3-5.
[9] 72 Fed. Reg. 37,107 (July 9, 2007)
[10] See 40 C.F.R. 122.21(r) and 40 C.F.R.125.90-99; see also EPA 316(b) Rules, 79 Fed. Reg. 48300, 48354 (August 15, 2014) ("The Second Circuit found that EPA exceeded its authority by allowing facilities subject to CWA section

through restoration, mitigation, and other "Special Conditions," NJDEP is in violation the Clean Water Act and its state law equivalent.

The factual area to be adjudicated for this issue is whether NJDEP improperly relied upon restoration, mitigation, and other Special Conditions as a part of its 316(b) compliance determination. As outlined above, DRN contends that NJDEP clearly has. Even Salem recognizes that the restoration measures and other Special Conditions were included in its Permit as a 316(b) compliance mechanism and requested the conditions be removed from the 2016 Permit and memorialized in a separate agreement outside the scope of the 2016 Permit.[11] Nonetheless, and despite NJDEP's early recognition that these measures were required for 316(b) compliance, NJDEP now maintains that these measures are not required as a part of NJDEP's 316(b) BTA determination.[12] This dispute clearly presents adjudicative facts ripe for an administrative hearing. See In re NJPDES Permit No. NJ0025241, 185 N.J. 474, 485 (2006) ("Adjudicative facts usually answer the questions of who did what, where, when, how, why, with what motive or intent; adjudicative facts are roughly the kind of facts that go to a jury in a jury case.") (internal citations omitted).

Also, this factual dispute is material because NJDEP's 316(b) determination is the mechanism by which NJDEP may set the control technology, under the BTA standard, for Salem's cooling water intake structures that kill more than 14 billion fish at varying life stages annually via entrainment and impingement. NJDEP's 316(b) BTA determination in the 2016 Permit also requires Salem to submit studies within specific time frames tied to the issuance of the final permit as well as a continued intake flow limit. Had NJDEP not required Salem to implement restoration, mitigation, and other Special Conditions as a part of NJDEP's 316(b) determination, NJDEP would have been required to, and is still required to, better address Salem's impingement and entrainment impacts.

ii. NJDEP's 316(a) determination, granting Salem a thermal variance, is improper because the Department failed to consider vital aspects of the issue

NJDEP's 316(a) determination, granting a thermal variance to Salem, failed to sufficiently consider important aspects of the issue thereby rendering its thermal variance determination arbitrary, capricious, and/or unreasonable.

As a part of NJDEP's final issuance of the 2016 Permit to Salem, NJDEP made a 316(a) determination renewing the facility's thermal variance. The thermal variance allows Salem to

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316(b) to comply with section 316(b) through restoration measures and, thus, EPA has deleted these provisions from the regulations")

[11] 2016 Permit, PSEG Comment 15, at 103 of 112("At the time that PSEG submitted its 2006 NJPDES permit renewal application, EPA's rules governing cooling water intake structures allowed the use of restoration in whole or in conjunction with other EPA approved options for determining BTA at a cooling water intake structure. . . . At this point, the regulatory reasons for including EEP related terms and conditions in PSEG-Salem's NJPDES permit no longer exist since the Section 316(b) regulations simply do not support the use of the restoration in a NJPDES Permit.")

[12] 2016 Permit, see Response to Comment 23, 40-43, 45, 47, and Response to PSEG Comment 15.

discharge more than 3 billion gallons per day of its thermal effluent in exceedance of state water quality standards. Thus, the 316(a) thermal variance is directly tied to the 2016 Permit approval.

Salem's devastating impact to the Delaware River is not limited to the impingement and entrainment of organisms as discussed above. After disrupting numerous species through the intake process, the water and entrained organisms are heated as they are cycled through Salem's cooling system once and discharged back into the Delaware River. Salem is permitted to discharge 3.024 billion gallons of heated water per day into the Delaware River. This heated water dumps up to 30.6 billion BTUs of heat hourly into the Delaware River.[13] This unnaturally warm water harms the sensitive ecosystem of the River. Salem increases the temperature of the surrounding portions of the Estuary by 8 to 10 degrees Fahrenheit on average, and the increase can be as high as 15 degrees Fahrenheit at times.[14] As the Second Circuit found in Riverkeeper, Inc. v. U.S. Envtl. Prot. Agency, "disrupting the natural thermal stratification [of a River habitat] also affects the balance of nutrients and oxygen, which, in turn, can affect fish migration and spawning." 358 F.3d 174, 200 (2d Cir. 2004) (internal citations omitted). This thermal pollution creates a barrier, which alters the aquatic balance, dramatically changes the habitat for aquatic organisms, and causes fatal heat shock in billions of fish.

To properly evaluate a thermal variance, NJDEP was required to evaluate the characteristics of Salem's thermal plume and then evaluate whether the plumes' effect will assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in and on the Delaware River.[15] In NJDEP's 316(a) determination, NJDEP failed to sufficiently consider the thermal issue. Namely, NJDEP failed to utilize the most recent (2004-2014) USGS temperature data in reviewing ambient water temperatures. Review of this temperature data is an integral part of understanding the impacts of thermal plume created by Salem's thermal discharges. Instead, NJDEP merely relied upon temperature data from 2004 and before.

Additionally, NJDEP failed to sufficiently analyze Salem's thermal plume itself. NJDEP only reviewed select lateral, downriver and upriver surface and subsurface temperature profiles for the thermal plume and did not sufficiently assess the length, surface and subsurface temperatures of the thermal plume. NJDEP also relied on Salem's use of two thermal plume modeling software programs to evaluate the different regions of the thermal plume. This is problematic because combining the two models allows Salem to mask the true effect of its thermal plume. Rather, each modeling software program must be used independently to demonstrate that Salem has properly accounted for the impact of its thermal plume. NJDEP has also failed to sufficiently

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[13] NJDEP's December 8, 2000 Fact Sheet to the Salem 2000 NJPDES Draft Permit, at 18.

[14] U.S. Nuclear Regulatory Commission, Essential Fish Habitat Assessment for the Proposed License Renewal for the Salem Nuclear Generating Station and Hope Creek Generating Station (2011) (the "Fish Habitat Assessment") at 10.

[15] See 33 U.S.C. 1326(a) and 40 C.F.R. 125.73(a) ("Thermal discharge effluent limitations or standards established in permits may be less stringent than those required by applicable standards and limitations if the discharger demonstrates to the satisfaction of the director that such effluent limitations are more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in and on the body of water into which the discharge is made. The demonstration must show that the alternative effluent limitation desired by the discharger, considering the cumulative impact of its thermal discharge together with all other significant impacts on the species affected, will assure the protection and propagation of a balanced indigenous community of shellfish, fish and wildlife in and on the body of water into which the discharge is to be made.")

consider the full extent of the thermal plume during all tidal cycles for all transects and failed to compare Salem's modeling to real time ambient water temperature data.

NJDEP's failure to properly support its NJDEP's 316(a) determination creates both factual and legal issues that require resolution via an administrative hearing. As identified above, the factual issues present are to what extent NJDEP analyzed the characteristics of Salem's thermal plume. DRN will argue, among other things, that NJDEP only reviewed select lateral, downriver and upriver surface and subsurface temperature profiles for the thermal plume and did not sufficiently assess the length, surface and subsurface temperatures of the thermal plume. Conversely, NJDEP claims that the thermal plume analysis it reviewed "**fully** accesse[d] the lateral and vertical profile of the thermal plume as well as its extent upriver and downriver." See NJDEP Final Permit Response to Comment 55, p. 73 of 112 (emphasis added). This discrepancy creates a dispute in material facts that are adjudicatory in nature as this dispute can be resolved by trial-type process whereby evidence can be presented, subject to cross-examination. See In re NJPDES Permit No. NJ0025241, 185 N.J. 474, 485 (2006).

Additionally, other factual issues present are whether NJDEP sufficiently utilized appropriate temperature data and sufficiently analyzed Salem's thermal plume in granting the thermal variance. DRN will present testimony substantiating its claims that NJDEP did not meet this burden. Presumably, NJDEP will offer testimony to the contrary, presenting a battle of the experts for the trier of fact to resolve. Thus, these too are adjudicative facts appropriate for resolution via an administrative hearing. See In re NJPDES Permit No. NJ0025241, 185 N.J. 474, 485 (2006).

These factual disputes are material because by failing to sufficiently utilize appropriate temperature data and sufficiently analyze Salem's thermal plume, there is a material data gap that compromises NJDEP's ability to assess the zone of passage for a number of sensitive aquatic organisms that utilize both the surface waters and shallow shoreline substrates of the Delaware River. As NJDEP has not properly characterized Salem's thermal plume, it has also failed to properly evaluate whether Salem's thermal variance will assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in and on the Delaware River and its tributaries.

3. A clear and concise factual statement of the nature and scope of the interest of the requester which meets the criteria set forth at N.J.A.C. 7:14A-17.3(c)4

Ms. van Rossum is the Delaware Riverkeeper and Executive Director of DRN. She is also a member of DRN. As the Delaware Riverkeeper, Ms. van Rossum advocates for the protection and restoration of the ecological, recreational, commercial and aesthetic qualities of the Delaware River and its tributaries, ecosystems, and habitats. She has served in this independent advocacy role and as the leader of DRN since 1996. DRN works throughout the Delaware River watershed states of New York, Pennsylvania, New Jersey, and Delaware, engaging in advocacy, waterway monitoring, habitat restoration, citizen engagement, and public interest litigation.

DRN has an interest in the present matter because Salem's 2016 Permit authorizes Salem to undertake activities that have adverse impacts on the entire Delaware River estuary; on wildlife, aquatic life, habitats and water quality that are important to the entire watershed and its communities. Namely, Salem's NJPDES Permit authorizes it to operate cooling water intake structures that withdraw over 3 billion gallons of water per day and kill more than 14 billion fish at all life stages annually via impingement and entrainment. Additionally, under Salem's Final Permit it has been given a thermal variance that allows the facility's thermal discharges to exceed New Jersey's water quality standards. Salem's thermal pollution creates a barrier, which alters the aquatic balance, dramatically changes the habitat for aquatic organisms, and causes fatal heat shock in billions of fish.

Because the water supplies, water quality, ecological health, aquatic life, recreational enjoyment of, and the environmental features of the Delaware River watershed are unnecessarily adversely impacted by the terms and conditions in Salem's 2016 Permit, DRN's interest in this matter can be fairly traced to the Department's issuance of the final NJPDES Permit and can likely be redressed by a decision favorable to DRN.

DRN members Ms. van Rossum's and Leona Fluck's environmental, aesthetic, and/or recreational interests are also affected by the Department's issuance of a final NJPDES Permit to Salem.

Ms. van Rossum has been a DRN member since 1992 and regularly uses and enjoys the shores and waters of the Delaware Estuary, Bay, River and tributary streams including in both New Jersey and Delaware, for professional, educational and recreational activities and aesthetic enjoyment. Ms. van Rossum is a wildlife watcher and a naturalist and has been for 50 years. She regularly participates in observing fish, birds and other wildlife in various locations along the Delaware River, its tributaries and in the Delaware Bay. Since 2008, Ms. van Rossum has, individually and often joined by her children and family members, aided scientists conducting research on the migratory shorebirds of the Delaware Bay, including from Moore's Beach and Reed's Beach in NJ and has worked to flip, tag and count horseshoe crabs on both New Jersey and Delaware beaches. Ms. van Rossum also visits and enjoys the banks of the River from various parks on both sides of the River including (but absolutely not limited to) National Park, River Winds, Cape May, Artificial Island, Slaughter Beach, Cape Henlopen, Penn Treaty Park, Moore's Beach, Reed's Beach and Heinz Wildlife Refuge; she often includes her children and family members in these outings. Many times she, individually and with family, colleagues and friends, has canoed and kayaked the non-tidal reaches of the Delaware River, enjoying the water quality, fish life, bird life and wildlife that are dependent upon a healthy River system, including a healthy Delaware Estuary. Ms. van Rossum has also enjoyed boating on the tidal reaches of the Delaware River system including the Estuary, bay and tidal tributaries. Ms. van Rossum has also enjoyed camping along the non-tidal Delaware River both on professional outings as well as personal outings and has enjoyed the River with family, friends and colleagues, in the area of Smith Beach, Dingmans Ferry, Narrowsburg, Hancock, Easton, Washington Crossing, and Morrisville. Other areas of personal and professional enjoyment have included wildlife, habitats and aquatic life in and along the River and tributary streams in Bristol, Burlington, Philadelphia, Oldmans, Wilmington, Dover and much more. Ms. van Rossum intends to continue her professional, aesthetic, educational, family and recreational activities within the watershed into the foreseeable future.

Ms. Fluck has been a DRN member since 2000, joining because DRN stands to protect the Delaware River and its estuaries which she believes are critical to the environment and wildlife. Ms. Fluck is an avid canoeist and has been paddling the Delaware River for 20 years from the Upper Delaware River through the Delaware Water Gap and through the Lower Delaware into the tidal area beginning at Trenton, New Jersey, and into the Philadelphia area. She and her husband participate in river trips during the summer season and enjoy hiking and camping along and near the River. While canoeing, hiking and camping, Ms. Fluck enjoys the water quality, fish life, bird life and wildlife that are dependent upon a healthy River system, including a healthy Delaware Estuary. Ms. Fluck also helps coordinate and manage the Piney Paddlers, an open group of conservation-minded individuals who enjoy hiking and paddling in and around the Pine Barrens ecosystem of Southern New Jersey as well as the Delaware River. Ms. Fluck intends to continue these educational, recreational and aesthetic activities into the foreseeable future.

Because of the aforementioned reasons identified in this section and those reasons identified in section B.1&2, if Salem is allowed to continue operating under its NJPDES permit, its operations will irreparably harm the aesthetic, recreational, and other interests of these DRN members. Moreover, Ms. van Rossum's and Ms. Fluck's interests at stake here are germane to the DRN's organizational purpose and Ms. van Rossum and Ms. Fluck could otherwise be a party in their own right.

4. <u>Statement in compliance with N.J.A.C. 7:14A-17.2(f)8</u>

Upon motion by any party granted by the administrative law judge, or upon order of the administrative law judge's initiative, DRN and Ms. van Rossum shall make available to appear and testify at the administrative hearing, if granted, the following persons:

i. Ms. van Rossum;

ii. All persons represented by DRN and Ms. van Rossum germane to this action; and

iii. All officers, directors, employees, consultants, and agents of DRN and Ms. van Rossum germane to this action;

5. <u>Specific references to the contested permit conditions, as well as suggested revised or alternative permit conditions, including permit denials, which, in the judgment of the person making the hearing request, would be required to implement the purposes of the State Act</u>

DRN's challenge to NJDEP's 316(b) determination contests Final Permit Conditions Part IV.G.1-8. NJDEP must withdraw its 316(b) determination and require Salem to install a closed cycle cooling system, or technology that can achieve comparable impingement and entrainment reductions to adequately address the significant impingement and entrainment impacts that are occurring at the facility. NJDEP must be directed to no longer require restoration, mitigation, and other Special Conditions in lieu of meaningful impingement and entrainment reductions.

DRN's challenge to NJDEP's 316(a) determination contests the surface water discharge monitoring report limits and monitoring requirement in Tables III-J-1, III-K-1, III-L-1 of the 2016 Permit, respectively pages 20-24 of Part III, and Part IV.G.9 of the 2016 Permit. NJDEP must withdraw its 316(a) determination, which granted Salem a thermal variance, reject the thermal variance requested by Salem in its 2006 NJPDES Permit Application and set appropriate surface water discharge monitoring report limits and monitoring requirements that comply with state water quality standards.

6. Identification of the basis for any objection to the application of control or treatment technologies, if identified in the basis or fact sheets, and the alternative technologies or combination of technologies which, in the judgment of the person making the hearing request are necessary to satisfy the requirements of the State Act

As identified above, NJDEP's 316(b) BTA determination in the 2016 Permit requires Salem to submit studies within specific time frames tied to the issuance of the 2016 Permit, continues to impose intake flow limit, and requires restoration, mitigation and other Special Conditions. The restoration, mitigation, and other Special Conditions are insufficient to satisfy the BTA standard because they are no longer permitted by law. As an alternative technology, NJDEP must set closed cycle cooling as BTA under 316(b) for Salem or a technology that can achieve comparable reductions of impingement and entrainment.

C. Date DRN received notification of the final permit decision

DRN received notification of NJDEP's final permit decision on June 10, 2016.

D. The names and addresses of all persons whom DRN represents

Ms. van Rossum makes this hearing request on behalf of DRN, herself as a DRN Member, and DRN Member Leona Fluck. DRN and Ms. van Rossum's address is included on the adjudicatory hearing request checklist and tracking form. Ms. Fluck's address is 229 Sharon Road, Robbinsville, New Jersey 08691.

E. Legal and Factual issues were raised by DRN during the public comment period in accordance with the provisions of N.J.A.C. 7:14A-15.13

DRN raised the above legal and factual issues in its timely submitted September 18, 2015 public comment ("Public Comment") on the 2015 Salem Draft NJPDES Permit in accordance with the provisions of N.J.A.C. 7:14A-15.13. Specifically, DRN raised the issue of NJDEP's failure to consider important aspects of the thermal variance issue on pages 3-8 and 22-23 of its Public Comments and the Carpenter Environmental Associates, Inc. Report referenced in and attached to DRN's Public Comments.[16] Additionally, DRN raised the issue of NJDEP's improper use of restoration, mitigations and other Special Conditions in its 316(b) determination on pages 18-20 of its Public Comment.

F. An estimate of the amount of time required for a hearing

DRN is hopeful that this hearing will not require an excessive amount of time. However, DRN is hesitant to estimate a specific amount of time that this hearing will require in light of the detailed technical issues presented herein. Notwithstanding that concern, DRN estimates that the hearing will take approximately two (2) to three (3) days.

G. Request for a barrier-free hearing location for disabled persons

DRN hereby requests a barrier-free hearing location for disabled persons.

H. Statement regarding DRN's willingness to negotiate a settlement

DRN is willing to enter into good faith settlement negotiations with the Department prior to the Department's processing of DRN's hearing request to the Office of Administrative Law.

[16] For ease of reference, DRN's Public Comment, Index of Attachments, and the Carpenter Environmental Associates, Inc. Report, which were all already timely submitted to NJDEP, are attached as Attachments 1-3, respectively. Upon the request of the Office of Legal Affairs, DRN will furnish any other of its timely submitted attachments to its Public Comment.

Conclusion

DRN respectfully submits that it meets the criteria to be a party to the action and that it meets the criteria to be granted an administrative hearing. Timely processing of these requests is required. We respectfully remind the Department that within 30 days of receipt of this request it must determine whether DRN is a party to the action or refer the request to an administrative law judge. See N.J.A.C. 7:14A-17.3(b). If the request is referred to an administrative law judge, the administrative law judge has an additional 30 days to make a party status determination. Id.

Respectfully submitted,

/s/ Nicholas Patton

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Counsel for Delaware Riverkeeper Network and the Delaware Riverkeeper

/s/ Stuart J. Lieberman

Stuart J. Lieberman
Michael G. Sinkevich
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10 Jefferson Plaza
Princeton, NJ 08540

Counsel for Delaware Riverkeeper Network and the Delaware Riverkeeper

Attachment 1

DELAWARE RIVERKEEPER NETWORK

September 18, 2015

Pilar Patterson, Chief
Mail Code 401-02B
Division of Water Quality, Bureau of Surface Water Permitting
P.O. Box 420
Trenton, NJ 08625-0420

susan.rosenwinkel@dep.nj.gov

Re: Draft NJPDES #: NJ0005622
Issued for PSEG Nuclear LLC Salem Generating Station, Alloway Creek Neck Road, Lower Alloways Creek Twp, Salem County

Dear Ms. Patterson and Ms. Rosenwinkel,

The Delaware Riverkeeper Network submits this comment along with the attached expert reports, scientific and factual materials with regards to Draft NJPDES Permit NJ0005622 issued for PSEG's Salem Nuclear Generating Station (Salem) located in Lower Alloways Creek Twp, Salem County, NJ. We believe this draft permit fails to fulfill the requirements of the Clean Water Act and implementing regulations. We urge you with withdraw the draft permit, for the New Jersey Department of Environmental Protection (NJDEP) to undertake the limited additional analysis necessary and to issue a revised Draft NJPDES permit that honors the legal mandates and the spirit of the law, and one that provides the protections needed by the fish populations of the Delaware River and for the benefit of all those people who depend upon and appreciate having a healthy, diverse and sustainable aquatic community in our River.

Pursuant to section 316(b) of the Clean Water Act and implementing regulations, the NJ Department of Environmental Permit should issue a draft permit that mandates closed cycle cooling at Salem.

Section 316(b) of the Clean Water Act (CWA) requires facilities like the Salem Nuclear Generating Station (Salem) to use the best technology available (BTA) on the design, location, construction and capacity of their cooling water intake structures to minimize their adverse environmental impact. In 2014 the Environmental Protection Agency issued new regulations to guide implementation of § 316(b). According to the regulations, found at 40 C.F.R. 122.21(r) and 40 C.F.R. 125.90-98, each regulated facility subject to 316(b) must submit entrainment and impingement performance studies, select an impingement technology to be implemented, and provide a comprehensive technical feasibility and cost evaluation study of entrainment technologies with its National Pollutant Discharge

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Elimination System (NPDES) permit renewal application in order to inform that aspect of a final NPDES permit issued.[1] But, facilities with administratively extended permits, like Salem are not required to submit the studies required in 40 C.F.R. 122.21(r) as long as their permits are issued before July 14, 2018. 40 C.F.R. 125.98(g) allows NJDEP, in the case where permit proceedings began prior to October 14, 2014, as they have with Salem, to "proceed with a determination of BTA standards for impingement and mortality and entrainment without requiring the facility to submit the information required in 40 CFR 122.21(r)", when the Director determines the information already submitted by the facility is sufficient. Should the Director determine he has sufficient information, his BTA determination "may be based on *some or all of the factors* in paragraphs [40 CFR 125.98] (f)(2) and (3) of this section and the BTA standards for impingement mortality at § 125.95(c)."[2]

As explored in great detail below, NJDEP has sufficient information in the areas outlined in 40 C.F.R. 125.98 (f)(2) and (f)(3), including Salem's significant entrainment impacts on the Delaware River, to make a determination that closed cycle cooling is BTA for the facility but has failed to use its best professional judgment to do so. Nonetheless, assuming *arguendo* that NJDEP may appropriately move forward with an interim BTA assessment per 40 C.F.R. 125.98(b)(6)[3], NJDEP must establish interim BTA requirements in Salem's permit based on the agency's best professional judgment on a site-specific basis in accordance with §125.90(b)[4] and 40 C.F.R. 401.14[5]. NJDEP has failed to exercise its BPJ in its interim BTA assessment.

PSEG's permit for Salem expired in 2006; the current draft permit issued on June 30, 2015 was issued as the result of a legal challenge brought by the Delaware Riverkeeper Network, NJ Clean Water Action and NJ Sierra Club. PSE&G had submitted its 2006 permit renewal application in a timely fashion under the law and as a result it has been allowed to operate since 2006 with a Clean Water Act permit that was first issued in 2001 and expired in 2006. As long as the new permit for Salem is finalized by July 14, 2018, NJDEP can and should use its best professional judgment, and information already on the record, to establish BTA for Salem. Given the years of data and analysis on the record for Salem, and given the extreme level of fish mortality inflicted by Salem through impingement and entrainment, as well as thermal impacts, on a wide variety of Delaware River fish species it would be irresponsible for NJDEP to give PSE&G a pass for another 5 years by allowing it to continue monitoring its massive fish kills rather than use best technology available to minimize those kills at the very achievable 95% level.

Among the factors presented in 40 CFR 125.98(f)(2) and (f)(3) that the Director can base a BTA determination on are: the number of organisms entrained, including endangered species; land

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[1] 40 CFR 122.21(r) specifically requires facilities to submit: (2) Source water physical data; (3) Cooling water intake structure data; (4) Source water baseline biological characterization data; (5) Cooling water system data; (6) A chosen method to comply with the Impingement Mortality Standard and a performance study if certain impingement technology is chosen; (7) Entrainment performance studies; (8) Operational status of each unit that uses cooling water; and, if the facility withdraws more than 125 mgd, the facility must additionally submit: (9) Entrainment Characterization Study; (10) A comprehensive technical feasibility and cost evaluation study of entrainment technologies; (11) A benefits valuation study; (12) A non-water quality environmental and other impact study.

[2] 40 C.F.R. 125.98(g)

[3] *See* 40 CFR 125.98(b)(6) (In the case of any permit issued after October 14, 2014, and applied for before October 14, 2014 . . . The Director must establish interim BTA requirements in the permit on a site-specific basis based on the Director's best professional judgment in accordance with § 125.90(b) and 40 CFR 401.14).

[4] 40 C.F.R. 125.90(b) (Cooling water intake structures not subject to requirements under §§ 125.94 through 125.99 or subparts I or N of this part must meet requirements under section 316(b) of the CWA established by the Director on a case-by-case, best professional judgment (BPJ) basis).

[5] 40 CFR § 401.14 Cooling water intake structures. ("The location, design, construction and capacity of cooling water intake structures of any point source for which a standard is established pursuant to section 301 or 306 of the Act shall reflect the best technology available for minimizing adverse environmental impact, in accordance with the provisions of part 402 of this chapter.)

availability as it relates to the feasibility of a particular entrainment technology; remaining plant life; quantified/qualitative social benefits and costs of available entrainment technologies when such information on both benefits and costs is of sufficient rigor to make a decision; thermal discharge impacts; and impacts on the reliability of energy delivery within the immediate area. When these factors are applied to Salem it becomes clear that BTA is closed cycle cooling and that there is ample evidence, data and information to support, and even dictate, that best professional judgment would mandate a requirement of closed cycle cooling at Salem.

- Given the well documented entrainment and impingement data on the record demonstrating Salem impinges and entrains over 14 billion fish, eggs and larva in a given year;
- Given the high level of age 1 equivalent fish that are lost from the Delaware River fish population as a result of impingement, entrainment and thermal impacts;,
- Given the endangered and threatened species impacted by Salem
- Considering the extended operational life given to Salem by the Nuclear Regulatory Commission;
- Given the facility's location in a sensitive and important estuary ecosystem;
- Given the cost analysis and technical analyses/comments included with this comment;
- Given the importance of commercial and recreational fishing to our region and the high level of takes by Salem of species targeted by commercial and recreational fishers; and
- Given the clear availability of closed cycle cooling at Salem both technologically and economically, so much so that NJDEP (based on its own hired experts) sought to require application of this technology at Salem 25 years ago;

Best Professional Judgment and well-reasoned agency action would clearly dictate that NJDEP mandate the use of closed cycle cooling or its functional equivalent at Salem; to do otherwise would be arbitrary, capricious and an abuse of discretion and an absolute failure to, in good faith, exercise the agency's best professional judgment.

Looking at all impingement and entrainment at Salem: 14.6 billion fish, eggs and larvae are killed a year in its once through cooling water intake structures.

(ECONorthwest analysis attached relying upon US EPA, 316(b) Case Studies, Part B: The Delaware Estuary.)

When just considering a limited set of species deemed Representative Import Species (RIS) by PSEG, data has shown the following levels of impingement and entrainment impacts:

Over 59 million Blueback Herring
Over 77 million Weakfish
Over 134 million Atlantic Croaker
Over 412 million White Perch
Over 448 million Striped Bass
Over 2 billion Bay Anchovy

(Figures provided are numbers of fish killed. Source: correspondence from US Fish & Wildlife Service to NJDEP, June 30, 2000 relying on PSE&G permit application data)

It is notable, that the US Fish & Wildlife Service made clear its position that the Best Technology Available is closed cycle cooling[6] thereby supporting the perspective that best professional judgment supports a closed cycle cooling mandate.

<u>The number of organisms impinged and entrained at Salem, including endangered species:</u>

[6] USF&WS comment to NJDEP, Sept 17, 2015

Every year, Salem kills an extreme number of fish, many of which are at depressed population levels within the Delaware River population/system, and some of which are endangered.

On average, every year, the Salem Nuclear Generating Station kills through entrainment 14.7 billion fish and impinges 6.6 million more at various life stages.

PSEG minimizes the perception of its impingement, entrainment and fish kill impacts by limiting its impingement and entrainment analyses to just a 10 or so species it has determined to be Representative Important Species (RIS) including: Alewife, American Shad, Atlantic Croaker, Bay Anchovy, Blueback Herring, Spot, Striped Bass Weakfish, White Perch, Blue Crab. But according to EPA's 316(b) Case Study, there are over 100 different kinds of fish vulnerable to impingement and entrainment by Salem and other CWIS' in the Delaware. [7]

According to a review by the US Fish and Wildlife Service of Salem's impingement and entrainment impacts on the 10 identified RIS species,[8] the Salem facility kills 5.5 million weakfish, striped bass, white perch, blueback herring, spot and other fish as the result of impingement.[9] An additional 3,327.9 million fish are lost due to entrainment.[10] This translates into over 3.3 billion killed due to impingement and entrainment a year at Salem when simply considering the 10 RIS species PSEG has identified.

Even PSE&G itself reports high kill levels – despite that previous reviews of PSE&G data by NJDEP hired consultants questioned and challenged the accuracy of their reported fish kills and figures, the level of fish mortality is so high that even PSE&G cannot mask the significance of its impingement and entrainment takes. For example, PSEG data shows annual impingement and entrainment takes of species as high as those noted on the table to the right …

Species	**Highest Take in a Single Year from 3 Year Time Frame Provided in NJDEP Fact Sheet**
Bay Anchovy	2,343,510,158
Atlantic Croaker	454,405,706
Striped Bass	403,748,868
Atlantic Menhaden	190,696,853
Weakfish	48,899,509
White Perch	26,592,221
Atlantic Silverside	44,922,417
Alewife	9,848,385
Blueback Herring	1,973,337
Spot	2,261,064

This table is based on the three years of data included in the NJDEP permit fact sheet years 2002, 2003, 2004.

PSEG uses averaging to try to reduce the perception of its annual impingement and entrainment levels, but when it comes to fish kills, including from a number of species that are already in decline or only holding steady at significantly low levels, the annual take in a given year is significant and should not be masked by averaging.

[7] US EPA, 316(b) Case Studies, Part B: The Delaware Estuary, Table B3-1.
[8] US Fish & Wildlife Service to NJDEP, June 30, 2000 (relying on PSE&G permit application data)
[9] Impingement occurs when organisms are trapped against screening devices by the force of the water passing through the cooling water intake structure. Impingement can result in starvation and exhaustion, asphyxiation and descaling.
[10] Entrainment occurs when organisms are drawn through a cooling water intake structure into the facility's cooling system. Organisms that become entrained are generally relatively small forms of fish and shellfish species. As entrained organisms pass through a plant's cooling system they are subject to mechanical, thermal, and toxic stress. The mortality rate of entrained organisms is high.

According to the Versar report provided to NJDEP in 1989 "Entrainment of early life stages of fish, including recreationally and commercially important species was projected to result in high population losses…" at Salem.[11] "Entrainment, and to a lesser degree impingement, losses are projected to: 1) adversely affect important spawning and nursery functions, 2) result in adverse changes to the food web of the Delaware Estuary, and 3) adversely affect beneficial uses (i.e. fishing) of the receiving water body." [12] Versar determined Salem to be a threat to the protection and propagation of the balanced indigenous populations of fish inhabiting the Delaware Estuary unless significant reductions in impingement and entrainment were achieved.

Impingement and entrainment levels at Salem since Versar's analysis remain similarly extreme -- in fact Salem has the second largest CWIS take of fish in the nation as noted in our attached expert report from ECONorthwest – and while there has been some reduction in impingement impacts,[13] entrainment impacts remain historically high and according to Versar it is the entrainment impacts that have always been the biggest harm and threat inflicted by Salem (see quote above). As such Versar's findings regarding Salem's adverse impacts on the fisheries of the Delaware River are still valid and applicable.

Furthermore many of the fish species impacted by Salem are at declining or depressed levels and so experience magnified affects from Salem's takes. Additionally, Versar's assessment is repeated by a line of other expert reports and analyses in the years since it was completed for NJDEP (see below in comment for more discussion of other assessments and reports). According to Versar, it is essential that the entrainment impacts at Salem be reduced and that closed cycle cooling is the demonstrated technology that can accomplish the kinds of reductions necessary for a facility with the large intake flow volumes required by Salem.

In addition, more recently, the US Fish & Wildlife Service has expressed concerns about Salem entraining the larval form of horseshoe crabs, particularly with increasing sea level rise in the estuary.[14] While the horseshoe crabs are not currently listed as threatened or endangered, they are a primary food source for the Red Knot is currently listed as threatened and so entrainment of the larval form of horseshoe crabs may have an adverse impact on that threatened species.

The level of impingement and entrainment at Salem is extreme with additional species such as the horseshoe crab now coming into its range of impact, and therefore BPJ and well-reasoned agency action would mandate closed cycle cooling technology to minimize these adverse impacts on the Delaware River, Estuary and Bay. In addition, when you look at the high level of fish mortality and take inflicted by Salem as compared to the documented conditions of a number of those fish populations the actual significance of the impacts inflicted by Salem are magnified.

Bay anchovy:
Bay Anchovy are important forage fish for many species that are the target of commercial and recreational fisheries.

"The bay anchovy is a species whose numbers have been decreasing at an alarming rate. These

[11] Versar Inc. ***Technical Review and Evaluation of Thermal Effects Studies and Cooling Water Intake Structure Demonstration of Impact for the Salem Nuclear Generation Station, Revised Final Report***, Prepared for NJDEP, 1989.
[12] Versar Inc. ***Technical Review and Evaluation of Thermal Effects Studies and Cooling Water Intake Structure Demonstration of Impact for the Salem Nuclear Generation Station, Revised Final Report***, Prepared for NJDEP, 1989.
[13] USF&WS comment to NJDEP, Sept 17, 2015
[14] USF&WS comment to NJDEP, Sept 17, 2015

> fish are usually one of the most abundant species in the Delaware estuary and are a primary food source for many fish inhabiting the river, including weakfish, bluefish and striped bass. The average number caught per seine haul … has been declining since 2000. Bay anchovy data correlates well with data from New Jersey Fish and Wildlife's Finfish Trawl Survey in Delaware Bay, which also indicates a bay anchovy decline since 1998."[15]

PSEG's data, as well as that of the US Fish and Wildlife Service, show bay anchovy takes in the range of 2 billion a year. This is a high level of take for a species that NJDEP itself describes as decreasing at an "alarming rate."

The Delaware City Refinery has a significantly lower impingement and entrainment take and kill rate as compared to Salem. One analysis found Bay Anchovy takes by the the Delaware City Refinery in 1998 to be in the 16 million to 17 million range. At this level it was "estimated that 19.0% of anchovy in the Delaware Bay and River stock were killed by the refinery in 1998." [16] According to this expert analysis: "The destruction of one-fifth of the anchovy stock in the Bay and River reduces the potential abundance and density of this important forage species to the point that attraction of desirable predators … to Delaware Bay and the production of younger predators targeted by the fisheries could be reduced to a significant degree. [17]

By comparison, Salem takes over 2 billion bay anchovy – well more than 100 times the level of take inflicted by the Delaware City Refinery.

Given that at a 19% take level of Bay Anchovy, the Refinery has been determined by experts to have the potential for "a noticeable impact on the total productivity of the Bay and River for the production of desirable predator species as well as reducing the attraction of adult predators" [18] it is most certain that Salem would be having these effects to a significantly higher degree given its massively higher impingement and entrainment takes and mortality levels for Bay Anchovy. In fact, Dr. Kahn has stated that "the combination of the refinery and the Salem Generating Station is certainly taking a significant part of the forage base of Delaware Bay." [19]

Clearly the continued use of once through cooling that will support Salem's continuing high level of Bay Anchovy impingement, entrainment and mortality is itself alarming and cannot be justified.

Blueback herring and Alewife:

Blueback herring and Alewife have been identified by NOAA as a species of concern and one that has been experiencing declines throughout their range, including in the Delaware River.[20] Among the reasons for decline are fishing and increased predation—Salem, which takes over 7 million of these two fish combined a year, falls into both of these River Herring take categories (fishing and predation). The continued use of once through cooling that supports this continuing high level of take is unjustified given its impact on these species of concern.

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[15] Bay Anchovy Fact Sheet, NJDEP, http://www.state.nj.us/dep/fgw/pdf/delriver/artdel_sp_bayanchovy.pdf

[16] D. Kahn, PhD., Impacts of Impingement and Entrainment Mortality by the Delaware City Refinery on Fish Stocks and Fisheries in the Delaware River and Bay, Delaware Division of Fish and Wildlife, Oct 9, 2008.

[17] D. Kahn, PhD., Impacts of Impingement and Entrainment Mortality by the Delaware City Refinery on Fish Stocks and Fisheries in the Delaware River and Bay, Delaware Division of Fish and Wildlife, Oct 9, 2008.

[18] D. Kahn, PhD., Impacts of Impingement and Entrainment Mortality by the Delaware City Refinery on Fish Stocks and Fisheries in the Delaware River and Bay, Delaware Division of Fish and Wildlife, Oct 9, 2008.

[19] D. Kahn, PhD., Impacts of Impingement and Entrainment Mortality by the Delaware City Refinery on Fish Stocks and Fisheries in the Delaware River and Bay, Delaware Division of Fish and Wildlife, Oct 9, 2008.

[20] River Herring (Alewife & Blueback Herring), Species of Concern, NOAA National Marine Fisheries Service, 5/19/2009.

American Shad:

The ASMFC has determined:

> " The American shad stock in the Delaware River is considered stable but at low levels compared to the historic population." [21]

As reported in the NJDEP fact sheet accompanying the Salem draft permit, Salem has killed as many as 72,486 American Shad in a single year. This is a significant figure for a stock that is considered significantly depressed from historic levels. The goal put forth by the ASMFC for Delaware River Shad is 750,000. Population estimates calculated for the years 2000 to 2006 provide an average population of only about 320,000 (less than half the target population) with the year 2006 estimate being in a mere 160,000 range. [22] Thus, the annual take of the shad population of the Delaware River by Salem is in the range of 23% to 45% of the entire population. (using the 2000 to 2006 average; and the 2006 estimate). Even if you use PSEG's 3 year average for their shad takes from 2002 to 2004 (also included in the NJDEP fact sheet) which is 29,837, you still have Salem impinging 9% to 19% of the Delaware River shad population a year.

Allowing these levels of take for a species determined to be at such low levels, and for a species that is of such recreational, cultural and historic importance to the Delaware River ecology, economies and communities is arbitrary, capricious and cannot be justified.

Because of concerns about American shad populations coast wide, and in the Delaware River, New Jersey has placed the following limitation on shad harvest:

> "Not more than 3 American shad in Del. Bay, River & tributaries."[23]

And so while commercial and recreational fishers have to limit their take of American Shad in an effort to preserve and restore the species and its populations Salem gets to take them indiscriminately, killing over 72,000 in a single year, without repercussion.

Weakfish:

Weakfish, while having a rich history for fishing, have suffered tremendous declines that has changed that picture, and they are now ill equipped as a population to sustain high level takes, particularly technologically avoidable ones, year after year. Weakfish are characterized as being among the dominant finfish collected from the Salem cooling water intake structures.

The Atlantic States Marine Fisheries Commission (ASMFC) has determined that weakfish populations in our region are in a "depleted state."[24]

For weakfish, Salem has "an estimated mortality rate of 17%"[25] -- that means Salem kills 1 out of every 6 weakfish in the Delaware River.

[21] Delaware River Sustainable Fishing Plan for American Shad, Prepared by the Delaware River Basin Fish & Wildlife Management Cooperative for The Atlantic States Marine Fisheries Commission Shad and River Herring Management Board, December 2011.
[22] 2007 Shad Stock Assessment Report Volume II ASMFC.
[23] http://www.state.nj.us/dep/fgw/pdf/2015/maregsum15.pdf
[24] Atlantic States Marine Fisheries Commission, ADDENDUM IV TO AMENDMENT 4 TO THE WEAKFISH FISHERY MANAGEMENT PLAN, Nov 2009.

While in the past Weakfish were severely overfished, regulations and lack of population has significantly reduced their harvest by commercial or recreational fishers. The cut back on fishing, for a brief period, allowed the population to begin to rebound. But in recent years the natural mortality rate of Weakfish (deaths from natural causes such as being eaten and starvation) has been on the rise. Between 1982 and 1990 the biomass of Weakfish age 1+ declined from 113.1 million pounds to 17.6 million pounds. In 2008 the biomass of Weakfish age 1+ was only 10.8 million pounds.

As stated by the ASMFC:

> "Current removals, combined with high natural mortality rates, risk reducing the spawning stock to a level where poor year-classes become typical." [26]
>
> "The review panel agreed with the assessment's findings, concluding that the current level of fishery removals further exacerbates the decline in abundance (Sullivan et al. 2009). Consequently, the Management Board initiated the development of this addendum to consider options ranging from significantly reduced harvest to eliminating harvest (moratorium) in order to decrease fishing mortality. "[27]

Whether one characterizes Salem as a fishing take from the Weakfish population or not, it is adding to the pressure on an already depleted population size that needs reductions in takes all the way around in order to maximize its ability to rebound. Salem kills in the range of 50 to 80 million Weakfish a year. Thus Salem is contributing to the population declines being experienced by Weakfish of the Delaware River and is a contributing impediment to their ability to rebound. Salem's impact on the Weakfish population would be reduced through the implementation of closed cycle cooling. Allowing Salem to continue to take in the range of 50 to 80 million a year cannot be supported by sound policy or science.

<u>Striped Bass:</u>
Striped bass have been characterized as "the most valuable finfish produced in the Delaware River. They command a high price in commercial markets and are valued by recreational fishers…."[28]

By multiple accounts, including the NJDEP draft permit fact sheet, Salem can kill over 400 million striped bass a year.

Looking at 1998 data, Dr. Kahn of DNREC determined that the number of Equivalent recruits at age 6 months from the Delaware City Refinery and Salem combined exceeded the number of striped bass survivors – in other words, they are killing more striped bass than are being left alive in the River!

> The estimated number of live 6-month old bass in 1998 was 1.274 million. "The number of Equivalent recruits at age 6 months from the [Delaware City] refinery kill was 0.471 million,

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[25] D. Kahn, PhD., Impacts of Impingement and Entrainment Mortality by the Delaware City Refinery on Fish Stocks and Fisheries in the Delaware River and Bay, Delaware Division of Fish and Wildlife, Oct 9, 2008.
[26] Atlantic States Marine Fisheries Commission, ADDENDUM IV TO AMENDMENT 4 TO THE WEAKFISH FISHERY MANAGEMENT PLAN, Nov 2009.
[27] Atlantic States Marine Fisheries Commission, ADDENDUM IV TO AMENDMENT 4 TO THE WEAKFISH FISHERY MANAGEMENT PLAN, Nov 2009.
[28] D. Kahn, PhD., ***Impacts of Impingement and Entrainment Mortality by the Delaware City Refinery on Fish Stocks and Fisheries in the Delaware River and Bay***, Delaware Division of Fish and Wildlife, Oct 9, 2008.

and the number from Salem was 1.169 million. When the two estimates from the two plants are summed, the total is 1.640 million, which exceeds the number of survivors." [29]

As compared to Salem, the Delaware City Refinery is reported to take 8.5 to 16.5 million in a year – far less than Salem. According to Dr. Kahn, the "combined mortality rate [of the two plants] is larger than either individually." A greater focus on the cumulative impact of other facilities along with Salem for all impacted species, is clearly warranted and has not been provided.

This high level of take cannot be justified in light of the important recreational values of Striped Bass for our river and region.

Additionally, according to a year 2000 analysis conducted by Dr. Kahn of Salem's impact on Striped Bass populations of the River he determined that that the conditional mortality rate inflicted by Salem is "high enough to be of serious concern."[30]

More recently the state of Delaware evaluated the 2002 to 2004 data provided by PSEG in its permit application that is the basis of the NJDEP draft permit, and they determined that Salem "the mean annual adult equivalent biomass lost to the operation of [Salem] greatly exceeded Delaware's annual commercial striped bass quota"[31] (i.e. the biomass lost to Salem from 2002 to 2004 was 278,576 pounds per year while Delaware's annual commercial striped bass allowable quota is a mere 145,085 pounds per year). The estimate economic value of this loss to Salem was determined to be between $745,218 and $5,903,482. [32]

<u>Salem is the largest industrial source of fish mortality on the Delaware River – there is no policy, legal or scientific justification to allow continued use of once through cooling and not to instead mandate closed cycle cooling or a comparable existing technology to reduce its fish mortality bootprint.</u>

<u>Impacts on threatened and endangered species is significant.</u>

The outdated once through cooling system at Salem affects six aquatic species that are federally listed as endangered or threatened by the U.S. Fish & Wildlife Service: the Shortnose sturgeon; Atlantic sturgeon; Kemp's Ridley sea turtle; the Leatherback sea turtle; and the Green sea turtle are listed as "endangered," while the Loggerhead sea turtle is listed as "threatened."

In addition Salem discharges over 3 billion gallons of heated water per day into the Delaware Estuary. This unnaturally warm water harms the sensitive ecosystem of the Estuary and impacts these species and others is significant and concerning ways.

The Atlantic Sturgeon of the Delaware River are listed as endangered as part of the NY Bight DPS listed by the National Marine Fisheries Service. "In the NYB DPS, there are two known spawning populations – the Hudson and Delaware Rivers. While the Hudson is presumably the largest extant reproducing Atlantic sturgeon population, the Delaware is presumably very small and extremely vulnerable to any sources of anthropogenic mortality."[33] In addition the Delaware River population of

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[29] D. Kahn, PhD., ***Impacts of Impingement and Entrainment Mortality by the Delaware City Refinery on Fish Stocks and Fisheries in the Delaware River and Bay***, Delaware Division of Fish and Wildlife, Oct 9, 2008.

[30] D. Kahn, PhD., ***Mortality of Delaware River Striped Bass from Entrainment and Impingement by the Salem Nuclear Generating Station***, March 30, 2000.

[31] DNREC comment to NJDEP, Aug. 27, 2015.

[32] DNREC comment to NJDEP, Aug. 27, 2015.

[33] Final Rule, Threatened and Endangered Status for Distinct Population Segments of Atlantic, Sturgeon in the Northeast Region, Fed Reg Vol

the Delaware River has been identified as being genetically unique, with only 300 spawning adults left in this population,[34] and so even small takes can have significant population impacts.

The following takes of Atlantic Sturgeon at Salem have been documented for 2014 and 2015 through searches undertaken by the Delaware Riverkeeper Network. The identification of takes for 2015 is not presumed to be complete, these are the reports we were able to find through online searches and information requests:

Date: 3/25/15
Size: 812.8 mm length, 1.59 kg weight
Found in SGS Unit 1; CWI bay 12B
Found live. Released live.
Damage found at base of caudal fin and along the upper dorsal margin of the caudal fin.

Date: 12/22/14
Size: 701 mm total length; 1.3 kg weight
Found SGS Unit 1; CWI bay 12A
Deceased at time of retrieval by Salem Yard Crew. Cause of death unknown.

Date: 8/5/2014
Size: 76.0 cm length; 19.8 kg weight
Unit 1 CWI 11A
Missing head and tail.

Date: 4/18/2014
Size: 67.3 cm Length 1.20 kg Weight
Deceased presumed[35] Juvenile
Expert reviewer concluded cause of death unknown

Date: 4/9/2014
Size: 69.3 cm Length 1.30 kg Weight
Deceased presumed Juvenile
Expert reviewer concluded cause of death impingement

Date: 4/7/2014
Size: 70.2 cm Length, 1.48 kg Weight
Deceased presumed Juvenile

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77 No. 24, Feb. 6, 2012.

[34] NOAA Fisheries Service, Atlantic Sturgeon New York Bight Distinct Population Segment: Endangered, http://www.nmfs.noaa.gov/pr/pdfs/species/atlanticsturgeon_nybright_dps.pdf

[35] According to the Atlantic States Marine Fisheries Commission an Atlantic Sturgeon's life cycle can be determined by using the length-at-age table cited from asmfc.org below.

Life Interval	**Age Range (years)**	**Fork Length (mm)**	**Total Length (mm)**
Larvae	<0.08 < 30		
Juvenile	0.08-11	~20-1340	~30-1490
Non-spawning adults	> 12	> 1350	> 1500
Female spawners	> 15	> 1800	> 2000
Male spawners	12-20	> 1350-1900	> 1500-2100

Table 8-1. Age and size range of Atlantic sturgeon throughout their life cycle

Expert reviewer concluded cause of death unknown

Date: 4/7/2014
Size: 70.2 cm 1.69 kg Weight
Alive presumed Juvenile

Date: 4/7/2014
Size: 67.6 cm Length 1.37 kg Weight
Alive presumed Juvenile

Date: 4/3/2014
Size: 63.0 cm Length 1.14 kg Weight
Alive presumed Juvenile (Damaged)

Date: 3/31/2014
Size: 77.0 cm Length
Alive presumed juvenile

Date: 3/27/2014
Size: 67.2 cm Length 1.35 kg Weight
Alive presumed Juvenile

Date: 2/20/2014
Size: 66.4 cm Length 1.31 kg Weight
Deceased presumed Juvenile
Expert reviewer concluded cause of death as impingement

Date: 2/19/2014
Size: 68.4 cm Length 1.37 kg Weight
Deceased presumed Juvenile
Expert reviewer concluded cause of death as impingement

Date: 2/12/2014
Size: 70.2 cm Length
Alive presumed Juvenile

Date: 1/27/2014
Size: 64.7 cm Length
Alive presumed Juvenile

Date: 1/27/2014
Size: 66.0 cm Length
Alive presumed Juvenile

Date: 1/8/2014
Size: 62.2 cm Length 1.2 kg Weight
Alive presumed Juvenile

Date: 1/6/2014
Size: 61.1 cm Length 0.927 kg Weight
Deceased presumed Juvenile
Expert review concluded cause of death by impingement

In addition to the 18 Atlantic Sturgeon found in the Salem intakes there were found at least 7 Shortnose sturgeon on: 3/13/14; 3/20/14; 4/15/14; 11/20/14; 11/21/14; and two on 12/10/14.

Furthermore we know there were at least 2 Kemp's Ridley Turtle takes reported on 7/9/14 and 9/3/14 – PSEG asserts the turtles had died prior to impingement at Salem (we have not been able to verify the accuracy of these assertions).

The NMFS Biological Opinion (BiOp) requires Salem to undertake certain Reasonable and Prudent Measures (RPMs) to minimize and monitor sturgeon takes. However, the BiOp does not take into account the cumulative impact of vessel strikes, a significant source of anthropogenic mortality. The BiOp only reports Brown and Murphy (2010) vessel strike mortality from 2005-2008 which doesn't even include all reports from that time period. Due to an increase in reporting enthusiasm adult Atlantic sturgeon vessel strike reports have increased from 17 in 2005-2008 to 43 from 2010-2013. When a reporting rate correction is applied to the 2010-2013 average, such as the James River 38% (Balazik et al 2012), estimated annual adult vessel strike mortality is 28.3. Considering cumulative effects, by combining the permitted lethal adult take of the Delaware population from all NMFS BiOp's, annual adult anthropogenic mortality is estimated to be 33.8. With a Delaware River adult population estimated to be <300 individuals the predicted mortality, F=0.11. This level of take mortality is greater than Boreman (1997) 50% of egg per recruit F of 0.05 that would be sufficient to rebuild the population. This analysis suggests that permitted lethal take of Delaware Atlantic sturgeon is currently not being managed for restoration and Salem is contributing significantly to Atlantic sturgeon mortality through impingement which is not considered in the NMFS BiOp.[36]

Salem is impacting threatened and endangered species in the estuary that have little capacity to absorb additional harms, particularly ones that are totally avoidable with a technology upgrade, as is the case at Salem with closed cycle cooling.

It is also important to note that not only are there ecological benefits in avoiding the unnecessary adverse impacts to threatened and endangered species inflicted by Salem, but there are also economic benefits. Our federal government spends nearly $22 million a year to benefit and protect the endangered species of fish and turtle that Salem is legally allowed to kill every year. Installing closed cycle cooling to reduce impingement, entrainment and thermal impacts of Salem enhances the value of this economic investment and brings us closer to the day when it is no longer needed for these species. [37]

[36] See: Brown, J. J. and G. W. Murphy. (2010). Atlantic sturgeon Vessel-strike mortalities in the Delaware Estuary. *Fisheries*, vol 35(2), 73-83.; Balazik, M. T., Reine, K. J., Spells, A. J., Fredrickson, C. A., Fine, M. L., Garman, G. C., & McIninch, S. P. (2012). The potential for vessel interactions with adult Atlantic sturgeon in the James River, Virginia. *North American Journal of Fisheries Management*, *32*(6), 1062-1069.; Boreman, J. (1997). Sensitivity of North American sturgeons and paddlefish to fishing mortality. *Environmental Biology of Fishes*, *48*(1-4), 399-405.
[37] **ECONorthwest,** Economic Benefits of Installing a Closed-Cycle Cooling System at Salem Nuclear Generating Station, Final Report, **Sept, 2015.**

Remaining plant life: Salem has received a life extension that will extend its adverse environmental impacts for another 21 to 25 years, thus increasing the importance of minimizing its fish kills.

The Salem Nuclear Generating station, as the result of an extension of its operating license by the Nuclear Regulatory Commission will be operating for an additional 21 (Unit 1 license expires 2036) to 25 (Unit 2 license expires 2040) years. Given the length of time the facility has to still operate it is important that NJDEP ensure PSEG is taking all actions to avoid the adverse environmental impacts Salem inflicts on the Delaware Estuary, including the massive fish kills inflicted every day and every year by impingement and entrainment, as well as the harms inflicted by its heated water and pollution discharges.

The fact that the draft permit will allow Salem to continue its indiscriminate kills of over 14 billion Delaware River fish a year at multiple stages of life (thereby denying us the many benefits each life stage provides our estuary ecosystem) is itself a demonstration that the draft permit fails to meet NJDEP's obligation to use its best professional judgment to ensure "that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact" as mandated by section 316(b) of the Clean Water Act.

Quantified/Qualitative social benefits and costs of available entrainment technologies

The U.S. Fish & Wildlife Service reports that in 2006 fishing was the "favorite recreational activity in the United States" with 13% of the population 16 and older (29.9 million anglers) spending an average of 17 days fishing in that year alone.[38] As a result, in 2006, "anglers spent more than $40 billion on trips, equipment, licenses and other items to support their fishing activities." [39] Of this, 44% ($17.8 billion) was spent on items related to their trips, including food, lodging and transportation. [40]

The annual economic value of the Delaware River Basin is nearly $22 billion with 1.54 billion of that being ascribed to fish and wildlife activities.[41]

"Fishing, hunting, and bird watching/wildlife associated recreation employ 44,941 jobs with $1.5 billion in wages in the Delaware Basin including:

- Delaware (4,080 jobs earning $134 million in wages)
- New Jersey (17,477 jobs earning $574 million in wages)
- New York (4,872 jobs earning $160 million in wages)
- Pennsylvania (18,512 jobs earning $608 million in wages)" [42]

"The annual value of fish landings [] in the tidal Delaware River and Bay is $25.4 million in $2000 or $34.1 million in $2010…"[43]

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[38] US Fish and Wildlife Service. "*2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, National Overview.*" (Preliminary Findings) May 2007. Pg. 5

[39] US Fish and Wildlife Service. "*2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, National Overview.*" (Preliminary Findings) May 2007. Pg. 5

[40] US Fish and Wildlife Service. "*2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, National Overview.*" (Preliminary Findings) May 2007. Pg. 5

[41] Gerald J. Kaufman, **Socioeconomic Value of the Delaware River Basin in Delaware, New Jersey, New York, and Pennsylvania,** *The Delaware River Basin, an economic engine for over 400 years,* Final Draft May 25, 2011.

[42] Gerald J. Kaufman, **Socioeconomic Value of the Delaware River Basin in Delaware, New Jersey, New York, and Pennsylvania,** *The Delaware River Basin, an economic engine for over 400 years,* Final Draft May 25, 2011.

[43] Gerald J. Kaufman, **Socioeconomic Value of the Delaware River Basin in Delaware, New Jersey, New York, and Pennsylvania,** *The Delaware River Basin, an economic engine for over 400 years,* Final Draft May 25, 2011.

According to a 2007 report of the National Marine Fisheries Service discussed in the Gerald Kaufman economic valuation study of the Delaware River, [44] in a given year, and calculated using year 2000 dollars the following benefits were obtained from the Delaware River:

- ✓ 752,882 lbs of striped bass at a year 2000 economic value of $1,717,372 and a year 2010 economic value of $2,301,278
- ✓ 189,110 lbs of weakfish at a year 2000 economic value of $261,228 and a year 2010 economic value of $350,046
- ✓ 88,060 lbs of white perch at a year 2000 economic value of $84,500 and a year 2010 economic value of $113,230.

Healthy fish populations in our Delaware Estuary and River are incredibly important ecologically but also economically to our region. The takes by Salem significantly diminish these values to the region.

As with many species in the Delaware River, Shad fishing on the Delaware is important economically recreationally and culturally. The American Shad are celebrated in several cities throughout the watershed during their spring spawn including in Philadelphia and Easton, Pennsylvania and Lambertville, New Jersey. These festivals attract visitors from all over the region to learn about shad and the Delaware River, to enjoy festival offerings, and to spend money in the host cities, thereby providing another source of economic revenue dependent upon the species. The annual Shad fishing tournament held each year following the Easton Shadfest charges a $20 entry fee, and with over 1000 competitors in 2006, that tournament alone raised $20,000 in proceeds. Lambertville's Shadfest has been an annual part of the community for nearly 30 years, attracting 30,000 to 35,000 visitors during the two day event.

A recent analysis provided by the State of Delaware documented that the loss of striped bass due to Salem's takes can be as high as $5,903,482 a year,[45] that is just for one of the many species that Salem kills, and it is by no means the species with the highest level of take.

The reduced impingement and entrainment that would result from installation of closed cycle cooling at Salem would result in as much as $577 million in economic benefit considering just a 20 year time frame, [46] this is far greater than the deceptive and misleading figure of just $8 million put forth by PSEG.

Attached is a full analysis by ECONorthwest documenting the benefits of mandating closed cycle cooling at Salem – in terms of meeting the mandates of 316(b) and 316(a), in terms of the economic benefits that will be secured, the comparison of those benefits to the cost of installing closed cycle cooling, and clearly demonstrating PSEG's and Exelon's clear ability to pay.

PSEG's assertion that improving health in the Delaware Estuary and in finfish density demonstrates no adverse impacts from Salem is a flawed and false argument.

There have been significant water quality improvements in the Delaware Estuary since construction of Salem due to increased water quality regulations and technological advancements in discharging industries. Among the improvements have been dissolved oxygen levels. Improvements are such

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[44] Gerald J. Kaufman, **Socioeconomic Value of the Delaware River Basin in Delaware, New Jersey, New York, and Pennsylvania,** *The Delaware River Basin, an economic engine for over 400 years,* Final Draft May 25, 2011.

[45] DNREC comment to NJDEP, Aug. 27, 2015.

[46] **ECONorthwest,** Economic Benefits of Installing a Closed-Cycle Cooling System at Salem Nuclear Generating Station, Final Report, **Sept, 2015.**

that fish propagation and other population benefits have been documented and the DRBC is studying the need for upgrading the Estuary's designated uses in order to comply with anti-degradation requirements of the Clean Water Act. That these and other improvements in Delaware Estuary conditions has provided benefits to the fish populations of the Delaware Estuary, Bay and River do not translate into an argument that Salem's destruction of over 14 billion fish a year at various life stages has not depressed fish populations and prevented even further enhancements and benefits to the Delaware Estuary's fish populations and the biological, recreational, commercial, economic, cultural and aesthetic values they provide.

In addition to the discussions provided above about specific species we offer the following expert opinions and discussion.

The US Fish and Wildlife Service has disagreed with PSE&G's assertions about having no adverse impact and characterizes the loss of aquatic organisms at Salem as "ecologically significant. In addition, conditional mortality rates for some Representative Important Species (RIS) are high enough to be of serious concern." [47]

According to an expert hired by the State of Delaware "Salem has, and will continue to have, important deleterious impacts on the fishery resources of Delaware Bay and adjacent coastal waters."[48]

In its most recent comments about Salem's operations and the NJDEP draft permit, DNREC stated that it "has found in both its previous and current analyses that the aquatic organism losses associated with the cooling water intake are substantial."[49] According to Delaware's most recent analysis, "The abundance of ecologically and economically important species such as alewife, American shad, Atlantic croaker, Atlantic menhaden, Atlantic silversides, bay anchovy, blue crab, blueback herring, spot, weakfish and white perch have all been reduced by the continued operation of the [Salem] cooling system." [50] And the State of Delaware goes on and "asserts that [Salem] will continue to have a substantial negative impact on multiple fisheries within the Delaware River Estuary, and that correlated cumulative primary and secondary losses will continue to impact the commercial and recreation fishing industries. "[51]

In the past, expert reviews commissioned by NJDEP have determined that PSEG has greatly underestimated its impacts on Delaware River fish and still, even with this undercounting of impacts, there have been significant concerns expressed regarding the impact of Salem on fish populations in the Estuary. According to ESSA Technologies Ltd, PSE&G "underestimates biomass lost from the ecosystem by perhaps greater than 2-fold." "… the actual total biomass of fish lost to the ecosystem … is at least 2.2 times greater than that listed" by PSE&G. [52]

Throughout the analysis provided by ESSA technologies to NJDEP in 2000, they found PSE&G analyses to include a variety of data gaps; biases; failure to substantiate analyses and/or findings; problems

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[47] US Fish & Wildlife Service to NJDEP, June 30, 2000 (relying on PSE&G permit application data)
[48] C. Philip Goodyear, Comments on Appendix F of the PSE&G Permit Application for Salem 4 March 1999, 12/13/99.
[49] DNREC Comment to NJDEP, Aug 27, 2015.
[50] DNREC Comment to NJDEP, Aug 27, 2015.
[51] DNREC Comment to NJDEP, Aug 27, 2015.
[52] ESSA Technologies, ***Review of Portions of New Jersey Pollutant Discharge Elimination System (NJPDES) Renewal Application for the Public Service Electric & Gas' (PSE&G) Salem Generating Station, Final Report***, Prepared for Division of Water Quality, NJDEP, June 14, 2000, p. xi. ("ESSA Report")

with sampling and PSE&G research; misrepresentations and/or unsubstantiated assertions by PSE&G; concerns about PSE&G analyses, assertions and/or findings.

Examples of ESSA findings in the past regarding PSEG's information, data and analyses:

- According to ESSA, PSE&G underestimates biomass lost from the ecosystem "... the actual total biomass of fish lost to the ecosystem (including fisheries, station losses, and losses of food to predators, summed over all species) is at least 2.2 times greater than that listed in the Application."[53]
- PSE&G's estimates exclude "a) actual biomass of fish lost at the station for all species including bay anchovy; b) lost prey production other than bay anchovy thereby underestimating catch foregone; and c) the projected increases in RIS abundance in the Application that should be included in estimates of catch and production foregone. The largest under-estimates are for bay anchovy, spot, striped bass, Atlantic croaker and weakfish. Problems with the estimates of natural mortality rates contribute to the underestimation of lost biomass. The difficulties with production foregone imply redoing all dependent and related analyses."[54]
- "The monitoring programs that collected these data often changed in location, timing and methods of sampling. The Application does not include sufficient caveats regarding the impact of these changes, the many assumptions made to transform field measures into model inputs, and the inherent uncertainty in original abundance estimates. We recommend that the current application: 1) list all assumptions made; 2) acknowledge and estimate uncertainty in the data; 3) perform sensitivity analyses to identify what uncertainties have the greatest influence on modeling results; and 4) adjust the conclusions to reflect uncertainties in data, analytical methods, and confounding factors."[55]
- ESSA states "It is judged, however, that the estimated impingement mortality rates are not representative of actual mortality rates of impinged fishes after they are returned to the Delaware river via the fish return system of the station."[56]
- ESSA concluded that "documentation of the uncertainty and potential bias associated with the impingement and entrainment loss estimates, and with the CMR estimates, is important because the results of these analyses provide key input to subsequent analyses of the effects of the station, such as fish stock jeopardy, lost fish production and biomass, assessment of the Base Case Future station operations scenario, and ultimately, the cost/benefit analyses of BTA to reduce entrainment and impingement."[57]
- Referring to PSE&G's discussion and presentation of entrainment CMR ESSA found PSE&G's "discussion in this section of the Application to be misleading."[58]
- "Thus, it is judged that the mortality of impinged fish returning to the Delaware River is likely not accurately described by the mortality estimates determined with the sampling pool and holding tanks."[59]
- "In summary, all the natural mortalities (M) for young fishes are likely overestimated, which has direct implications to CMRs if estimated with the EEIM. The CMRs of pre-juvenile 1 stages would be underestimated. The elevated Ms would result in underestimation of production foregone of

[53] ESSA Report p. 75
[54] ESSA Report p. ix
[55] ESSA Report p. x
[56] ESSA Report p. 6
[57] ESSA Report p. 6
[58] ESSA Report p. 13
[59] ESSA Report p. 24

growing populations, which would directly affect the fisheries benefit analyses of the cost/benefit assessment of alternative technologies to reduce entrainment and impingement."[60]

- " In particular, there is a tendency to draw subjective and unsupported conclusions about the importance of Salem's impact on RIS finfish species."[61]

But, ESSA's report clearly articulates not just a concern about the misrepresentation of data by PSEG, but a concern regarding the impacts of Salem on Delaware Estuary fish populations:

> "It is often concluded that the impact of Salem is "trivial" despite the evidence that there is an impact."[62]

In addition, while there have been enhancements in the health of the Delaware Estuary, species that are adversely impacted by Salem are continuing to suffer – as discussed above, the adverse impacts to these species that are in decline or at depressed population levels gets lost from view in the 10,000 foot characterizations provided by PSEG and NJDEP in the draft permit materials.

Salem is clearly having an adverse environmental impact, regardless of PSE&G's self-serving claims based on faulty scientific studies.

According to a study conducted by a NJDEP hired expert in 1989 as well as experiences at other facilities, installation of cooling towers at Salem would reduce their fish kills by 95%. And dry cooling at Salem could reduce their fish kills by 99%. As a result, NJDEP must issue a permit that requires technology that will reduce Salem's fish kills by 99%.

NJDEP does not need more time or data in order to mandate closed cycle cooling as the most appropriate and defensible exercise of its Best Professional Judgment.

NJDEP asserts on page 64 of its fact sheet that it is "designating the use of the existing modified Ristroph traveling screens with a fish handling system as interim BTA for impingement mortality for the circulating water system until such time as the final impingement and entrainment determination is made based on submission and review of the required study components" articulated in regulation.

NJDEP asserts also that "in order to render an entrainment BTA Determination under the 2014 rule, the permittee is required to comply with" regulations regarding a variety of information submissions. But this is not an accurate reflection of the law, the law is clear that NJDEP can use its BPJ based on the information on the record for a facility like Salem for whom the permit application was submitted prior to 2014 and for whom there will be a final permit by mid 2018.

NJDEP goes on to say that it is "determined that inclusion of a continued intake flow limit in combination with the conduct of the required studies at the circulating water system and the service water system is BTA for entrainment in accordance with best professional judgment". This is really a circular argument, NJDEP says that mandating more studies is best professional judgement when in fact the "best professional judgement" option is intended by the regulations to allow NJDEP to act now, based on the overwhelming information it has already before it on the record.

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[60] ESSA Report p. 31
[61] ESSA Report p. 77
[62] ESSA Report p. 125

In the case of Salem, the fish kills are excessive and overwhelming, the level of data and information on the Salem record is also massive, and there is clear information and evidence to document that the most effective best technology available, and very viable economic alternative, for minimizing the impingement and entrainment impacts of the facility is closed cycle cooling.

As a clear demonstration of how the information already on the record is sufficient to demonstrate the significant adverse environmental impacts that will continue to result from Salem should it be allowed to continue to operate with closed cycle cooling, the State of Delaware used this existing information and the NJDEP draft permit scenario to demonstrate the substantial losses Salem will continue to have on the "iconic" striped bass population of the Delaware Estuary and River, and making clear the data demonstrates similar high level losses for other species.

The flow limitation of 3,024 MGD remains a mere paper limitation -- prior to 1994, the first time this limitation was instituted, 3,024 MGD already represented the maximum level at which the Salem plant operated. EPA's 316(b) case study, Figure B2-2, documents that in fact up until 1998 Salem's withdrawals topped out at a mere 2,612 MGD. [63] The design capacity of the facility is 3,200 MGD. The minimal reduction from 3,200 to 3,024 MGD (a mere 176 MGD) was and is not only minimal, but is in fact no reduction in reality, it is a mere reduction on paper as Salem did not historically operate above this level.

Providing PSEG more time to continue to operate business as usual given the excessively high fish kills at the facility and given the large amounts of data on the record collected by PSEG, analyzed by independent consultants commissioned by NJDEP, submitted by experts from other agencies, and provided by organizations like the Delaware Riverkeeper Network (as part of comments of the past and this current comment) is a transparent ploy to take no action.

According to a 1990 review of the Salem facility conducted by Versar, Inc. on behalf of NJDEP, installation of closed cycle cooling at Salem would reduce its fish kills by over 95%.

In 1994, rather than require PSE&G to install closed cycle cooling, or some technology that would reflect the minimization of impacts that closed cycle cooling could achieve, i.e. reducing their fish kills by 95%, NJDEP allowed PSE&G to embark on a series of paper changes, mitigation experiments, studies, and modifications to their operations. None of the actions required reflected a 95% reduction in the fish kills inflicted by Salem's cooling water intake structure. In fact, the permit primarily relied on a wetlands mitigation experiment designed to eradicate phragmites using herbicides, burning, mowing and other marsh manipulations to fulfill the requirements of 316(b). Such actions are contrary to the clear letter, intent and history of the Clean Water Act as it pertains to fulfillment of section 316(b) and were rejected by the courts as a means for achieving the 316(b) best technology mandate.

Draft Permit Continues to Allow Compliance with 316(b) Through the use of Special Conditions, in violation of the plain language of the Clean Water Act and the outcome of judicial proceedings.

Allowing the use of special conditions to fulfill the requirements of 316(b) is not an appropriate application of the Clean Water Act (CWA). The CWA requires application of the best technology available to the design, location, construction and capacity of the cooling water intake structures to

[63] US EPA, 316(b) Case Studies, Part B: The Delaware Estuary.

minimize adverse environmental impact. And yet, for over 20 years, PSE&G has been allowed to comply with section 316(b) of the Clean Water Act largely through application of a series of special conditions including wetlands "restoration", construction of fish ladders and associated fish stocking, and Delaware Bay fish abundance analyses. With this 2015 draft permit, and its continuing emphasis on special conditions to mitigate the adverse impacts of Salem, the use of mitigation measures wholly unrelated to the Salem CWIS perpetuates this illegal approach for complying with 316(b).

The Second Circuit in 2007 made clear that section 316(b) requires a technological approach, and one that is associated with the location, design, construction or capacity of cooling water intake structures for minimizing adverse environmental impacts (i.e. impingement and entrainment). As the court stated:

- "[R]estoration measures contradicts the unambiguous language of section 316(b)."
- "Restoration measures are not part of the location, design, construction or capacity of the cooling water intake structures…."
- "…restoration measures substitute after-the-fact compensation for adverse environmental impacts that have already occurred for the minimization of those impacts in the first instance."

(*Riverkeeper, Delaware Riverkeeper Network, et. al. v. US EPA*, 475 F.3d 83; 2007)

Mitigation or restoration projects, such as those being carried on by PSE&G at its Salem Nuclear Generating Station are not an appropriate or legal way to come into compliance with the 316(b) requirements of the Clean Water Act. According to the second circuit ruling, PSE&G's wetlands mitigation program, its fish ladders, its educational efforts, and its baywide abundance research clearly do not, and cannot, fulfill the requirements of section 316(b) of the Clean Water Act.

The Second Circuit supported that the law requires minimization of the impingement and entrainment impacts of a facility. Modifications to the Salem intake screens, continued operation at a capacity of 3,024 MGD which impinges and entrains over 14 billion fish at various life stages a year, research into bubbles, noise and lights for deterring fish, cannot be said to even come close to the minimization requirements of 316(b). Closed cycle cooling is, by all accounts, the technology that will minimize the impingement and entrainment impacts of Salem's cooling water intake structure – this was the express finding of Versar, Inc. when it considered the facility as a consultant working for NJDEP. Closed cycle cooling is a proved and proven technology available to existing facilities like Salem. It is a technology that can be and should be mandated by the State of New Jersey.

The following are all characterized in the same way, by NJDEP in the Fact Sheet accompanying the draft permit – i.e. as special conditions benefiting the fish populations of the Delaware Estuary:

- The circulating water intake flow volume,
- The flow rate,
- The travelling screen mandate,
- The impingement and entrainment monitoring,
- The wetlands program requirement,
- The fish ladders mandate,
- The artificial reefs requirement,
- The biological monitoring program

Thus, it is clear that all of these provisions are of equal standing in the NJPDES section 316 determinations and mandates. In the permit itself these provisions are all located under Part IV.G. As such, it is clear that NJDEP continues to use mitigation and restoration as a primary means of helping PSEG to meet its CWA 316(b) obligations – an approach which is a violation of the law.

Moreover, since the Department first incorporated the restoration measures into Salem's 1994 NJPDES Permit, it has been clear that those measures were incorporated to comply with section 316(b)'s mandates. Namely, in the Department's own Fact Sheet that supported the 1994 NJPDES Permit it stated:

- "On March 4, 1993, PSE&G filed the 1993 Application Supplement which proposed Special Conditions for a proposed Draft Permit **in support of the Company's request for a BTA determination under Section 316(b)** . . ." See p. 125 of 152 of the June 24, 1993 Fact Sheet (emphasis added).

- "As part of the Company's 1993 Application Supplement, the Company submitted a Technical Appendix which provides the scientific and technical basis for the proposed Special Conditions to the Draft Permit **for resolution of . . . the Department's Section 316(b) BTA determination**." See p. 125 of 152 of the June 24, 1993 Fact Sheet (emphasis added).

All of the Special Conditions, including the wetland restoration measures, the construction of fish ladders, and Delaware Bay fish abundance analyses, were received with the understanding that they were to be considered as a part of the Department's 316(b) analysis. See p. 125-134 of 152 of the June 24, 1993 Fact Sheet. Thus, these unbiased statements by the Department demonstrate it evaluated these restoration measures as a part of its 316(b) assessment.

We would also like to note, in light of the claim that these special conditions would mitigate for the adverse fish impacts inflicted by Salem, that claim has so far proven false. See for example the findings of Evaluation of Special Conditions Contained in Salem Nuclear Generation Station NJDPES Permit to Restore Wetlands, Install Fish Ladders, and Increase Biological Abundance Within the Delaware Estuary[64] undertaken in 2003 in which it was determined, based upon PSEG provided data, that the program had not in fact mitigated for the impacts of Salem or enhanced the quality and quantity of fish in the Delaware Estuary.

October 3, 1990 NJDEP determined that the best technology available for minimizing adverse environmental impact at Salem was closed cycle cooling. They based this decision largely upon the input and findings of their hired expert, Versar Inc. It is time to reinstitute this decision for Salem.

The uses the draft permit seeks to protect fail to consider the existence of existing uses that exceed the designated uses of the Delaware River.

The NJDEP fact sheet asserts that the following uses of zone 5 need to be protected:

- Industrial water supplies after reasonable treatment
- Maintenance of resident fish and other aquatic life
- Propagation of resident fish from R.M. 70 to R.M. 48.2

[64] Evaluation of Special Conditions Contained in Salem Nuclear Generation Station NJDPES Permit to Restore Wetlands, Install Fish Ladders, and Increase Biological Abundance Within the Delaware Estuary , Carpenter Environmental Associates, 2003

- Passage of anadromous fish
- Wildlife
- Recreation
- Navigation

This characterization of uses to be protected fails to recognize that in the Delaware Estuary, in many ways, existing uses exceed designated uses and as such the level of protection required is higher as per the anti-degradation mandates of the Clean Water Act.

Attached find a petition submitted by the Delaware Riverkeeper Network, Delaware River Shad Fishermen's Association, and the Lehigh Stocking Association, documenting how the existing using of the Delaware estuary exceed designated uses, and therefore the level of protection required of PSEG and its Salem facility are higher than articulated in the NJDEP fact sheet. In addition, attached find a draft DRBC report documenting, with a higher level of specificity, some of the specific ways that existing uses for particular species exceeds designated uses.[65] Please note, the DRBC document is merely a draft, and so also attached are comments from the Delaware Riverkeeper Network articulating deficiencies in the draft report we anticipate being corrected in future iterations.

As recognized in the Delaware Riverkeeper Network, Delaware River Shad Fishermen's Association, and the Lehigh Stocking Association petition:

1) designated uses of Zones 3, 4, and River Miles 78.8 to 70.0 of Zone 5 to must be upgraded to include the existing use of propagation of resident fish and other aquatic life;

2) designated uses of Zones 2 through 5 must be updated to include the exists uses of spawning and nursery habitat for anadromous fish; and

Atlantic sturgeon, American Shad, Striped Bass, White Perch, Bay Anchovy, Atlantic Silverside, Alewife, Blueback Herring and Menhaden are all among the species discussed in the DRBC Existing Use Evaluation and are all among the species being significantly impacted by Salem. Pursuant to the anti-degradation mandates of the Clean Water Act, the obligation to protect these species is greater than described in NJDEP's documentation supporting its draft permit proposal.

Furthermore, as has been properly noted in the Delaware Riverkeeper Network et. al. petition as well as the DRBC Draft Existing Use Evaluation, dissolved oxygen levels are a focal point for evaluation of the enhancements to estuary fish populations as well as an ongoing limitation.

As noted by Dr. Danielle Kreeger of the Delaware Estuary Partnership:

> *"Kreeger said that even with temporary warming of the water, that warmer water holds less oxygen so she and others are starting to see more instances in the upper estuary where dissolved oxygen in the water drops. When it gets too low, fish that can't swim away fast enough, often schooling fish like mehanden, die.*
>
> *And warmer, saltier water can mean outbreaks of Dermo, an oyster disease caused by the pathogen Perkinsus marinus, and is common in the Delaware and Chesapeake bays."*[66]

[65] DRBC, ***Existing Use Evaluation for Zones 3, 4, 5 of the Delaware Estuary, draft report***, March 24, 2015.
[66] Wetland loss the issue in Delaware Bay, **The News Journal**, *September 5, 2015*

Salem is an ongoing source of super heated water to the Estuary. The discharge of heat from Salem, individually as well as cumulatively with anticipated warming from climate change, and the implications for Atlantic Sturgeon, for estuary oysters, and for other species is not evaluated, considered or addressed in this draft permit in any meaningful way; an agency using best professional judgment would not allow for such a substantial oversight.

PSEG has also proposed construction of an additional Nuclear Power Plant on Artificial Island – commonly referred to as Salem 4. Salem 4 will be another source of impingement, entrainment and heated cooling water discharge. The implications of Salem 4 cumulatively with Salem 1 & 2, as well as Hope Creek, in this stretch of the Delaware River, further support the best professional judgment determination of closed cycle cooling at Salem.

Continuing to grant a variance from DRBC temperature standards is not legally defensible. Since 1977 Salem has been allowed to operate under a variance from DRBC's temperature standards. It is inappropriate to allow Salem to continue to operate in exceedence of DRBC's temperature standards given that (1) it has been over 20 years since DRBC granted this variance and conditions in the Delaware River have changed significantly;[67] (2) climate change is causing, and will continue to cause, increased temperature increases in the Delaware Estuary that magnify the adverse impact of the temperature increase caused by Salem; (3) the cumulative impact of Salem, climate change and/or an anticipated new nuclear power plant on Artificial Island called Salem 4, will likely contribute to increased mortality of aquatic life in the Delaware Estuary and the variance ignores the significance of this adverse impact.

As noted in the ECONorthwest expert report attached to this comment:

> "the average temperature increase at the [Salem] discharge is from 8 to 10 °F (4 to 6 °C).[68] The Delaware River Basin Commission (DRBC) temperature standards for Water Quality Zone 5 of the Delaware Estuary (where the Salem discharge is located) state that the temperature in the river may not be raised above ambient by more than 4 degrees Fahrenheit (°F; 2.2 degrees Celsius [°C]) during non-summer months (September through May) or 1.5°F (0.8°C) during the summer (June through August). However, Salem has received a variance and has been exempt from these temperature standards since it began operation in 1977.[69] Salem's thermal plume under the Baseline Scenario is likely to contribute to increased mortality as water in the Delaware River increases in temperature due to climate change."

The temperature exceedences at Salem have adverse impacts on a variety of fish species; as well stated by ECONorthwest:

> "Effluent from Salem regularly exceeds the Delaware River Basin Commission's water quality regulations for temperature …. Thermal impacts from Salem occur during seasons of particular importance for critical life stages, and temperatures within the plume exceed thresholds for

[67] Carpenter Environmental Associates, ***Review and Analysis of the Salem Generating Station's Draft New Jersey Department of Environmental Protection (NJDEP) New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Surface Water (DSW) Permit NJ0005622 Renewal for The Salem Generating Station in Lower Alloways Creek Township, Salem County, New Jersey***, Sept. 2015.
[68] U.S. Nuclear Regulatory Commission. 2011. *Essential Fish Habitat Assessment - Salem Nuclear Generating Station Units 1 and 2 Hope Creek Generating Station*. Available online at: http://pbadupws.nrc.gov/docs/ML1103/ML110320668.pdf
[69] NOAA National Marine Fisheries Service. 2014. *Endangered Species Act Section 7 Consultation Biological Opinion - Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581*. Available online at: https://www.greateratlantic.fisheries.noaa.gov/protected/section7/bo/actbiops/salemhcnmfsfinalbiopjuly172014.pdf

the spawning of federally-listed species including Shortnose sturgeon and Atlantic sturgeon. Other important species have similar potential effects of elevated water temperatures including American shad, white perch, and striped bass. Temperatures are also outside of optimal for other life stages of these fish species as well as channel catfish, bluegill and others.

NJDEP and DRBC should not continue in place the variance from temperature standards that allows these adverse impacts to continue, and doing so fails to fulfill the mandates of 316(a).

Furthermore, pursuant to section 316(a) of the Clean Water Act and implementing regulations, the NJDEP should issue a draft permit that mandates closed cycle cooling at Salem.

Under section 316(a) of the Clean Water Act, NJDEP may provide Salem a water quality variance for its thermal discharges only if the variance will assure the protection and propagation of a balanced, indigenous population ("BIP") of shellfish, fish, and wildlife in and on the Delaware River. Because Salem and NJDEP failed to consider important aspects of the thermal variance issue, including (but not limited to)[70], failing to calculate the extent of the lateral, downriver and upriver surface and subsurface temperature profiles for the modeled thermal plumes and failing to utilize the most recent (2004-14) USGS temperature data, they have not sufficiently demonstrated that BIP are adequately maintained. Thus, NJDEP's grant of thermal variance to Salem would be arbitrary, capricious and/or unreasonable. NJDEP must withdraw its thermal variance in order to comply with its mandate to fully and properly apply DRBC regulatory mandates that apply.

The cost of installing cooling towers, given the economic, recreational, and other benefits, is well justified.

The NJPDES draft permit fact sheet asserts the cost of retrofitting to natural draft cooling towers is an estimated $852,440,200 and that the capital cost for retrofitting with mechanical draft cooling towers is an estimated $814,844,200. As demonstrated in the attached report by ECONorthwest, the costs of installing closed cycled cooling at Salem are affordable, and are not wholly disproportionate to or significantly greater than their resulting environmental benefits.[71]

The annual economic value of the Delaware River Basin is nearly $22 billion with 1.54 billion of that being ascribed to fish and wildlife activities.[72]

The market value of commercial and recreational fishing in the Delaware River has been estimated as $610 million with an additional recreational value of $76 million attributable to fishing.[73]

"Fishing, hunting, and bird watching/wildlife associated recreation employ 44,941 jobs with $1.5 billion in wages in the Delaware Basin including:

- Delaware (4,080 jobs earning $134 million in wages)
- New Jersey (17,477 jobs earning $574 million in wages)
- New York (4,872 jobs earning $160 million in wages)

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[70] See the attached Carpenter Environmental report for a full account of deficiencies, Carpenter Environmental Associates, ***Review and Analysis of the Salem Generating Station's Draft New Jersey Department of Environmental Protection (NJDEP) New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Surface Water (DSW) Permit NJ0005622 Renewal for The Salem Generating Station in Lower Alloways Creek Township, Salem County, New Jersey***, Sept. 2015.

[71] **ECONorthwest,** Economic Benefits of Installing a Closed-Cycle Cooling System at Salem Nuclear Generating Station, Final Report, **Sept, 2015**

[72] Gerald J. Kaufman, **Socioeconomic Value of the Delaware River Basin in Delaware, New Jersey, New York, and Pennsylvania,** *The Delaware River Basin, an economic engine for over 400 years,* Final Draft May 25, 2011.

[73] Kaufman, Socioeconomic Values of the Delaware River Basin, University of Delaware.

• Pennsylvania (18,512 jobs earning $608 million in wages)" [74]

As the Marine Recreational Fisheries Statistics Survey demonstrated, fishing the Delaware is a highly prized activity – providing high levels of enjoyment as well as economic values to the region. On average, anglers in our region spend $62.43 to $100.24 for single and multiple day trips catching millions of pounds of striped bass, weakfish, flounder, bluefish, atlantic croaker, tautog, spot, white perch and more.

The benefits of protecting and enhancing the health and number of fish in the Delaware Estuary is significant and well comparable, economically and otherwise, with the cost of mandating closed cycle cooling at Salem.

The attached report by ECONorthwest describes how much economic value would be generated by cooling towers even without including all of the benefits that can and should be included in such a calculation but was not by PSEG, NJDEP or EPA. In addition, the attached report documents the many ways that closed cycle cooling is demonstrably affordable to PSEG and Exelon, the owners of Salem. For example:

- ✓ "for the fiscal year ending December 31, 2014, PSEG's annual operating revenues were $5.4 billion. … for the fiscal year ending December 31, 2014, Exelon's operating revenues were $17.4 billion." And so, the annual amortized cost of closed cycle cooling at Salem would represent a mere 0.3 percent of PSEG and Exelon's combined annual operating revenues.

- ✓ "The total installed cost of [closed cycle cooling at Salem] ($852 million) represents about 31 percent of the companies [PSEG & Exelon, Salem's owners] combined <u>annual</u> capital expenditure, and the annual loan payment just 2 percent." [75]

In addition, to the extent PSEG and Exelon pass the costs on to the public, they are passing on a cost that is quite low considering the high level benefits to be achieved, e.g. [76]

- ✓ Installing closed cycle cooling at Salem "would increase electricity rates by $0.0036 per kWh".

- ✓ If the costs of closed cycle cooling were passed on to residential customers of Salem the potential increase in electricity costs is only about $26 per customer per year (for NJ customers it is likely to be lower given deregulation of NJ's energy market).

These costs are particularly small when considered in comparison to the benefits the public will receive, and in comparison to the public's willingness to pay for environmentally beneficial and protective energy options as discussed in the ECONorthwest report attached.

PSE&G has successfully evaded compliance with the law for over 4 decades. NJDEP and the current administration have the opportunity to change this illegal course of conduct and to reign PSE&G into compliance with the law.

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[74] Kaufman, Socioeconomic Values of the Delaware River Basin, University of Delaware.
[75] **ECONorthwest,** Economic Benefits of Installing a Closed-Cycle Cooling System at Salem Nuclear Generating Station, Final Report, **Sept, 2015.**
[76] **ECONorthwest,** Economic Benefits of Installing a Closed-Cycle Cooling System at Salem Nuclear Generating Station, Final Report, **Sept, 2015.**

Respectfully,

Maya K. van Rossum
the Delaware Riverkeeper

Attachments:

ECONorthwest, Economic Benefits of Installing a Closed-Cycle Cooling System at Salem Nuclear Generating Station, Final Report, **Sept, 2015.**

Carpenter Environmental Associates, ***Review and Analysis of the Salem Generating Station's Draft New Jersey Department of Environmental Protection (NJDEP) New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Surface Water (DSW) Permit NJ0005622 Renewal for The Salem Generating Station in Lower Alloways Creek Township, Salem County, New Jersey***, Sept. 2015.

Plus all documents referenced in footnotes.

Attachment 2

Index of Attachments

1. **ECONorthwest**, Economic Benefits of Installing a Closed-Cycle Cooling System at Salem Nuclear Generating Station, Final Report, Sept, 2015.

2. **Carpenter Environmental Associates**, Review and Analysis of the Salem Generating Station's Draft New Jersey Department of Environmental Protection (NJDEP) New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Surface Water (DSW) Permit NJ0005622 Renewal for The Salem Generating Station in Lower Alloways Creek Township, Salem County, New Jersey, Sept. 2015

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3. **Atlantic States Marine Fisheries Commission**, ADDENDUM IV TO AMENDMENT 4 TO THE WEAKFISH FISHERY MANAGEMENT PLAN, Nov 2009.

4. **Balazik, M. T., Reine, K. J., Spells, A. J., Fredrickson, C. A., Fine, M. L., Garman, G. C., & McIninch, S. P**. (2012). The potential for vessel interactions with adult Atlantic sturgeon in the James River, Virginia. North American Journal of Fisheries Management, 32(6), 1062-1069.

5. Bay Anchovy Fact Sheet, NJDEP, http://www.state.nj.us/dep/fgw/pdf/delriver/artdel_sp_bayanchovy.pdf.

6. **Boreman, J.** (1997). Sensitivity of North American sturgeons and paddlefish to fishing mortality. Environmental Biology of Fishes, 48(1-4), 399-405.

7. **Brown, J. J. and G. W. Murphy**. (2010). Atlantic sturgeon Vessel-strike mortalities in the Delaware Estuary. Fisheries, vol 35(2), 73-83.

8. **Carpenter Environmental Associates**, Evaluation of Special Conditions Contained in Salem Nuclear Generating Station NJPDES Permit to Restore Wetlands, Install Fish Ladders, and Increase Biological Abundance within the Delaware Estuary, Dec. 3, 2003.

9. **C. Philip Goodyear**, Comments on Appendix F of the PSE&G Permit Application for Salem 4 March 1999, 12/13/99.

10. **D. Kahn, PhD**., Mortality of Delaware River Striped Bass from Entrainment and Impingement by the Salem Nuclear Generating Station, March 30, 2000.

11. **D. Kahn, PhD**., Assessment of the Impact of the Salem Nuclear Generating Station on Weakfish and Striped Bass, DNREC, March 8, 2001.

12. **D. Kahn, PhD**., Impacts of Impingement and Entrainment Mortality by the Delaware City Refinery on Fish Stocks and Fisheries in the Delaware River and Bay, Delaware Division of Fish and Wildlife, Oct 9, 2008.

13. Delaware River Sustainable Fishing Plan for American Shad, Prepared by the Delaware River Basin Fish & Wildlife Management Cooperative for The Atlantic States Marine Fisheries Commission Shad and River Herring Management Board, December 2011.

14. Delaware Riverkeeper Network, Dissolved Oxygen Petition to DRBC, March 5, 2013.

15. Delaware Riverkeeper Network, Existing Use Report Comments to DRBC, July 3, 2015.

16. DNREC, Salem Nuclear Generating Station NJPDES Comments. August 27, 2015.

17. **DRBC**, Existing Use Evaluation for Zones 3, 4, 5 of the Delaware Estuary, draft report, March 24, 2015.

18. **ESSA Technologies**, Review of Portions of New Jersey Pollutant Discharge Elimination System (NJPDES) Renewal Application for the Public Service Electric & Gas' (PSE&G) Salem Generating Station, Final Report, Prepared for Division of Water Quality, NJDEP, June 14, 2000.

19. Final Rule, Threatened and Endangered Status for Distinct Population Segments of Atlantic, Sturgeon in the Northeast Region, Fed Reg Vol 77 No. 24, Feb. 6, 2012.

20. **Gerald J. Kaufman**, Socioeconomic Value of the Delaware River Basin in Delaware, New Jersey, New York, and Pennsylvania, *The Delaware River Basin, an economic engine for over 400 years*, Final Draft May 25, 2011.

21. **Kavanaugh**, Comments on the Salem Cooling Water Intake Analysis. March 9, 2001.

22. NJDEP June 24, 1993 Fact Sheet that supported the 1994 Final NJPDES Permit to Salem.

23. **NOAA Fisheries Service**, Atlantic Sturgeon New York Bight Distinct Population Segment: Endangered, http://www.nmfs.noaa.gov/pr/pdfs/species/atlanticsturgeon_nybright_dps.pdf.

24. **NOAA National Marine Fisheries Service**. 2014. Endangered Species Act Section 7 Consultation Biological Opinion - Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581. Available online at: https://www.greateratlantic.fisheries.noaa.gov/protected/section7/bo/actbiops/salemhcnmfsfinalbiopjuly172014.pdf

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26. PSE&G, Biothermal Assessment of the effects of the thermal plume on the biological community. March 4, 1999.

27. River Herring (Alewife & Blueback Herring), Species of Concern, NOAA National Marine Fisheries Service, 5/19/2009.

28. **Secor, David and Gunderson, Troy**, Effects of hypoxia and temperature on survival, growth, and respiration of juvenile Atlantic sturgeon. Fishery Bulletin 96(3), 1998.

29. **US EPA**, 316(b) Case Studies, Part B: The Delaware Estuary (EPA-821-R-02-002).

30. **US EPA**, Benefits Analysis, 2014. Benefits Analysis for the Final 316(b) Existing Facilities Rules. EPA-821-R-14-005. This document also includes the EPA Survey (Chapter 11).

31. **US Fish & Wildlife Service,** Letter to NJDEP, June 30, 2000.

32. **US Fish & Wildlife Service**. "2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, National Overview." (Preliminary Findings) May 2007.

33. **US Fish & Wildlife Service**, Comment on Salem Draft Permit. Sept. 17, 2015.

34. **US Nuclear Regulatory Commission**. 2011. Essential Fish Habitat Assessment - Salem Nuclear Generating Station Units 1 and 2 Hope Creek Generating Station. Available online at: http://pbadupws.nrc.gov/docs/ML1103/ML110320668.pdf.

35. **Versar Inc**., Technical Review and Evaluation of Thermal Effects Studies and Cooling Water Intake Structure Demonstration of Impact for the Salem Nuclear Generation Station, Revised Final Report, Prepared for NJDEP, 1989.

36. Wetland loss the issue in Delaware Bay, The News Journal, September 5, 2015

37. 2007 Shad Stock Assessment Report Volume II ASMFC.

38. 2015 NJDEP Recreational Minimum Size, Possession Limits & Seasons, http://www.state.nj.us/dep/fgw/pdf/2015/maregsum15.pdf.

Attachment 3

Review and Analysis of the Salem Generating Station's Draft New Jersey Department of Environmental Protection (NJDEP) New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Surface Water (DSW) Permit NJ0005622 Renewal for The Salem Generating Station in Lower Alloways Creek Township, Salem County, New Jersey

Prepared for:

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CEA No. 21527
September 2015

Table of Contents

1.0 INTRODUCTION

I have been retained by the Delaware Riverkeeper Network to prepare this review of the Draft New Jersey Department of Environmental Protection (NJDEP) New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Surface Water (DSW) Permit NJ0005622 Renewal for PSEG Nuclear LLC Salem Generating Station (SGS) in Lower Alloways Creek Township, Salem County, New Jersey and supporting documentation.

I hold a master's degree in fisheries biology from Eastern Kentucky University and a bachelor's degree in biology from the University of Louisville. I have over 30 years of experience in the wetlands, wildlife biology, and environmental permitting industry. My areas of expertise include environmental impact assessment; wetland delineation, enhancement, and creation; flora and fauna studies; natural resource inventories; and environmental permitting. I have 15 years of direct experience with §316(a) and §316(b) projects and issues, including cooling water intake structure assessment, effects of cooling water discharges, and impingement and entrainment studies. My qualifications are contained in my curriculum vitae attached as Appendix A.

I have been recognized as an expert witness in environmental and biological sciences in local, state, and federal courts, and I have provided testimony at deposition and at trial. A list of my testimony at deposition and trial is attached as Appendix B.

A list of the documents that I have relied upon in my investigation and in the preparation of this report is attached as Appendix C.

Compensation to Carpenter Environmental Associates, Inc., for the work that has resulted in this report and for future work will be at the rates that are attached as Appendix D. My time is billed as a consultant.

Either myself, or the staff of Carpenter Environmental Associates, Inc., under my supervision, have done all work that is summarized in this report.

2.0 COOLING WATER INTAKE STRUCTURES

NJDEP states in their draft NJPDES permit action (draft permit action) that the 2006 Comprehensive Demonstration Survey (CDS) was written to comply with the September 2004 Final Section 316(b) Rule (2004 Rule), a different rule than the rule that is applicable today, the August 2014 NPDES Final Regulations to Establish Requirements for Cooling Water Intake Structures (CWIS) at Existing Facilities (2014 rule). As such, the NJDEP reviewed the renewal application based on the 2006 submissions, written to comply to the 2004 Phase II rule and has asserted the need for various additional application components including numerous data updates and a multitude of studies including Entrainment Characterization Study, Comprehensive Technical Feasibility and Cost Evaluation Study, Benefits Valuation Study, Non-water Quality Environmental and Other Impacts Study).[1]

As the NJDEP states in their draft NJPDES permit action, both historical and ongoing data collection efforts and NJPDES permitting decisions at SGS have been focused on the Representative Important Species (RIS) approach.[2,3] In contrast to the RIS approach, the 2014 rule focuses on fragile and non-fragile species. The 2014 rule defines and lists fragile species as:

> *…those species of fish and shellfish that are least likely to survive any form of impingement. For purposes of this subpart, fragile species are defined as those with an impingement survival rate of less than 30 percent, including but 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.*[4]

PSEG's RIS list includes many species identified on the fragile species list, for example, alewife, American shad, Atlantic herring, Atlantic menhaden, bay anchovy, and blueback herring. The NJDEP draft NJPDES permit action is requiring the PSEG to submit a list of fragile

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[1] NJDEP. Draft Surface Water Renewal Permit Action. Category: B -Industrial Wastewater. NJPDES Permit No. NJ0005622. PSEG Nuclear LLC Salem Generating Station. Lower Alloways Creek Twp, Salem County. June 30, 2015.
[2] NJDEP. Draft Surface Water Renewal Permit Action. Category: B -Industrial Wastewater. NJPDES Permit No. NJ0005622. PSEG Nuclear LLC Salem Generating Station. Lower Alloways Creek Twp, Salem County. June 30, 2015.
[3] The assumption is that if the RIS are doing well, then the entire community should also be doing well. Thus, a 316(a) demonstration can focus primarily or even entirely on RIS where RIS is defined at 40 CFR Part 125.71.
[4] 40 CFR 125.92(m).

species, not already identified as fragile, within six months from the Effective Date of Permit (EDP), as the data submitted in the 2006 permit application is insufficient.[5]

CEA reviewed the PSEG Nuclear LLC Salem NJPDES Permit Renewal Application for NJPDES Permit No. NJ 0005622, Section 4 - Comprehensive Demonstration Study (CDS), dated February 2006.[6] The CDS evaluated alternative candidate technologies in terms of biological efficacy, availability, engineering/biological advantages, ability to potentially reduce entrainment and impingement, and cost. The analysis provided by PSEG in 2006 was focused primarily on cost analyses. The record for Salem also includes over 25 years of data and analysis regarding Salem's operations and impingement and entrainment impacts, that can be used to support a best professional judgment (BPJ) analysis and determination. In 1993, the NJDEP determined that there was enough scientific, technical and other information to support a BPJ determination when it found "a combination of technological improvements, together with operational measures, were BTA for Salem, based upon a BPJ determination".[7] Since 1993 there has been significantly more data obtained regarding Salem operations.

While more data can always be collected, there is significant information on the record and available to NJDEP regarding SGS's operations, impacts from impingement and entrainment, regarding the fish populations of the Delaware estuary, and regarding the benefit of existing technologies for addressing its adverse environmental impacts – more data is not necessary to support a BPJ determination.

Fish impingement occurs when aquatic organisms, such as larvae or fish, become impinged, or pressed, against the screens of the cooling water intake structure (CWIS), which will be lethal for many species due to asphyxiation.[8] Entrainment occurs when organisms pass through the screens of the CWIS and into the cooling system. Mortality will typically occur as a result of entrainment due to physical impacts in the cooling system piping, pressure changes, thermal shock, or chemical toxemia as a result of being exposed to antifouling agents, such as

[5] NJDEP. Draft Surface Water Renewal Permit Action. Category: B -Industrial Wastewater. NJPDES Permit No. NJ0005622. PSEG Nuclear LLC Salem Generating Station. Lower Alloways Creek Twp, Salem County. June 30, 2015.
[6] PSEG Nuclear LLC, Salem NJPDES Permit Renewal Application, NJPDES Permit No. NJ 0005622, Section 4 Comprehensive Demonstration Study (CDS), February 2006.
[7] NJDEP. Draft Surface Water Renewal Permit Action. Category: B -Industrial Wastewater. NJPDES Permit No. NJ0005622. PSEG Nuclear LLC Salem Generating Station. Lower Alloways Creek Twp, Salem County. June 30, 2015.
[8] United States Environmental Protection Agency (U.S. EPA). Development Document for Best Technology Available for the Location, Design, Construction and Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact. April 1976.

chlorine, that are used to control the growth of algae and bacteria.[9] One of the first steps in determining BTA for a CWIS to minimize adverse environmental impacts (AEI), including impingement and entrainment, is through identification of the spatial and temporal distribution of aquatic species within the area of the proposed CWIS, in this case, the RIS species and the federally endangered sturgeon species within the Delaware River. SGS has a comprehensive data set covering both historical and current periods for previously assessed RIS species which can be integrated with available sturgeon tagging data.[10]

A variety of different technologies exists to protect fish from impingement and entrainment. These technologies range from screening systems that prevent fish from entering the CWIS to cooling systems that dramatically reduce the amount of intake water required.

Existing Technology

SGS is currently permitted to withdraw a monthly average of 3,024 million gallons per day (MGD) for its circulating water intake system. The circulating water system currently employs fish protection technology for impingement that consists of a modified traveling screen system with Ristroph screens and a fish handling and return system that has been in place since 1995. [11] The current modified-Ristroph traveling screens used at the SGS consist of screen mesh panels, composite material fish buckets, neoprene flap seals, and a spray wash system.[12] Ristroph screens typically operate in a continuous fashion to reduce impingement duration. The openings of the screen are ¼ in. wide by ½ in. (6 mm by 12 mm) high.[13] As each bucket passes over the top of the screen, fish that have been collected are rinsed into a trough by a low-pressure spray wash.[14] There is a high pressure spray wash system that removes debris from the screens into the debris return trough. The fish and debris troughs are joined after leaving the building. The

[9] U.S. EPA. Development Document for Best Technology Available for the Location, Design, Construction and Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact. April 1976.
[10] U.S. EPA. Development Document for Best Technology Available for the Location, Design, Construction and Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact. April 1976.
[11] NJDEP. Draft Surface Water Renewal Permit Action. Category: B -Industrial Wastewater. NJPDES Permit No. NJ0005622. PSEG Nuclear LLC Salem Generating Station. Lower Alloways Creek Twp, Salem County. June 30, 2015.
[12] PSEG Nuclear LLC, Salem NJPDES Permit Renewal Application, NJPDES Permit No. NJ 0005622, Section 4 Comprehensive Demonstration Study (CDS), February 2006.
[13] PSEG Nuclear LLC, Salem NJPDES Permit Renewal Application, NJPDES Permit No. NJ 0005622, Section 4 Comprehensive Demonstration Study (CDS), February 2006.
[14] PSEG Nuclear LLC, Salem NJPDES Permit Renewal Application, NJPDES Permit No. NJ 0005622, Section 4 Comprehensive Demonstration Study (CDS), February 2006.

troughs are bi-directional; they are emptied in the direction of the tide, so that fish and debris will flow away from the CWIS and avoid being re-impinged on the screens.[15] Traveling and fixed screens do not effectively protect smaller aquatic organisms such as eggs or aquatic organisms in their early life stages, that are too small to be screened out and/or that lack motility (ability to move spontaneously and actively), thus resulting in entrainment.[16]

In addition to the circulating water system, SGS employs a service water system (SWS) which is a non-contact cooling water system that uses 60.48 MGD.[17] For the SWS, SGS operates traveling screens that do not have a modified traveling screen design and there is no fish handling system or return. The NJDEP is requiring PSEG to install modified traveling screens and a fish return system (or other allowable control measures under 40 CFR 125.95(c)) at the SWS intake within EDP + 4 years, as appropriate BTA for impingement, as these technologies are currently not being utilized.[18,19] Prior to installation and operation of the modified traveling screens and a fish return system at the service water system, which could take over four years, aquatic species within the Delaware River are susceptible to ongoing higher levels of impingement and entrainment.

Alternative Technology

In screening technology, the size of the opening in the screen mesh can vary, with smaller sized openings known as fine mesh screens, being more effective at reducing entrainment and capturing small aquatic organisms.[20] Fine mesh screens have mesh sizes between 0.5 mm and 2.0 mm.[21] Fine mesh screens mounted on traveling screens are used to exclude eggs, larvae, and

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[15] PSEG Nuclear LLC, Salem NJPDES Permit Renewal Application, NJPDES Permit No. NJ 0005622, Section 4 Comprehensive Demonstration Study (CDS), February 2006.
[16] PSEG Nuclear LLC, Salem NJPDES Permit Renewal Application, NJPDES Permit No. NJ 0005622, Section 6 Comprehensive Demonstration Study (CDS), February 2006.
[17] NJDEP. Draft Surface Water Renewal Permit Action. Category: B -Industrial Wastewater. NJPDES Permit No. NJ0005622. PSEG Nuclear LLC Salem Generating Station. Lower Alloways Creek Twp, Salem County. June 30, 2015.
[18] NJDEP. Draft Surface Water Renewal Permit Action. Category: B -Industrial Wastewater. NJPDES Permit No. NJ0005622. PSEG Nuclear LLC Salem Generating Station. Lower Alloways Creek Twp, Salem County. June 30, 2015.
[19] It is understood that EDP indicates Effective Date of Permit, although not defined in the NJDEP Draft Surface Water Renewal Permit Action.
[20] USEPA, Preliminary Regulatory Development Section 316B of the Clean Water Act Background Paper Number 3: Cooling Water Intake Technologies, April 4, 1994.
[21] PSEG Nuclear LLC, Salem NJPDES Permit Renewal Application, NJPDES Permit No. NJ 0005622, Section 6 Comprehensive Demonstration Study (CDS), February 2006.

juvenile forms of fish from intakes.[22] These screens rely on gentle impingement of organisms on the screen surface or retention of larvae within the screens.[23] Velocities too high can result in damage to aquatic organisms or death.[24] The success of an installation using fine mesh screens is contingent on the application of satisfactory handling and recovery facilities to allow the safe return of impinged organisms to the aquatic environment.[25] In situ studies on the use of fine mesh on conventional traveling screens and modified traveling screens have indicated that these mesh screens reduce entrainment.[26] Effective handling and recovery facilities and adequate velocity can be included in CWIS design, thus eliminating design limitations for fine mesh screens. Fine mesh screens clog very quickly and require frequent maintenance.[27] Through effective CWIS operation and maintenance programs, clogging can be reduced.

Wedgewire screens consist of mesh shaped like a wedge (or a "V"), and are often configured in a cylindrical manner.[28] In order for wedgewire screens to be effective at reducing impingement and entrainment, a combination of low through-mesh velocity (typically less than or equal to 0.5 feet per second) and cross-cross current configuration to the ambient flow are required to allow organisms with limited motility to flow past the screens without being entrained.[29] Additionally, the size of the opening in wedgewire screens must be sufficiently small (typically between 0.5 mm and 2.0 mm) to be effective at physically blocking small aquatic organisms in the earliest stages of life from passing through the screen.[30] Testing of wedge-wire screens has demonstrated that fish impingement can be virtually eliminated and that entrainment of fish eggs and larvae reduced.[31]

[22] USEPA, Preliminary Regulatory Development Section 316B of the Clean Water Act Background Paper Number 3: Cooling Water Intake Technologies, April 4, 1994.
[23] USEPA, Preliminary Regulatory Development Section 316B of the Clean Water Act Background Paper Number 3: Cooling Water Intake Technologies, April 4, 1994.
[24] USEPA, 316(b) Phase II Final Rule – TDD, Attachment A to Chapter 4, Cooling Water Intake Structure Technology Fact Sheets
[25] USEPA, Preliminary Regulatory Development Section 316B of the Clean Water Act Background Paper Number 3: Cooling Water Intake Technologies, April 4, 1994.
[26] USEPA, Preliminary Regulatory Development Section 316B of the Clean Water Act Background Paper Number 3: Cooling Water Intake Technologies, April 4, 1994.
[27] USEPA, 316(b) Phase II Final Rule – TDD, Attachment A to Chapter 4, Cooling Water Intake Structure Technology Fact Sheets.
[28] Field Evaluation of Wedgewire Screens for Protecting Early Life Stages of Fish at Cooling Water Intakes. EPRI, Palo Alto, CA: 2005. 1010112.
[29] USEPA, 316(b) Phase II Final Rule – TDD, Attachment A to Chapter 4, Cooling Water Intake Structure Technology Fact Sheets.
[30] PSEG Fossil LLC. Mercer Generating Station 316(b) Demonstration. November 2001. Appendix D.
[31] USEPA, 316(b) Phase II Final Rule – TDD, Attachment A to Chapter 4, Cooling Water Intake Structure Technology Fact Sheets.

Closed cycle cooling transfers a power plant's waste heat to the environment through the recycle and recirculation of cooling water.[32, 33] Closed cycle cooling systems allow a power plant to withdraw small quantities of water from nearby water bodies, and in some cases require no water withdrawal at all.[34] In comparison, once-through cooling withdraws water from a water body, passes it through the cooling system once, and discharges the heated water back into the water body.[35]

Closed cycle cooling can be done through two different processes, wet cooling and dry cooling systems. Dry cooling systems do not utilize water for cooling via evaporation, rather waste heat is transferred through convection and radiation, thus completely eliminating the need for cooling water withdrawals and discharges to and from waterbodies.[36] Wet cooling systems transfer heat primarily through the evaporation of heated cooling water into the air.[37,38] Compared to once-through cooling systems, wet cooling systems are able to reduce the volume of water required to be withdrawn from a water body up to 95%, with similar reductions in impingement and entrainment achievable.[39] Retrofitting a power plant that employs a once-through cooling system to the use of a wet cooling system will also reduce the size of the thermal plume discharged to the water body, as well as reducing the temperature of the plume.[40]

CEA developed Tables 1 and 2 to compare the effectiveness of the technology utilized at the time of study (traveling mesh screen) with the effectiveness of closed cycle cooling systems. CEA based its estimates for entrainment and impingement for closed cycle cooling systems on a

[32] Clean Water Act Section 316(b) Existing Facilities Proposed Rule Qs and As, March 28, 2011.
[33] USEPA, Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Rule, EPA-821-R-11 001, March 28, 2011.
[34] USEPA, Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Rule, EPA-821-R-11 001, March 28, 2011.
[35] Clean Water Act Section 316(b) Existing Facilities Proposed Rule Qs and As, March 28, 2011.
[36] USEPA, Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Rule, EPA-821-R-11 001, March 28, 2011.
[37] USEPA, Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Rule, EPA-821-R-11 001, March 28, 2011.
[38] California Ocean Protection Council, Tetra-Tech, Inc., California's Coastal Power Plants: Alternative Cooling System Analysis, February 2008.
[39] California Ocean Protection Council, Tetra-Tech, Inc., California's Coastal Power Plants: Alternative Cooling System Analysis, February 2008.
[40] California Ocean Protection Council, Tetra-Tech, Inc., California's Coastal Power Plants: Alternative Cooling System Analysis, February 2008.

95% reduction on entrainment and impingement and the technology utilized by SGS at the time of study.[41]

With regard to BTA for CWIS and in order to optimize reduction of AEI, NJDEP must include additional provisions for reissuance of the permits involving CWIS, including details of appropriate operation and maintenance (O&M) of CWIS technologies and details of fish escape device O&M.

Sampling

The SGS 2006 CDS does not document impingement and entrainment of Atlantic and shortnose sturgeon life stages and the draft permit issued does not include provisions that will address the known and anticipated adverse impacts to these species. The 2014 Endangered Species Act Section 7 Consultation Biological opinion provided by NOAA NMFS Greater Atlantic Regional Fisheries Office for the Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581 (2014 BO) predicts the death of 61 federally endangered Atlantic sturgeon (all age classes and sub-populations) and 22 federally endangered shortnose sturgeon due to impingement at the trash bars and 26 injured or killed federally endangered Atlantic sturgeon at the traveling screen at SGS throughout the remaining term of the renewed operating licenses. This is a very significant loss to the Delaware River Atlantic sturgeon population, which is estimated to be less than 300 spawning adults that are already highly susceptible to many sources of anthropogenic mortality.[42,43] CEA recommends that additional justification be required to determine that federally endangered species, such as Atlantic and shortnose sturgeon, and the fishery within the Delaware River will not be adversely impacted by the current CWIS design by utilizing available historic and current fisheries data as well as recent sturgeon tagging data.

Supplemental analysis of tagged sturgeon data should be immediately undertaken by PSEG to better establish how both Atlantic and shortnose sturgeon populations select and utilize

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[41] USEPA, Preliminary Regulatory Development Section 316B of the Clean Water Act Background Paper Number 3: Cooling Water Intake Technologies, April 4, 1994.

[42] NOAA. Atlantic Sturgeon New York Bight Distinct Population Segment: Endangered. June 26, 2012.

[43] "Endangered and Threatened Wildlife and Plants; Threatened and Endangered Status for Distinct Population Segments of Atlantic Sturgeon in the Northeast Region". 77 Federal Register 24 (6 February 2012), pp. 5880-5912.

environments within the Delaware River in the vicinity of SGS. In recent years, the number of Atlantic and shortnose sturgeon that have been "tagged" or implanted with acoustic transmitters within Atlantic Coast river systems has increased dramatically. Within the Delaware River, tagged sturgeon are currently tracked using hydrophone sensors placed throughout the river system. As of 2010, the Delaware River had 131 hydroacoustic receivers capable of detecting tagged Atlantic and shortnose sturgeon.[44] Although detection varies in rivers depending on the environmental conditions, hydroacoustic receivers can pick up signals to at least 500 meters.[45] Furthermore, it has been conclusively demonstrated by the Delaware Division of Fish and Wildlife Department of Natural Resources and Environmental Control (DNREC) that increased efficiency and improved tracking of tagged juvenile Atlantic sturgeon has facilitated a more targeted sampling effort that has resulted in a greater catch per unit effort (CPUE) during annual sampling.[46] In addition to DNREC fish and wildlife staff, PSEG should also consult with Atlantic and shortnose sturgeon researchers at Delaware State University and the University of Delaware to establish sampling procedures and protocols that utilize information from tagged sturgeon. The potential wealth of data would ensure a much better understanding of endangered sturgeon activity in the vicinity of SGS and help to better establish appropriate CWIS technologies are in place for their protection.

Reductions in AEI may be realized by seasonal flow reduction during periods when larval and juvenile aquatic species are present and most sensitive to impingement and entrainment. Closed cycle cooling provides significant reductions in impingement, entrainment, and thermal discharges compared with other available CWIS technology and should not be overlooked as a viable alternative for maintaining the health and vitality of the federally endangered species and the fisheries in the Delaware River. The entirety of the fish assemblages and resident aquatic biota of the Delaware River watershed must be used to establish an accurate.

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[44] Atlantic Cooperative Telemetry Network; *Collaborative Efforts, Current Status, & Directions*; Brown, Lori. M., Savoy, Thomas F., Manderson, John P., and Fox, Dewayne A.; Delaware State University, Department of Agriculture and Natural Resources; Dover, Delaware.

[45] Pers. Communication DSU researcher.

[46] Fisher, Matthew T.; Delaware Division of Fish and Wildlife-Department of Natural resources and Environmental Control State of Delaware Annual Compliance Report for Atlantic Sturgeon; Submitted to the Atlantic States Marine Fisheries Commission Atlantic Sturgeon Plan Review Team; September 2009.

3.0 THERMAL IMPACTS

<u>Hydrothermal Assessment</u>

The Hydrothermal Assessment for the SGS, prepared by PSEG in 1999, uses hydrographic surveys, in-situ moorings, ambient temperature models, and shipboard surveys to generate thermal mapping models to determine the surficial area for the SGS thermal discharge plume and assess the impacts of changing temperature distributions on Representative Important Species (RIS) in the Delaware Estuary. NJDEP Surface Water Quality Standards (SWQS) criteria and Delaware River Basin Commission's (DRBC) Administrative Manual-Part III, Water Quality Regulations (WQR), which serve as the basis for thermal effluent limitations in the Plant's NJPDES permits, were used to formulate the models and assess the surface dimensions of the thermal discharge plumes. The hydrothermal modeling was based on limited field verified and modeled temperatures for both ambient water and effluent discharge water. Based on the selective information provided by PSEG, it appears that maximum ebb and end-of-flood tides for the modeled data as depicted in the report generated plumes with the greatest lengths, surface areas, elevated water temperatures, and subsequently the greatest impacts to RIS species.

Regulatory Context

Section 3.30.5.C.2 of the Delaware River Basin Commission's (DRBC) Administrative Manual-Part III, WQR (December 4, 2013) lists the Stream Quality Objectives for temperature for Zone 5 of the Delaware River as follows:

Temperature. shall not be raised above ambient by more than

a. *Shall not be raised above ambient by more than*
    1. *4°F (2.2°C) during September through May, nor*
    2. *1.5°F (0.8°C) During June Through August;*

b. *Nor shall maximum temperatures exceed 86°F (30.0°C). [See 4.30.6.F.4]*

Section 4.30.6.F.4 of the Delaware River Basin Commission's (DRBC) Administrative Manual-Part III, WQR (December 4, 2013) defines the Heat Dissipation Areas for Zone 5 of the Delaware River as follows:

Heat Dissipation Areas: The limitations specified above [4.30.6.C.1] may be exceeded by special permit in heat dissipation areas designated on a case-by-case basis, subject to the following conditions:

4. Zones 5 and 6.

a. Maximum Length. As a guideline, heat dissipation areas shall not be longer than 3,500 feet, measured from the point where the waste discharge enters the stream.

Section 4.30.6.F.7 of the Delaware River Basin Commission's (DRBC) Administrative Manual-Part III, WQR (December 28, 2010) states:

Other Considerations.

a. The rate of temperature change in designated heat dissipation areas shall not cause mortality of fish or shellfish.
b. The determination of heat dissipation areas in tidal waters shall take into special consideration the extent and nature of the receiving waters so as to meet the intent and purpose of the criteria and standards, including provisions for the passage of free-swimming and drifting organisms so that negligible or no effects are produced on their populations."

Section 4.30.6.G of the Delaware River Basin Commission's (DRBC) Administrative Manual-Part III, WQR (December 28, 2010) states:

Definitions.

1. *Ambient temperature is the temperature of a water body unaffected by the heated waste discharge or waste discharge complex.*
2. *Natural temperature is the temperature of a waterbody unaffected by artificial sources of waste heat.*
3. *Stream temperature is the temperature of the stream outside of the heat dissipation area.*

SGS's 2015 NPDES Permit Fact Sheet states in Section 9(C)-Section 316(a) Determination that:

Based on a review of the current data and modeling pertaining to the thermal plume as well as the biothermal assessment, the Department has determined that a continued variance under section 316(a) is warranted. A thermal discharge at the Station, which *does not exceed a maximum of 115°F (46.1°C) is expected to assure the protection and propagation of the balanced indigenous population.*

The DRBC issued Docket No. D-68-20 CP (Revisions 2) on September 18, 2001 to PSEG for the Station consistent with the NJPDES permit. The docket specified that the project discharge shall not cause a temperature rise in excess of 1.5°F (24-hour average during June through August) above ambient temperature. Such limitations may be exceeded within a heat dissipation area which shall not exceed a length of 25,300 feet upstream and 21,000 feet downstream from the end of the stations discharge pipes nor extend closer than 1,320 feet to the present eastern boundary of the shipping channel of the Delaware River. The docket also states that the project shall not cause a temperature rise in excess of 4°F (24-hour average during September through May) above ambient temperatures. Such limitations may be exceeded within a heat dissipation area which shall not exceed a length of 3,300 feet upstream and 6,000 feet downstream from the end of the Stations discharge pipes nor extend closer than 3,200 feet to the present eastern boundary of the shipping channel of the Delaware River.

Section Part IV.G.9(C)- Section 316(a) Variance Conditions further states:

The Departments 316(a) determination will include, but not be limited to: 1) a review of whether the nature of the thermal discharge or the aquatic population associated with the Station has changed; 2) whether the protection and propagation of the balanced indigenous population is assured; 3)whether the best scientific methods to assess the effects of the permittee's cooling water system have changed; 4) whether the technical knowledge of stresses cause by the cooling system has changed

The hydrothermal assessment results contained in PSEG's Renewal Application - Salem Generating Station, Permit No. NJ0005622 –Appendix E, 316(a) Demonstration are outdated and do not reflect current surface and subsurface water temperatures within and along the perimeter of the thermal plume.

- The report only documents select lateral, downriver and upriver surface and subsurface temperature profiles for the thermal plume.

- Figures contained within Section E-V of the Report do not provide an adequate means to precisely measure and assess the length, extent, surface and subsurface temperatures of the thermal plume as it relates to DRBC requirements for heat dissipation areas and NJDEP permit effluent limitations.

Excess temperature distribution contour maps and associated discharge centerline cross-sections utilizing updated ambient, influent and effluent temperature data and depicting a modeled worst-case side-by-side comparison of both surface and bottom Delta-T contours for End-of-Ebb, Ebb, End-of-Flood, and Flood tidal phases should be provided to more accurately assess the thermal plume for compliance with DRBC and NJAC permit requirements.

The Salem 316(a) Demonstration Study is outdated and PSEG must be required to update field sampled temperature data, USGS temperature gauge data, and SGS DMR intake and effluent data to conduct new thermal plume modeling and subsequently evaluate thermal plume impacts to RIS. This includes utilizing USGS water temperature data from Reedy Island beyond the 1988-1998 and 2000-2004 data sets to include data from 2004-2014. Coupled with this data should be current shipboard and mooring buoy temperature data to field check new model runs of thermal plume mixing. PSEG must revisit and justify the continued combined use of the two thermal plume model programs (CORMIX and RMA-10) and the linkage procedure to describe the near-field/ zone of initial mixing (ZIM) region, transition region, and far-field thermal plume modeling. PSEG should provide an updated justification as to why the use of multiple modeling software programs are needed to evaluate the different regions of the thermal plume. The justification should utilize updated field verified ambient, influent, and effluent water temperature data. PSEG should provide the following:

- A comparison of each individual model run independent of the other models compared with the models grouped together with the transition programming in order to demonstrate that PSEG does not gain an advantage in using this combination of modeling (i.e. to model shorter plume lengths or smaller temperature gradients within the thermal plume that avoid potential violation of DRBC WQ requirements).

- The results of the thermal plume modeling data in a format that allows a direct comparison to DRBC and NJAC temperature requirements, both with and without the 316(a) variance granted in prior permits. The hydrothermal analysis does not report the results of the thermal modeling in a format that allows for a proper analysis of segmented transects across the sampling area. A clear depiction of surficial and vertical water temperatures within and beyond the edge of the thermal plume for all tidal phases, at appropriate transects, for at least the sustained full-load pattern during summer and winter must be provided that correspond to DRBC WQR temperature and heat dissipation requirements provided above. The failure to model the full extent of the plume during all tidal cycles for all the transects greatly underestimates the impacts to the aquatic biota in the Delaware River as well as the area available for fish passage.

PSEG's draft permit once again proposes to renew the 316(a) thermal variances, inclusive of thermal plume length (up to 7 times the length (3,500 feet) allowed by DRBC WQ requirements). The variance allows for increases above ambient temperature requirements within the boundaries of these exaggerated heat dissipation areas (4.8 miles upstream and 4.0 miles downstream). NJDEP in conjunction with the DRBC must require a new, comprehensive field-sampling program that captures the current prevailing mid-summer field and operating conditions to support a more detailed validation and application of the hydrothermal models provided by updated CORMIX and/or RMA analyses.

The thermal plume model runs and assessments that utilize ambient temperature based on the Ambient Temperature Model (ATM) must be evaluated against real time measured data such as that from USGS gauging stations located above, in the vicinity of, and below SGS's location on the Delaware River. This temperature data combined with updated shipboard and mooring buoy readings and 15 years of DMR influent data can be compared and studied against the model data to better delineate and depict temperature gradients both within and outside of the heat dissipation areas of the thermal plume to ensure there are not additional impacts to RIS species.

Field verified data was collected for the thermal plume generated by heated cooling water from SGS from May 21, 1998 through June 4, 1998.[47] In addition to the historical data provided by PSEG, Table 3 provides CEA's analysis of SGS's influent and effluent data obtained from NJDEP's Dataminer Daily Monitoring Reports (DMRs) from 2000-2015. CEA compared the mean monthly average and mean daily maximum effluent temperatures with DRBC's WQR (Table 3, Figures 1-4). SGS's documented mean monthly average effluent temperature from 2000-2015 exceeds DRBC's WQR during the months of June, July, August and September. AEI to RIS species due to thermal plume impacts must be reevaluated in relation to documented DRBC WQR exceedances during summer months prior to permit issuance to ensure all life stages of marine species, and more precisely RIS species associated with SGS, can be properly evaluated.

Not calculating the extent of the lateral, downriver and upriver surface and subsurface temperature profiles for the modeled thermal plumes as described above results in a data gap that greatly reduces the ability to assess the zone of passage for a number of sensitive aquatic organisms that utilize both the surface waters and shallow shoreline substrates of the Delaware River, namely the pelagic and demersal eggs and larvae of the RIS identified in the PSEG Renewal Application - Salem Generating Station, Permit No. NJ0005622 –Appendix E, 316(a) Demonstration. This results in a failure to meet the conditions set forth in 4.30.6.F.7 of the DRBC Administrative Manual-Part III, WQR.

<u>Ecological Impacts of Thermal Discharges</u>

The potential for impacts to fish populations associated with thermal discharges from SGS was evaluated in SGS's 316(a) Demonstration, sponsored by Dr. Charles C. Coutant and Dr. E. Eric Adams, March 4, 1999 and SGS's 316(b) Comprehensive Demonstration Study, by PSEG Nuclear LLC, February 2006.[48,49] Growth in aquatic species, the presence of juveniles, and spawning only occur at certain times during each year. The fact that these essential growth and life cycles only take place during certain times of the year magnifies the significance of the

[47] PSEG. Renewal Application - Salem Generating Station, Permit No. NJ0005622 –Appendix E, 316(a) Demonstration - March 4, 1999.
[48] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[49] PSEG Nuclear LLC, Salem NJPDES Permit Renewal Application, NJPDES Permit No. NJ 0005622, Section 4 Comprehensive Demonstration Study (CDS), February 2006.

impact of the thermal plume from SGS on aquatic species. The following discussion depicts the threats and impacts that the high temperatures of the measured thermal plume in the near-field mixing zone, shoreline, and shallow depths will have on the life stages of the RIS.

RIS are used to assess the wellbeing of the entire aquatic community. The assumption is that if the RIS are doing well, then the entire community should also be doing well.[50] PSEG choose three macroinvertebrate and nine fish species as RIS of the Delaware River community including, scud (*Gammarus spp.)*, opossum shrimp (*Neomysis americana*), blue crab, alewife, American shad, Atlantic croaker, bay anchovy, blueback herring, spot, striped bass, weakfish, and white perch.[51] Atlantic and shortnose sturgeon were not included in the RIS and although allowable take has been permitted in the 2014 BO, SGS must be required to integrate the wealth of data provided by current and ongoing tagged sturgeon surveys to field verify that the 2014 BO and RIS exclusions are warranted.

Finfish

Alewife (Alosa pseudoharengus)

Alewives are a federally listed species of concern.[52] Alewives critical life stages include eggs, larvae, and early juveniles.[53] Larval, juvenile, and adult alewives are pelagic and are directly impacted by elevated surface water temperatures caused by SGS's effluent.[54] Alewife eggs are semi-demersal and slightly adhesive, being easily torn free and carried by currents and therefore are also impacted by elevated subsurface temperatures resulting from SGS's thermal plume.[55]

- Spawning occurs when water temperatures are between 61°F to 66°F. [56] Spawning within the Delaware River occurs from mid-March to early April.[57] The mean daily maximum

[50] NJDEP. Draft Surface Water Renewal Permit Action. Category: B -Industrial Wastewater. NJPDES Permit No. NJ0005622. PSEG Nuclear LLC Salem Generating Station. Lower Alloways Creek Twp, Salem County. June 30, 2015.
[51] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[52] NOAA National Marine Fisheries Service. Species of Concern: River Herring (Alewife & Blueback herring). May 19, 2009.
[53] Klauda, Ronald Et al. Alewife and Blueback Herring: *Alosa pseudoharengus and Alosa aestivalis.* University of Maryland Agricultural Experiment Station Wye Research and Education Center. Undated.
[54] NOAA National Marine Fisheries Service. Species of Concern: River Herring (Alewife & Blueback herring). May 19, 2009.
[55] Smith, C.L. The Inland Fishes of New York State. New York State Department of Environmental Conservation. Albany, NY. August 1985.
[56] NOAA National Marine Fisheries Service. Species of Concern: River Herring (Alewife & Blueback herring). May 19, 2009.

temperature of both SGS's FAC A and FAC B effluent during the month of March and April exceeds alewives spawning temperature range.[58]

- Optimum temperature for alewife eggs is 61°F to 70°F.[59] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of April and May exceeds the optimum temperature range for alewife eggs.[60]
- According to PSEG, larvae of alewife occur in the vicinity of SGS during the month of May.[61] Optimum temperature for alewife yolk-sac larva is 59°F to 75°F.[62] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the month of May exceed the optimal temperature range for alewives larvae.[63]
- According to PSEG, young-of-the-year (YOY) alewives occur in the vicinity of SGS from October to December.[64] Preferred temperature for early alewife juveniles is 63°F to 75°F.[65] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the month of October exceeds the preferred temperature range for early alewife juveniles.[66]
- According to PSEG, alewives older than one year occur in the vicinity of SGS from March through May.[67]

Based on sensitivity to high water temperatures discharged from SGS (Tables 3 and 4), alewife spawning, eggs, larvae, and early juveniles have the known potential to be negatively impacted.[68] Based on the 2013 Biological Monitoring Report data, implementation of a closed cycle cooling

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[57] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[58] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[59] Klauda, Ronald Et al. Alewife and Blueback Herring: *Alosa pseudoharengus and Alosa aestivalis.* University of Maryland Agricultural Experiment Station Wye Research and Education Center. Undated.
[60] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[61] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[62] Klauda, Ronald Et al. Alewife and Blueback Herring: *Alosa pseudoharengus and Alosa aestivalis.* University of Maryland Agricultural Experiment Station Wye Research and Education Center. Undated.
[63] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[64] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[65] Klauda, Ronald Et al. Alewife and Blueback Herring: *Alosa pseudoharengus and Alosa aestivalis.* University of Maryland Agricultural Experiment Station Wye Research and Education Center. Undated.
[66] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[67] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[68] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.

system has the potential to reduce impingement and entrainment by 95% and protect the lives of tens of thousands of impinged and entrained alewife at SGS per year.[69]

American shad (Alosa sapidissima)

American shad eggs are neutrally buoyant, dispersed through the water column, and are directly impacted by elevated surface water temperatures caused by SGS's effluent.[70,71] American shad larvae, juveniles, and adults are pelagic fish and are directly impacted by elevated surface water temperatures caused by elevated subsurface temperatures resulting from SGS's effluent.[72]

- Spawning occurs when water temperatures are between 54°F and 70°F, peaking around 65°F.[73,74] American shad spawning in the Delaware River occurs from mid-April through July, peaking in early May. [75,76] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of April, May, June and July exceeds the temperature range that American shad spawning occurs.[77]
- According to PSEG, following spawning, American shad eggs are dispersed throughout the water column and are gradually transported downstream by freshwater flows.[78] Optimum temperature for American shad egg development is 63°F.[79]
- According to PSEG, following hatching, American shad larvae are continually transported downstream. Optimal temperature range for American shad larvae is 59°F to 77°F.[80]

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69 Entrainment totals are for Alosa spp. as reported in the 2013 BMR.

70 Smith, C.L. The Inland Fishes of New York State. New York State Department of Environmental Conservation. Albany, NY. August 1985.

71 Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.

72 USFWS. Maryland Fisheries Resource Office. Park, I. et al. U.S. Fish and Wildlife Service Susquehanna River American Shad (*Alosa sapidissima*) Restoration: Potomac River Egg Collection, 2012. August 22, 2012.

73 Smith, C.L. The Inland Fishes of New York State. New York State Department of Environmental Conservation. Albany, NY. August 1985.

74 Virginia Department of Game and Inland Fisheries. American Shad (*Alosa sapidissima*). http://www.dgif.virginia.gov/wildlife/fish/details.asp?fish=010040. 2013.

75 Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.

76 Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.

77 NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.

78 Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.

79 Smith, C.L. The Inland Fishes of New York State. New York State Department of Environmental Conservation. Albany, NY. August 1985.

- According to PSEG, American shad YOY occur in the vicinity of SGS from mid-October to December.[81] Optimal temperature range for juvenile American shad is 60°F to 75°F.[82] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the month of October exceeds the optimum temperature for American shad eggs.[83]
- According to PSEG, American shad one year and older occur within the vicinity of SGS from February to early May.[84]

Based on sensitivity to high water temperatures discharged from SGS (Tables 3 and 4), American shad spawning and YOY have the known potential to be negatively impacted.[85] Based on the 2013 Biological Monitoring Report data, implementation of a closed cycle cooling system has the potential to reduce impingement and entrainment by 95% and protect the lives of hundreds of thousands of impinged and entrained American shad at SGS per year.

Atlantic croaker (Micropogonias undulatus)

- Atlantic croaker spawn in estuaries at temperatures ranging from 61°F to 77°F. Atlantic croaker spawning begins in late summer and continues on to early spring, peaking in late fall and winter.[86] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of August, September, and October exceeds the temperature range for spawning Atlantic croaker.[87]
- According to PSEG, Atlantic croaker larvae occur in the vicinity of SGS in January and from September through October.[88]
- According to PSEG, Atlantic croaker juvenile occur in the vicinity of SGS from September through April.[89, 90]

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80 Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
81 Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
82 Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
83 NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
84 Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
85 NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
86 Atlantic States Marine Fisheries Commission, Life History and Habitat Needs. Atlantic Croaker - *Micropogonias undulates.* Undated.
87 NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
88 PSEG. Biological Monitoring Program 2013 Report.

- In the Delaware Estuary, which extends from Cap May, New Jersey, to Trenton, New Jersey, adult Atlantic croaker are found from late spring through mid-fall. [91] Adults are tolerant of temperature ranges from 41°F to 97°F.[92] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of July and August exceeds the temperature range for Atlantic croaker adults.[93]

Based on sensitivity to high water temperatures discharged from SGS (Tables 3 and 4), Atlantic croaker adults have the known potential to be negatively impacted.[94] Based on the 2013 Biological Monitoring Report data, implementation of a closed cycle cooling system at SGS has the potential to reduce impingement and entrainment by 95% and protect the lives of millions of impinged and entrained Atlantic croaker at SGS per year.

Bay anchovy (Anchoa mitchilli)

Bay anchovy eggs, larvae, juveniles, and adults are pelagic fish and are directly impacted by elevated surface water temperatures caused by SGS's effluent.[95]

- Spawning occurs throughout much of the Delaware Estuary from May through mid-August with two peaks, one usually in late May and the other usually in mid-July when water temperatures are higher than 63°F.[96] The optimal spawning range is 68-81°F.[97] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of May, June, July and August exceeds the temperature range for bay anchovy spawning.[98]

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[89] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[90] PSEG. Biological Monitoring Program 2013 Report.
[91] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[92] Atlantic States Marine Fisheries Commission, Life History and Habitat Needs. Atlantic Croaker - *Micropogonias undulates.* Undated.
[93] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[94] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[95] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[96] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[97] Smith, C. Lavett. *The Inland Fishes of New York State.* Albany, NY: New York State Department of Environmental Conservation. August 1985.
[98] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.

- According to PSEG, bay anchovy eggs occur in the vicinity of SGS from May through early September.[99,100] Hatching time within depends on water temperature.[101] The hatch temperature for bay Anchovy is between 81-82°F.[102] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of May, June, July, August and September exceeds the hatch temperature range for bay anchovy eggs.[103,104]
- According to PSEG, bay anchovy larvae occur in the vicinity of SGS from May through November.[105,106]
- According to PSEG, bay anchovy juveniles occur in the vicinity of SGS from June through April. [107,108]
- According to PSEG, bay anchovy adults occur in the vicinity of SGS from mid-April to November.[109] Optimum growth temperature for bay anchovy is 85°F. [110] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of May, June, July, August, September, and October exceeds the temperature range for bay anchovy adults.[111]

Based on sensitivity to high water temperatures discharged from SGS (Tables 3 and 4), bay anchovy spawning, eggs, and adults have the known potential to be negatively impacted.[112] Based on the 2013 Biological Monitoring Report data, implementation of a closed cycle cooling

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[99] PSEG. Biological Monitoring Program 2013 Report.
[100] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[101] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[102] Smith, C. Lavett. *The Inland Fishes of New York State*. Albany, NY: New York State Department of Environmental Conservation. August 1985.
[103] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[104] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[105] PSEG. Biological Monitoring Program 2013 Report.
[106] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[107] PSEG. Biological Monitoring Program 2013 Report.
[108] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[109] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[110] ASA Analysis & Communication, Inc., Bridgeport Harbor Generating Station Biothermal Assessment Report, November 2011.
[111] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[112] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.

system has the potential to reduce impingement and entrainment by 95% and protect the lives of millions to billions of impinged and entrained bay anchovy at SGS per year.

Blueback herring (Alosa aestivalis)

Blueback herring are a federally listed species of concern.[113] Blueback herring's critical life stages include eggs, larvae, and early juveniles.[114] Blueback herring eggs are pelagic to semi-demersal and are directly impacted by elevated surface water temperatures caused by SGS's effluent.[115]

- The mid-Atlantic spawning populations, including the Delaware River, spawn in late April.[116] The optimal spawning temperature range for blueback herring is 70°F to 77°F.[117]
- Optimum temperature for blueback herring eggs is 57°F to 79°F.[118] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of May, June, July, August, September and October exceeds the optimum temperature range for blueback herring eggs.[119]
- According to PSEG, blueback herring larvae occur in the vicinity of SGS in May.[120] Suitable temperature for blueback herring yolk-sac larva is 57°F to 79°F.[121] Suitable temperature for blueback herring post yolk-sac larva is 57°F to 82°F.[122] The mean daily

[113] NOAA National Marine Fisheries Service. Species of Concern: River Herring (Alewife & Blueback herring). May 19, 2009.

[114] Klauda, Ronald Et al. Alewife and Blueback Herring: *Alosa pseudoharengus and Alosa aestivalis.* University of Maryland Agricultural Experiment Station Wye Research and Education Center. Undated.

[115] NOAA National Marine Fisheries Service. Species of Concern: River Herring (Alewife & Blueback herring). May 19, 2009.

[116] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.

[117] Klauda, Ronald Et al. Alewife and Blueback Herring: *Alosa pseudoharengus and Alosa aestivalis.* University of Maryland Agricultural Experiment Station Wye Research and Education Center. Undated.

[118] Klauda, Ronald Et al. Alewife and Blueback Herring: *Alosa pseudoharengus and Alosa aestivalis.* University of Maryland Agricultural Experiment Station Wye Research and Education Center. Undated.

[119] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.

[120] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.

[121] Klauda, Ronald Et al. Alewife and Blueback Herring: *Alosa pseudoharengus and Alosa aestivalis.* University of Maryland Agricultural Experiment Station Wye Research and Education Center. Undated.

[122] Klauda, Ronald Et al. Alewife and Blueback Herring: *Alosa pseudoharengus and Alosa aestivalis.* University of Maryland Agricultural Experiment Station Wye Research and Education Center. Undated.

maximum temperature of both SGS's FAC A and FAC B effluent during the month of May exceeds the optimum temperature range for blueback herring larvae.[123]

- According to PSEG, blueback herring YOY occur in the vicinity of SGS from November through early December.[124] Preferred temperature for early blueback herring juvenile is 68°F to 82°F.[125]

Based on sensitivity to high water temperatures discharged from SGS (Tables 3 and 4), blueback herring spawning, eggs and larvae have the known potential to be negatively impacted.[126] Based on the 2013 Biological Monitoring Report data, implementation of a closed cycle cooling system has the potential to reduce impingement and entrainment by 95% and protect the lives of tens of thousands of impinged and entrained blueback herring at SGS per year.

Spot (Leiostomus xanthurus)

- According to PSEG, spot larvae occur in the vicinity of SGS from March through June.[127, 128]
- According to PSEG, spot YOY occur in the vicinity of SGS from late May through August (spring) and October through December.[129]

Based on the 2013 Biological Monitoring Report data, implementation of a closed cycle cooling system has the potential to reduce impingement and entrainment by 95% and protect the lives of tens of thousands of impinged and entrained spot at SGS per year.

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[123] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[124] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[125] Klauda, Ronald Et al. Alewife and Blueback Herring: *Alosa pseudoharengus and Alosa aestivalis.* University of Maryland Agricultural Experiment Station Wye Research and Education Center. Undated.
[126] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[127] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[128] PSEG. Biological Monitoring Program 2012 Report.
[129] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.

Striped bass (Morone saxatilis)

The Delaware River striped bass population is one of the major spawning stocks on the Atlantic coast.[130] Striped bass are pelagic and are directly impacted by elevated surface water temperatures caused by SGS's effluent.[131]

- Spawning in the Delaware River occurs from April through May.[132] Peak spawning activities occur between 59°F and 68°F.[133] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of April and May exceeds the temperature range for striped bass spawning.[134]
- According to PSEG, striped bass eggs occur in the vicinity of SGS from early April through mid-May.[135,136] Optimal temperature range for striped bass eggs and larvae is 64°F to 70°F.[137] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of April and May exceeds the temperature range for striped bass eggs.[138]
- According to PSEG, striped bass larvae occur in the vicinity of SGS from mid-April through July.[139,140]
- According to PSEG, striped bass juveniles occur in the vicinity of SGS from June through July and from late September through December.[141,142] Striped bass juveniles can tolerate temperatures ranging from 50°F to 81°F; however, optimum temperatures range

[130] Partnership for the Delaware Estuary. 2012. Technical Report for the Delaware Estuary and Basin. PDE Report No. 12-01. 255 pages. www.delawareestuary.org/science_programs_state_of_the_estuary.asp.
[131] Costantini, M., et al. Effect of Hypoxia on Habitat Quality of Striped Bass (Morone saxatilis) in Chesapeake Bay. Can. J. Fish. Aquat. Sci. 65: 989-1002. NRC Canada. 2008.
[132] Partnership for the Delaware Estuary. 2012. Technical Report for the Delaware Estuary and Basin. PDE Report No. 12-01. 255 pages. www.delawareestuary.org/science_programs_state_of_the_estuary.asp.
[133] Shepard, G. NOAA NEFSC – Resource Evaluation and Assessment Division. Striped Bass (Morone saxatilis). December 2006.
[134] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[135] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[136] PSEG. Biological Monitoring Program 2013 Report.
[137] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[138] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[139] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[140] PSEG. Biological Monitoring Program 2013 Report.
[141] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[142] PSEG. Biological Monitoring Program 2013 Report.

from 57°F to 70°F.[143] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of June, July, September and October exceeds the tolerate temperature range and during the months of June, July, September, October, and November exceeds the optimum temperature range for striped bass juveniles.[144]

- According to PSEG, striped bass adults occur in the vicinity of SGS from January through late April.[145] Estuarine striped bass adults can tolerate temperatures ranging from 50°F to 81°F; however, optimum temperatures range from 57°F to 70°F.[146] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the month of April exceeds the optimal temperature range for estuarine striped bass adults.[147]

Based on sensitivity to high water temperatures discharged from SGS (Tables 3 and 4), striped bass spawning, eggs, juveniles and adults have the known potential to be negatively impacted.[148] Based on the 2013 Biological Monitoring Report data, implementation of a closed cycle cooling system has the potential to reduce impingement and entrainment by 95% and protect the lives of millions of impinged and entrained striped bass at SGS per year.

Weakfish (Cynoscion regalis)

Juvenile weakfish are semi-pelagic and are directly impacted by elevated surface water temperatures caused by SGS's effluent.[149]

- Weakfish spawn in the Delaware River from May to mid-July.[150] The optimum spawning temperature range is from 61-82°F. [151] The mean daily maximum temperature of both

[143] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[144] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[145] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[146] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[147] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[148] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[149] http://nefsc.noaa.gov/publications/tm/tm161/tables/t44.htm
[150] Mercer, Linda P. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic): Weakfish*. U.S. Army Corps of Engineers, Fish and Wildlife Service. August 1989.
[151] Mercer, Linda P. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic): Weakfish*. U.S. Army Corps of Engineers, Fish and Wildlife Service. August 1989.

SGS's FAC A and FAC B effluent during the months of May, June, and July exceeds the optimum spawning temperature range for weakfish.[152]

- According to PSEG, weakfish eggs occur in the vicinity of SGS from May through mid-July.[153,154] The optimum hatch temperature range of weakfish eggs is 64-75°F.[155] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of May, June, and July exceeds the optimum hatch temperature range for weakfish hatching.[156]
- According to PSEG, weakfish larvae occur in the vicinity of SGS from May through September.[157,158]
- According to PSEG, weakfish juveniles occur in the vicinity of SGS from June through mid-September.[159,160] Upper optimum growth temperature for juvenile weakfish is 85°F.[161] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of June, July, August and September exceeds the upper optimum growth temperature for juvenile weakfish.[162]

Based on sensitivity to high water temperatures discharged from SGS (Tables 3 and 4), weakfish spawning, eggs and juveniles have the known potential to be negatively impacted. [163] Based on the 2013 Biological Monitoring Report data, implementation of a closed cycle cooling system has the potential to reduce impingement and entrainment by 95% and protect the lives of millions of impinged and entrained weakfish at SGS per year.

White perch (Morone americana)

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[152] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[153] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[154] PSEG. Biological Monitoring Program 2013 Report.
[155] Mercer, Linda P. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic): Weakfish*. U.S. Army Corps of Engineers, Fish and Wildlife Service. August 1989.
[156] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[157] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[158] PSEG. Biological Monitoring Program 2013 Report.
[159] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[160] PSEG. Biological Monitoring Program 2013 Report.
[161] Mercer, Linda P. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic): Weakfish*. U.S. Army Corps of Engineers, Fish and Wildlife Service. August 1989.
[162] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[163] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.

White perch eggs are pelagic in flowing waters, like the Delaware River, and are directly impacted by elevated surface water temperatures caused by SGS's effluent.[164] White perch adults are pelagic and are also directly impacted by elevated surface water temperatures caused by SGS's effluent.[165]

- Spawning occurs at temperatures ranging from 50°F to 61°F.[166] Optimum spawning occurs at 54°F to 57°F.[167] Spawning in the Delaware River occurs from early April through early June, peaking in May.[168] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of April, May and June exceeds the tolerate and optimal temperature ranges for white perch spawning.[169]
- According to PSEG, white perch eggs occur in the vicinity of SGS from April through May. [170] Hatching of white perch eggs occurs between 51°F to 68°F.[171] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of April, May and June exceeds the optimum hatching temperature range for white perch eggs.[172]
- According to PSEG, white perch larvae occur in the vicinity of SGS from mid-April through mid-July.[173,174] Suitable temperatures for white perch larvae ranges from 54°F to 68°F.[175] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of April, May, June and July exceeds the suitable temperature range for white perch larvae.[176]

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164 Hamilton-Setzler, E. M. University of Maryland Center for Environmental and Estuarine Studies: Chesapeake Biological Laboratory. White Perch (*Morone americana*). Undated. P.12- 4.
165 Okoye, A.O., et al. White Perch Fecundity Relationships in Western Albemarle Sound, North Carolina. Journal of North Carolina Academy of Science, 124(2), 2008, pp. 46-50.
166 Hamilton-Setzler, E. M. University of Maryland Center for Environmental and Estuarine Studies: Chesapeake Biological Laboratory. White Perch (*Morone americana*). Undated. P. 12-2.
167 Hamilton-Setzler, E. M. University of Maryland Center for Environmental and Estuarine Studies: Chesapeake Biological Laboratory. White Perch (*Morone americana*). Undated. P.12- 4.
168 Partnership for the Delaware Estuary. 2012. Technical Report for the Delaware Estuary and Basin. PDE Report No. 12-01. 255 pages. www.delawareestuary.org/science_programs_state_of_the_estuary.asp.
169 NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
170 Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
171 Hamilton-Setzler, E. M. University of Maryland Center for Environmental and Estuarine Studies: Chesapeake Biological Laboratory. White Perch (*Morone americana*). Undated. P.12- 4.
172 NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
173 Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
174 PSEG. Biological Monitoring Program 2013 Report.
175 Hamilton-Setzler, E. M. University of Maryland Center for Environmental and Estuarine Studies: Chesapeake Biological Laboratory. White Perch (*Morone americana*). Undated. P.12- 18.
176 NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.

- According to PSEG, white perch juveniles occur in the vicinity of SGS from mid-October through January and in June and July.[177,178] Suitable temperatures for white perch juveniles range from 50°F to 86°F.[179] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of June, July, and October exceeds the suitable temperature range for white perch juveniles.[180]
- According to PSEG, white perch adults occur in the vicinity of SGS from January through mid-May.[181] Suitable temperatures for white perch adults range from 50°F to 86°F.[182] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the month of May exceeds the suitable temperature range for white perch adults.[183]

Based on sensitivity to high water temperatures discharged from SGS (Tables 3 and 4), white perch spawning, eggs, larvae, juveniles and adults have the known potential to be negatively impacted.[184] Based on the 2013 Biological Monitoring Report data, implementation of a closed cycle cooling system has the potential to reduce impingement and entrainment by 95% and protect the lives of millions of impinged and entrained white perch at SGS per year.

Shortnose Sturgeon (Acipenser brevirostrum)

Independent of an RIS analysis, any potential impact to a federally endangered species, such as the shortnose sturgeon located in the Delaware River and potentially affected by the thermal plume of SGS, must be studied to assess and compensate for the potential take of the species. CEA conducted a thorough review of readily available literature regarding the federally endangered shortnose sturgeon. Information, essential for understanding potential impacts to

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[177] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[178] PSEG. Biological Monitoring Program 2013 Report.
[179] Hamilton-Setzler, E. M. University of Maryland Center for Environmental and Estuarine Studies: Chesapeake Biological Laboratory. White Perch (*Morone americana*). Undated. P.12- 18.
[180] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[181] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[182] Hamilton-Setzler, E. M. University of Maryland Center for Environmental and Estuarine Studies: Chesapeake Biological Laboratory. White Perch (*Morone americana*). Undated. P.12- 18.
[183] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[184] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.

shortnose sturgeon life stages caused by thermal discharges, is summarized in the following sections. Information regarding thermal tolerance of shortnose sturgeon eggs, larvae and juveniles is not readily available. CEA finds it difficult to fully understand the impacts of SGS's CWIS on the federally endangered species.

Endangered Species Preservation Act – 1966

On March 11, 1967, the shortnose sturgeon was listed under the Endangered Species Preservation Act (ESPA) and as such, its protection and preservation fall under the following tenets of the Act.[185] The ESPA presented a means to provide limited protections to native animal species.[186] In 1973, Congress passed the Endangered Species Act (ESA) that expanded the limits of protection provided by the ESPA. According to the U.S. Fish and Wildlife Service, "The purpose of the ESA is to protect and recover imperiled species and the ecosystem upon which they depend."[187] Being listed as an endangered species under the ESA means that a species is in danger of extinction throughout all or a significant portion of its range. The ESA protects endangered and threatened species and their habitats by prohibiting the take of listed animals without a permit. Threats to shortnose sturgeon include construction of dams, river pollution, habitat alterations from discharges, dredging or disposal of material into rivers and related development activities involving estuarine/riverine mudflats and marshes.[188] Thermal discharges from SGS pose a threat to shortnose sturgeon populations.

Life History – Spawning

Male and female shortnose sturgeon reach maturity at approximately ages 4 and 7 years, respectively; however, spawning may not occur in males for 1 to 2 years later and up to 5 years later for females.[189] Female shortnose sturgeon average approximately 11 years of age at the time of their first spawning and spawn roughly every 3 years.[190] Male shortnose sturgeon spawn annually.[191]

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[185] Native Fish and Wildlife: Endangered Species. 32 Federal Register 48 (11 March 1967), pp. 4001.
[186] US Fish and Wildlife Service. A History of the Endangered Species Act of 1973. August 2011.
[187] US Fish and Wildlife Service. ESA Basics: 40 years of Conserving Endangered Species. January 2013.
[188] NOAA Fisheries. Shortnose Sturgeon (*Acipenser brevirostrum*). April 5, 2013.
[189] NOAA Fisheries. Shortnose Sturgeon (*Acipenser brevirostrum*). April 5, 2013.
[190] NOAA Fisheries. Shortnose Sturgeon (*Acipenser brevirostrum*). April 5, 2013.
[191] NOAA Fisheries. Shortnose Sturgeon (*Acipenser brevirostrum*). April 5, 2013.

In undammed rivers, like the Delaware, spawning occurs in the farthest accessible reach.[192] Spawning primarily occurs within the non-tidal area of the Delaware River (above the head-of-tide at RM 133).[193] Shortnose sturgeon spawn over hard substrates such as gravel, cobble, rubble or large rocks.[194]

- Spawning migration from overwintering habitats occur when water temperatures reach approximately 45°F to 50°F (late March in the Delaware River), with males migrating prior to females.[195,196]
- Spawning occurs from late March to early May.[197]
- Spawning can occur between 46°F and 77°F, but occur optimally at 50°F to 64°F.[198]

Life History – Eggs

Shortnose sturgeon eggs are demersal and adhesive.[199] Shortnose sturgeon eggs generally hatch after approximately 9-12 days.[200]

Life History – Larvae

Shortnose sturgeon larvae are the most likely life stage to be entrained and/or impinged by water intakes at the SGS as spawning primarily occurs just upstream.[201] Entraining young and vulnerable life stages of shortnose sturgeon directly affect sturgeon populations.[202]

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192 Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser brevirostrum*). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.
193 Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser brevirostrum*). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.
194 Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser brevirostrum*). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.
195 Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser brevirostrum*). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.
196 National Marine Fisheries Service. 1998. Recovery Plan for the Shortnose Sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 104 pages.
197 Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser brevirostrum*). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.
198 Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser brevirostrum*). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.
199 Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (Acipenser brevirostrum). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.
200 Endangered Species Act Section 7 Consultation Biological opinion. NOAA NMFS Greater Atlantic Regional Fisheries Office. Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581July 17, 2014.
201 Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser*

Life History – Juvenile

Juvenile shortnose sturgeon are likely to occur in the vicinity of between April and November.[203] Water temperatures above 82°F can limit juvenile rearing habitat.[204] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of May, June, July, August, September and October exceeds the temperature at which juvenile shortnose sturgeon habitat can become limited.[205]

Furthermore, acoustic tracking of tagged juvenile shortnose sturgeon indicate that juveniles are overwintering in the vicinity of SGS.[206] In the Delaware River, shortnose sturgeon overwinter from early November to mid-April. [207]

Life History – Adults

Shortnose sturgeon in the vicinity of SGS are likely to be using it for migration and for foraging.[208]

Foraging

Shortnose sturgeon are benthic feeders throughout their lives feeding on such prey as small bivalves, gastropods, polychaetes and small benthic fishes by filtering mud and food through their mouths.[209] Shortnose sturgeon prey is typically found within sandy-mud

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brevirostrum). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.

202 National Marine Fisheries Service. 1998. Recovery Plan for the Shortnose Sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 104 pages.

203 Endangered Species Act Section 7 Consultation Biological opinion. NOAA NMFS Greater Atlantic Regional Fisheries Office. Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581July 17, 2014.

204 National Marine Fisheries Service. 1998. Recovery Plan for the Shortnose Sturgeon (Acipenser brevirostrum). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 104 pages.

205 NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.

206 Endangered Species Act Section 7 Consultation Biological opinion. NOAA NMFS Greater Atlantic Regional Fisheries Office. Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581July 17, 2014.

207 Endangered Species Act Section 7 Consultation Biological opinion. NOAA NMFS Greater Atlantic Regional Fisheries Office. Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581July 17, 2014.

208 Endangered Species Act Section 7 Consultation Biological opinion. NOAA NMFS Greater Atlantic Regional Fisheries Office. Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581July 17, 2014.

209 Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser brevirostrum*). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.

bottoms.[210] Foraging in the Delaware River occurs year round, declining slightly in the winter months.[211] The majority of foraging within the Delaware River occurs after spawning (i.e. summer and early fall).[212] Shortnose sturgeon in the Delaware River use channels and shoals to forage.[213]

Overwintering

Overwintering usually occurs over sandy bottom habitats.[214] Adult shortnose sturgeon are likely to occur in the action area any time water temperatures are greater than 50°F (trigger for movement to overwintering sites) between April and November. [215] Overwintering occurs in the Delaware River from December to March.[216] Juvenile shortnose sturgeon tend to overwinter in a dispersed fashion rather than in dense aggregations like adults.[217]

Based on sensitivity to high water temperatures discharged from SGS (Tables 3 and 4), shortnose sturgeon juveniles have the known potential to be negatively impacted.

Despite the fact that the biological monitoring, consisting of seine sampling and bottom trawl sampling conducted since 1995, does not target the federally endangered shortnose sturgeon, PSEG contends that the numerous studies performed have demonstrated that the health of the Delaware Estuary has been improving for over thirty years. [218,219]

Atlantic Sturgeon (Acipenser oxyrhynchus)

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[210] Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser brevirostrum*). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.
[211] Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser brevirostrum*). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.
[212] Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser brevirostrum*). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.
[213] National Marine Fisheries Service. 1998. Recovery Plan for the Shortnose Sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 104 pages.
[214] Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser brevirostrum*). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.
[215] Endangered Species Act Section 7 Consultation Biological opinion. NOAA NMFS Greater Atlantic Regional Fisheries Office. Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581July 17, 2014.
[216] Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser brevirostrum*). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.
[217] Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser brevirostrum*). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.
[218] PSEG. Biological Monitoring Reports. 1995-2013.
[219] NJDEP. Draft Surface Water Renewal Permit Action. Category: B -Industrial Wastewater. NJPDES Permit No. NJ0005622. PSEG Nuclear LLC Salem Generating Station. Lower Alloways Creek Twp, Salem County. June 30, 2015.

Independent of an RIS analysis, any potential impact to a federally endangered species, such as the Atlantic sturgeon located in the Delaware River and potentially affected by the thermal plume of SGS, must be studied to assess and compensate for the potential take of the species. CEA conducted a thorough review of readily available literature regarding the federally endangered Atlantic sturgeon. Information, essential for understanding potential impacts to Atlantic sturgeon life stages caused by thermal discharges, is summarized in the following sections.

Endangered Species Act of 1973

The Atlantic sturgeon New York Bight (NYB) Distinct Population Segment (DPS) includes all Atlantic sturgeon that are spawned within the watersheds that drain to the Atlantic Ocean from Chatam, MA to the Delaware-Maryland border on Fenwick Island.[220] On February 6, 2012, the NYB DPS of Atlantic sturgeon was listed as endangered under the ESA (effective April 6, 2012) and as such, its protection and preservation fall under the following tenets of the Act.[221] "The purpose of the ESA is to protect and recover imperiled species and the ecosystem upon which they depend."[222] Being listed as an endangered species under the ESA means that a species is in danger of extinction throughout all or a significant portion of its range.[223] The ESA protects endangered and threatened species and their habitats by prohibiting the take of listed animals without a permit.[224] The NYB DPS Atlantic sturgeon are continually and significantly affected by degraded water quality, habitat impacts from dredging, continued bycatch in state and federally managed fisheries, vessel strikes and the lack of regulatory mechanisms to adequately address these threats.[225]

Life History - Spawning

[220] "Endangered and Threatened Wildlife and Plants; Threatened and Endangered Status for Distinct Population Segments of Atlantic Sturgeon in the Northeast Region". 77 Federal Register 24 (6 February 2012), pp. 5880-5912.
[221] "Endangered and Threatened Wildlife and Plants; Threatened and Endangered Status for Distinct Population Segments of Atlantic Sturgeon in the Northeast Region". 77 Federal Register 24 (6 February 2012), pp. 5880-5912.
[222] US Fish and Wildlife Service. ESA Basics: 40 years of Conserving Endangered Species. January 2013.
[223] US Fish and Wildlife Service. ESA Basics: 40 years of Conserving Endangered Species. January 2013.
[224] US Fish and Wildlife Service. ESA Basics: 40 years of Conserving Endangered Species. January 2013.
[225] "Endangered and Threatened Wildlife and Plants; Threatened and Endangered Status for Distinct Population Segments of Atlantic Sturgeon in the Northeast Region". 77 Federal Register 24 (6 February 2012), pp. 5880-5912.

Historically, the Delaware River supported the largest stock of Atlantic sturgeon along the Atlantic coast.[226] Now an endangered species, there are only two known spawning populations of the NYB DPS existing in the Hudson and the Delaware rivers with no indications of recovery.[227] It is believed that the Delaware spawning population is less than 300 spawning adults.[228] The Delaware River spawning population is smaller than that of the Hudson River and highly susceptible to any sources of anthropogenic mortality.[229]

As an anadromous fish, the Atlantic sturgeon spends most of its life at sea and enters freshwater estuaries to spawn.[230] The NYS DPS female Atlantic sturgeon reach sexual maturity between ages 15 and 30 years and male Atlantic sturgeon reach sexual maturity between the ages 8 and 20 years.[231] Atlantic sturgeon do not spawn every year, rather females spawn every 2 to 5 years and males every 1 to 5 years.[232] Male Atlantic sturgeon typically migrate upstream prior to spawning and reside there until fall, while female Atlantic sturgeon will enter the river to spawn and migrate back to sea shortly thereafter.[233] Likely spawning grounds for Atlantic sturgeon in the Delaware River reside between north Philadelphia, PA and Trenton, NJ in freshwater-tidal reaches.[234] Experts are now considering that there may also be a fall spawning season for Atlantic Sturgeon in the Delaware River.[235]

- Atlantic sturgeon within mid-Atlantic estuaries, including the Delaware River, migrate upriver to spawn between April and May.[236]
- Temperatures at which Atlantic sturgeon in the Delaware River spawn range from 55°F to 64°F which occurs between April and May.[237,238] The mean daily maximum

[226] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[227] "Endangered and Threatened Wildlife and Plants; Threatened and Endangered Status for Distinct Population Segments of Atlantic Sturgeon in the Northeast Region". 77 Federal Register 24 (6 February 2012), pp. 5880-5912.
[228] NOAA. Atlantic Sturgeon New York Bight Distinct Population Segment: Endangered. June 26, 2012.
[229] "Endangered and Threatened Wildlife and Plants; Threatened and Endangered Status for Distinct Population Segments of Atlantic Sturgeon in the Northeast Region". 77 Federal Register 24 (6 February 2012), pp. 5880-5912.
[230] Atlantic Sturgeon Status Review Team. 2007. Status Review of Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.
[231] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[232] Atlantic Sturgeon Status Review Team. 2007. Status Review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.
[233] Atlantic Sturgeon Status Review Team. 2007. Status Review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.
[234] Simpson, P.C., Fox, D.A. Atlantic Sturgeon in the Delaware River: contemporary population status and identification of spawning areas. 2007.
[235] Personal communication from Maya van Rostrum.
[236] Atlantic Sturgeon Status Review Team. 2007. Status Review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

temperature of both SGS's FAC A and FAC B effluent during the months of April and May exceeds the temperature range for Atlantic sturgeon spawning. [239]

Life History - Eggs

Atlantic sturgeon eggs are demersal and strongly adhesive to hard bottom habitats.[240]

- Optimal hatch temperature ranges from 64°F to 68°F. [241]

Life History – Larvae

Atlantic sturgeon yolk-sac larvae are pelagic for about the first ten days after hatching and are directly impacted by elevated surface water temperatures caused by SGS's effluent.[242] Late-stage larvae settle into a demersal habitat, the habitat they will embrace the remainder of their lives.[243]

- Post yolk-sac larvae optimal temperature for growth is 66°F.[244]

Life History – Juvenile

Juvenile Atlantic sturgeon are between the ages of 1 and 15 years.[245] Juveniles migrate downstream during winter months and upstream during summer months as temperatures fall and

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[237] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[238] USGS. USGS Monthly Statistics. USGS 01477050 Delaware River at Chester, PA. September 1, 2015.
[239] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[240] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[241] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[242] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[243] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[244] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[245] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.

rise, respectively.[246] Juveniles remain in their natal freshwater habitat for approximately one year and migrate seaward between the ages of 2 and 6 years.[247]

- Juvenile Atlantic sturgeon are demersal.[248] Juveniles could be present year round in the vicinity of SGS. [249]
- Juvenile Atlantic sturgeon exhibit a tolerable temperature range of 37°F to 82°F and an optimal temperature of 68°F.[250] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during May through October exceeds the tolerable temperature range and from April through November exceeds the optimum temperature range for Atlantic sturgeon juveniles.[251]
- Juveniles begin to migrate downstream when temperatures reach 68°F (mid-September). Migrations peaks when temperature drop between 54°F and 64°F (October).[252]

Despite the fact that the biological monitoring, consisting of seine sampling and bottom trawl sampling conducted since 1995, does not target the federally endangered Atlantic sturgeon, PSEG contends that the numerous studies performed have demonstrated that the health of the Delaware Estuary has been improving for over thirty years.[253,254] PSEG also contends that the long term trend data shows no decline in juvenile abundance that can be attributable to PSEG-Salem.[255] CEA finds it hard to make such assertions when, in fact, with regard to juvenile Atlantic sturgeon, the Delaware Division of Fish and Wildlife DNREC reported a trending

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[246] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[247] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[248] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[249] Endangered Species Act Section 7 Consultation Biological opinion. NOAA NMFS Greater Atlantic Regional Fisheries Office. Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581. July 17, 2014.
[250] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[251] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[252] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.
[253] PSEG. Biological Monitoring Reports. 1995-2013.
[254] NJDEP. Draft Surface Water Renewal Permit Action. Category: B -Industrial Wastewater. NJPDES Permit No. NJ0005622. PSEG Nuclear LLC Salem Generating Station. Lower Alloways Creek Twp, Salem County. June 30, 2015.
[255] NJDEP. Draft Surface Water Renewal Permit Action. Category: B -Industrial Wastewater. NJPDES Permit No. NJ0005622. PSEG Nuclear LLC Salem Generating Station. Lower Alloways Creek Twp, Salem County. June 30, 2015.

decline in late stage juvenile Atlantic sturgeon abundance in the Delaware estuary from 1991 through 2009 (Figure 5).[256]

Foraging

Atlantic sturgeon larvae become benthic feeders once the yolk sac is absorbed.[257] Post yolk-sac Atlantic sturgeon larvae remain benthic habitat feeders for the rest of their lives, eating by filtering mud and food.[258] In freshwater, juveniles eat plant and animal matter, sludge worms, chironomid larvae, may fly larvae, isopods, amphipods and small bivalve mollusks.[259] Juveniles compete with other demersal feeding species inclusive of catfish and white perch.[260] Studies have also indicated that Atlantic sturgeon consume mud while foraging within the benthic habitat.[261]

Overwintering

Juveniles that are not ready to leave their natal estuary may overwinter in deep holes and channels once the temperature drops to 68°F.[262]

Adults

Adult Atlantic sturgeon could be present year round in the vicinity of SGS. [263] Adults are likely to be present in the river from mid-April to mid-June. [264]

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[256] Fisher, Matthew T.; Delaware Division of Fish and Wildlife-Department of Natural resources and Environmental Control State of Delaware Annual Compliance Report for Atlantic Sturgeon; Submitted to the Atlantic States Marine Fisheries Commission Atlantic Sturgeon Plan Review Team; September 2009.

[257] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.

[258] Partnership for the Delaware Estuary. 2012. Technical Report for the Delaware Estuary and Basin. PDE Report No. 12-01. 255 pages. www.delawareestuary.org/science_programs_state_of_the_estuary.asp.

[259] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.

[260] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.

[261] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.

[262] Atlantic States Marine Fisheries Commission. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. January 2009.

[263] Endangered Species Act Section 7 Consultation Biological opinion. NOAA NMFS Greater Atlantic Regional Fisheries Office. Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581. July 17, 2014.

[264] Endangered Species Act Section 7 Consultation Biological opinion. NOAA NMFS Greater Atlantic Regional Fisheries Office. Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581. July 17, 2014.

Based on sensitivity to high water temperatures discharged from SGS (Tables 3 and 4), Atlantic sturgeon spawning, eggs, larvae and juveniles have the known potential to be impacted.[265] CEA finds it difficult to fully understand the impacts of SGS's CWIS on the federally endangered Atlantic sturgeon due to the lack of recent quantitative sampling and tracking data. As a number of Atlantic sturgeon in the Delaware River have been implanted with acoustic transmitters for tracking, PSEG must be required to monitor the yearly activities of the fish within and migrating through the vicinity of SGS to accurately assess population numbers of juvenile and mature sturgeon.[266]

Macroinvertebrates

Blue crab (Callinectes sapidus)

Female blue crabs only mate once in their lives and store the male's sperm for spawning at a later time.[267] Blue crab eggs and adults are demersal.[268]

- Spawning occurs from May through August.[269]
- Blue crab eggs hatch between temperatures of 77°F and 86°F.[270] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of May, June, July, August, September, and October exceeds the hatching temperature range for blue crab eggs.[271]
- Growth occurs when water temperatures are above 59°F.[272] An optimal temperature for juvenile growth has been reported as 73°F. The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the months of April, May, June, July,

[265] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[266] Delaware State University and University of Delaware Atlantic Sturgeon research.
[267] Zinski, Steven C. *BLUECRAB.INFO: The Blue Crab Archives*. Accessed May 23, 2012. Web. <http://www.bluecrab.info/>. 2006.
[268] Zinski, Steven C. *BLUECRAB.INFO: The Blue Crab Archives*. Accessed May 23, 2012. Web. <http://www.bluecrab.info/>. 2006.
[269] Zinski, Steven C. *BLUECRAB.INFO: The Blue Crab Archives*. Accessed May 23, 2012. Web. <http://www.bluecrab.info/>. 2006.
[270] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[271] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[272] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.

August, September, and October and from SGS's effluent for FAC A during November exceeds the optimal growth temperature for blue crabs.[273]

- According to PSEG, blue crab occur in the vicinity of SGS from mid-April through November.[274]
- Water temperature of 91°F is lethal to blue crabs.[275] The mean daily maximum temperature of SGS's effluent during the months of June, July, August and September exceeds the lethal temperature limit for blue crabs.[276]

Based on sensitivity to high water temperatures discharged from SGS (Tables 3 and 4), blue crab eggs and adults have the known potential to be impacted.[277] Based on the 2013 Biological Monitoring Report data, implementation of a closed cycle cooling system has the potential to reduce impingement and entrainment by 95% and protect the lives of approximately 79,590 impinged blue crab per year.

Opossum shrimp (Neomysis americana)

Juvenile and adult opossum shrimp are considered semi-planktonic and are directly impacted by elevated surface water temperatures caused by SGS's effluent. [278]

- According to PSEG, opossum shrimp occur in the vicinity of SGS from mid-April through mid-December.[279]
- Spawning of opossum shrimp can occur from approximately mid-March through December, although production is generally slow at temperatures lower than 59°F. [280]
- Maximum growth rates occur at approximately 77°F. [281] The mean daily maximum temperature of both SGS's FAC A and FAC B effluent during the

[273] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[274] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[275] PSEG Fossil LLC. Mercer Generating Station 316(a) Demonstration. November 2001.
[276] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[277] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[278] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[279] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[280] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[281] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.

months of May, June, July, August, September, and October exceeds the optimal growth temperature range for opossum shrimp.[282]

Based on sensitivity to high water temperatures discharged from SGS (Tables 3 and 4), opossum shrimp have the potential to be impacted.[283]

Scud (Gammarus spp.)

The term scud refers to members of the Class crustacae, Order amphipoda, Family gammarus.[284] Scud do not participate in a migration for mating and remain in the same habitat during growth and mating.[285] Mating can occur from late spring to fall months with water temperature being the deciding factor.[286]

- According to PSEG, scud occur in the vicinity of SGS from mid-March through mid-September.[287]

Based on sensitivity to high water temperatures discharged from SGS (Tables 3 and 4), scud have the known potential to be impacted.[288]

Global Warming

In assessing the BTA for SGS, consideration must be given to future impacts due to global warming. The predicted rise in ambient water temperatures will ultimately result in the need for more non-contact cooling water at the SGS. The relationship between the temperature of the incoming cooling water and the amount of cooling water required for non-contact cooling is not linear. This means that even a small rise in incoming ambient water temperature could result in a large increase in the amount of water required for non-contact cooling. The increased volume and flow of water moving through the once-through cooling system will result in increases of impingement and entrainment of aquatic organisms. Furthermore, the greater volumes of water would be discharged into the Delaware River resulting in larger thermal plumes. The plumes would have an increased cross-sectional area to allow for mixing and dissipation of high

[282] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[283] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.
[284] Chan, B. Fly Fisher's Republic. Freshwater Shrimp. July 19, 2006.
[285] Chan, B. Fly Fisher's Republic. Freshwater Shrimp. July 19, 2006.
[286] Chan, B. Fly Fisher's Republic. Freshwater Shrimp. July 19, 2006.
[287] Coutant, Dr. Charles C., Dr. E. Eric Adams. Appendix E. 316(a) Demonstration Study. PSE&G Renewal Application. Salem Generating Station. Permit No. NJ0005622. March 4, 1999.
[288] NJDEP Dataminer DMR data for Salem Generating Station 2000-2015.

temperature discharge water from the once-through cooling system. RIS species and the overall assemblage of aquatic species would be further impacted than they currently are due to greater early life stage mortality and further restrictions to fish passage.

The Incidental Take Statement (ITS) for the federally endangered shortnose sturgeon and Atlantic sturgeon completed in the 2014 BO highlights predicted environmental changes that have the potential to occur the Delaware River at SGS due to global warming.[289] The conditions noted by the 2014 BO include reduced river discharge and increase temperature. The 2014 BO states the following with regard to the predicted low flow and high temperature conditions:

"Shortnose sturgeon are tolerant to water temperatures up to approximately 28°C (82.4°F); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28°C are experienced in larger areas, sturgeon may be excluded from some habitats."

"Increased droughts (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all shortnose sturgeon life stages, including adults, may become susceptible to strandings. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing shortnose sturgeon in rearing habitat; however, this would be mitigated if prey species also had a shift in distribution or if developing sturgeon were able to shift their diets to other species."

"Atlantic sturgeon prefer water temperatures up to approximately 28°C (82.4°F); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28°C are experienced in larger areas, sturgeon may be excluded from some habitats."

[289] Endangered Species Act Section 7 Consultation Biological opinion. NOAA NMFS Greater Atlantic Regional Fisheries Office. Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581. July 17, 2014.

Increased droughts (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all Atlantic sturgeon life stages, including adults, may become susceptible to strandings or habitat restriction. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing sturgeon in rearing habitat." [290]

As the 2014 BO stated, river discharge and temperature can affect the seasonal and spatial distribution of fish species in the Delaware River. PSEG's analysis, which relies on very limited sturgeon sampling data, cannot accurately discern the interplay between sturgeon populations and weather events in the vicinity of SGS. PSEG must assess potential impacts to both Atlantic and shortnose sturgeon that takes into account the increased occurrence of low flow and high temperature that have the potential to impact sturgeon populations within the vicinity of SGS. As both Atlantic and shortnose sturgeon are federally endangered species, SGS must institute measures that address both below or above average flow and temperature scenarios within the Delaware River in the vicinity of SGS. They should be required to institute the BTA to ensure that the very limited numbers of both sturgeon population life stages are not impacted by impingement, entrainment or thermal plumes that are exacerbated by future river flow and water temperature conditions.

4.0 CONCLUSIONS

As SGS discharges to the Delaware River, an invaluable habitat to both RIS and two additional federally endangered fish species, the shortnose sturgeon (*Acipenser brevirostrum)* and the Atlantic sturgeon (*Acipenser oxyrinchus*), currently available data must be integrated into

[290] Endangered Species Act Section 7 Consultation Biological opinion. NOAA NMFS Greater Atlantic Regional Fisheries Office. Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581. July 17, 2014.

the BTA analysis to more accurately assess AEI. In addition, NJDEP must include additional provisions for reissuance of the permits involving CWIS, including details of appropriate operation and maintenance (O&M) of CWIS technologies and details of fish escape device O&M.

Reductions in AEI may be realized by seasonal flow reduction during periods when larval and juvenile aquatic species are present and most sensitive to impingement and entrainment. The move towards closed cycle cooling would provide up to 95% reductions in impingement, entrainment, and thermal discharges compared with other available CWIS technology and should not be overlooked as a viable alternative for maintaining the health and vitality of the federally endangered species and the fisheries in the Delaware River.

Review of the available reports submitted in support of the issuance of the NJPDES Permit for SGS reveals the need for a reevaluation and depiction of the hydrothermal modeling scenarios that accurately reflect potential plume effects with regard to DRBC Water Quality Standards and further evaluation of the impacts thermal discharges have on the life stages of the aquatic biota and the potential for fish passage specifically targeting the federally endangered Atlantic and shortnose sturgeon populations that are affected by SGS's thermal plume during different life stages.

Hydrological modeling scenarios for the thermal plume associated with once-through non-contact cooling water discharges must be reassessed to include a proper depiction and discussion of plume size, subsequent cross-sectional area calculations and associated near- and far-field assessment of pelagic and demersal RIS communities. DRBC's preexisting determination is over 20 years old and was initially issued on September 27, 1995 Docket No. D-68-20 CP (renewed in 1999 and 2001). The bulk of the temperature data and inputs used for the hydrothermal modeling are from 1968-1998. That means the data being relied on is over 18 years old and outdated, with the majority of field measurements taken over a two week period from May 21st to June 4th 1998. DRBC must request an updated 316(a) characterization and hydrothermal assessment, inclusive of a biothermal assessment, of SGS's thermal discharge utilizing updated field measurements and modeling to evaluate and accurately characterize the current extent and subsequent impacts of SGS's thermal plume on the Delaware River and populations of resident and migratory aquatic species. DRBC cannot issue a continued variance for a heat dissipation area of up to 7 times the mandated water quality guidelines based on such outdated data.

We believe that the reissuance of the NPDES permit must be tied to a new hydrothermal assessment that provides updated measured and modeled surface, sub-surface and cross-sectional data analyses that accurately depict current conditions and impacts to resident and migratory aquatic species of the Delaware River. Additionally, a more targeted impact study based on historic and currently available data for the Atlantic and shortnose populations of the Delaware River fishery within the vicinity of the SGS, and an examination of AEI associated with impingement, entrainment, and thermal discharges of all RIS species that together or separately ensure a BIP, must be considered prior to final decision of permit issuance.

TABLES

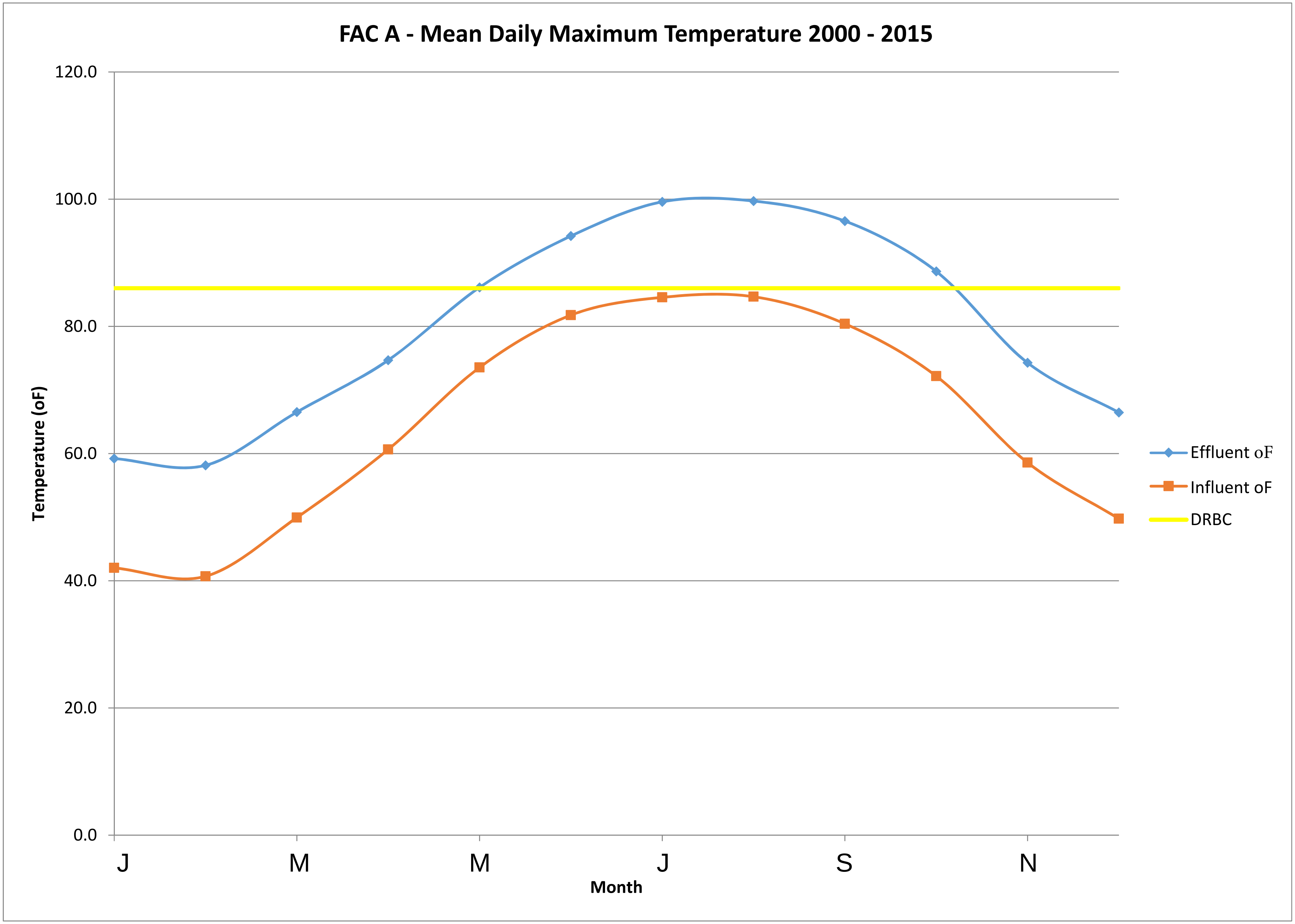
Table 1 - Estimated Number of Finfish and Blue Crab Lost Due to Impingement				
Fish Protection Technology	**Total Impingement Finfish - Sampled**	**Total Finfish Impinged in 2013**	**Total Impingement Blue Crab - Sampled**	**Total Blue Crab Impinged in 2013**
Existing 0.125 by 0.5 in Traveling Mesh Screen	60,004	19,000,000	4,988	1,600,000
Closed Cycle Cooling System		950,000		80,000

Table 2 - Estimated Number of Life Stages Lost Due to Entrainment								
Fish Protection Technology	**Total Entrainment Eggs - Sampled**	**Total Eggs Entrained in 2013**	**Total Entrainment Larvae - Sampled**	**Total Larvae Entrained in 2013**	**Total Entrainment Juveniles - Sampled**	**Total Juveniles Entrained in 2013**	**Total Entrainment Adults- Sampled**	**Total Adults Entrained in 2013**
Existing 0.125 by 0.5in Traveling Mesh Screen	45,018	1,900,000,000	33,546	1,400,000,000	7,999	330,000,000	82	3,400,000
Closed Cycle Cooling System		95,000,000		70,000,000		16,500,000		170,000

Table 3 - Salem Generating Station - DMR Intake & Effluent Temperature Data 2000-2015 - FAC A					
	Mean Monthly Average		Mean Daily Max		Standards
Month	Intake T (°F)	Effluent T (°F)	Intake T (°F)	Effluent T (°F)	DRBC Max T (°F)
January	38.1	54.4	42.0	59.2	86
February	37.7	54.1	40.7	58.2	86
March	44.2	59.7	49.9	66.5	86
April	54.4	66.8	60.6	74.7	86
May	65.9	78.9	73.5	**86.1**	86
June	76.0	**90.4**	81.8	**94.2**	86
July	81.8	**95.6**	84.6	**99.6**	86
August	81.8	**96.3**	84.7	**99.7**	86
September	75.9	**90.8**	80.4	**96.6**	86
October	65.3	77.6	72.2	**88.6**	86
November	53.3	67.9	58.6	74.3	86
December	43.6	59.0	49.8	66.5	86
Source: NJDEP Dataminer DMR data for Mercer Generating Station, July 2000 - June 2015					
Note: NJDEP Dataminer contained no data for the time period May 2014 through April 2015					
Note: Bolded effluent temperatures exceed the DRBC Regulations Maximum Temperature					

Table 4 - Salem Generating Station - DMR Intake & Effluent Temperature Data 2000-2015 - FAC B					
	Mean Monthly Average		Mean Daily Max		Standards
Month	Intake T (^oF)	Effluent T (^oF)	Intake T (^oF)	Effluent T (^oF)	DRBC Max T (^oF)
January	38.1	54.1	42.0	59.2	86
February	37.7	53.7	40.7	57.6	86
March	44.2	59.3	49.9	66.2	86
April	54.4	67.2	60.6	74.1	86
May	66.3	79.6	72.1	**88.1**	86
June	76.0	**90.7**	80.6	**95.7**	86
July	81.8	**95.9**	84.6	**99.8**	86
August	81.8	**96.4**	84.7	**99.4**	86
September	75.9	**91.0**	80.4	**96.5**	86
October	65.0	78.5	72.2	**89.0**	86
November	53.3	66.7	58.6	72.9	86
December	43.6	59.4	49.8	67.1	86
Source: NJDEP Dataminer DMR data for Mercer Generating Station, July 2000 - June 2015					
Note: NJDEP Dataminer contained no data for the time period May 2014 through April 2015					
Note: Bolded effluent temperatures exceed the DRBC Regulations Maximum Temperature					

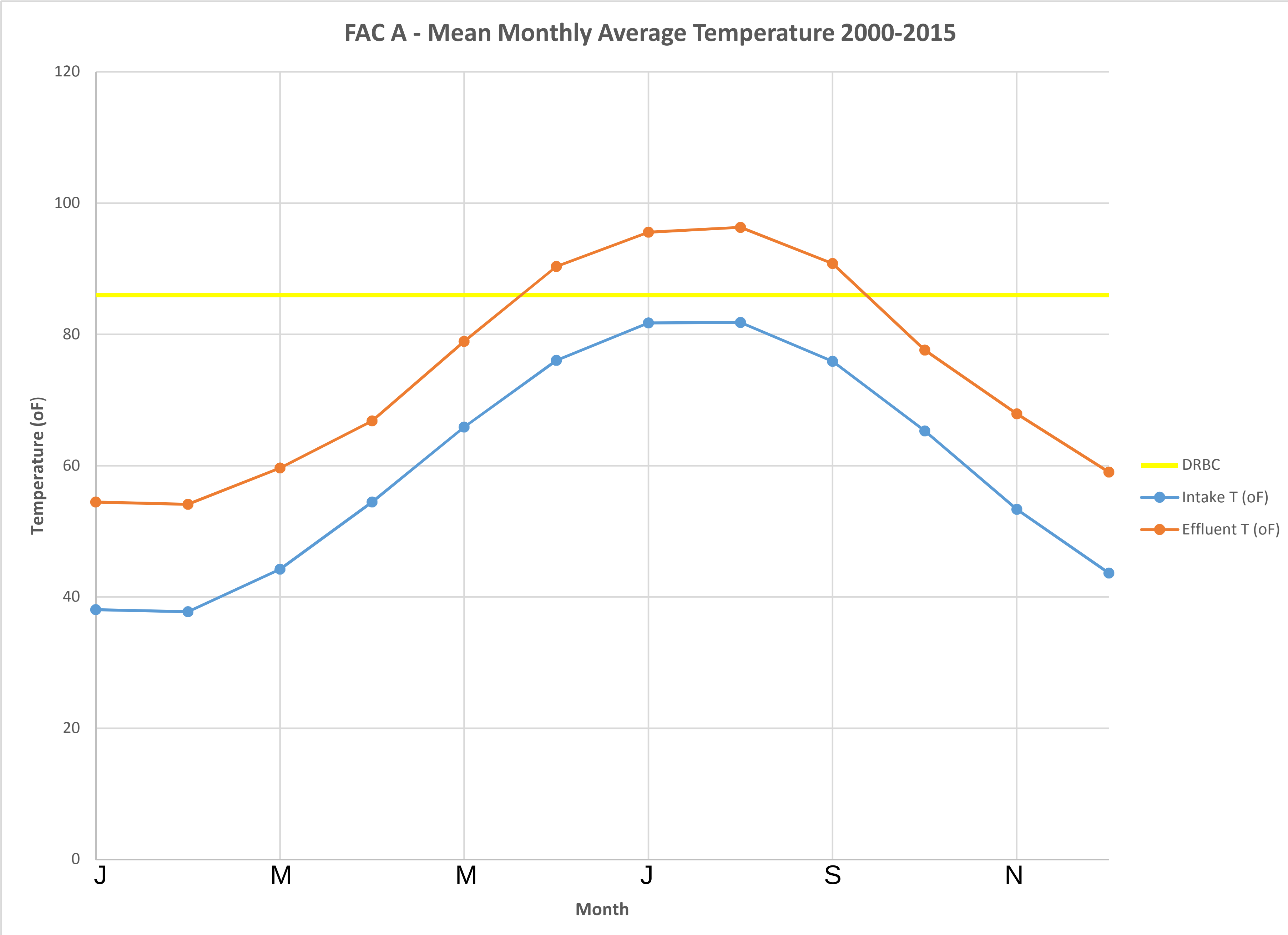
FIGURES



CARPENTER ENVIRONMENTAL ASSOCIATES, Inc.
CEA ENGINEERS, P.C.

CEA #21527

Figure 1



CARPENTER ENVIRONMENTAL ASSOCIATES, Inc.
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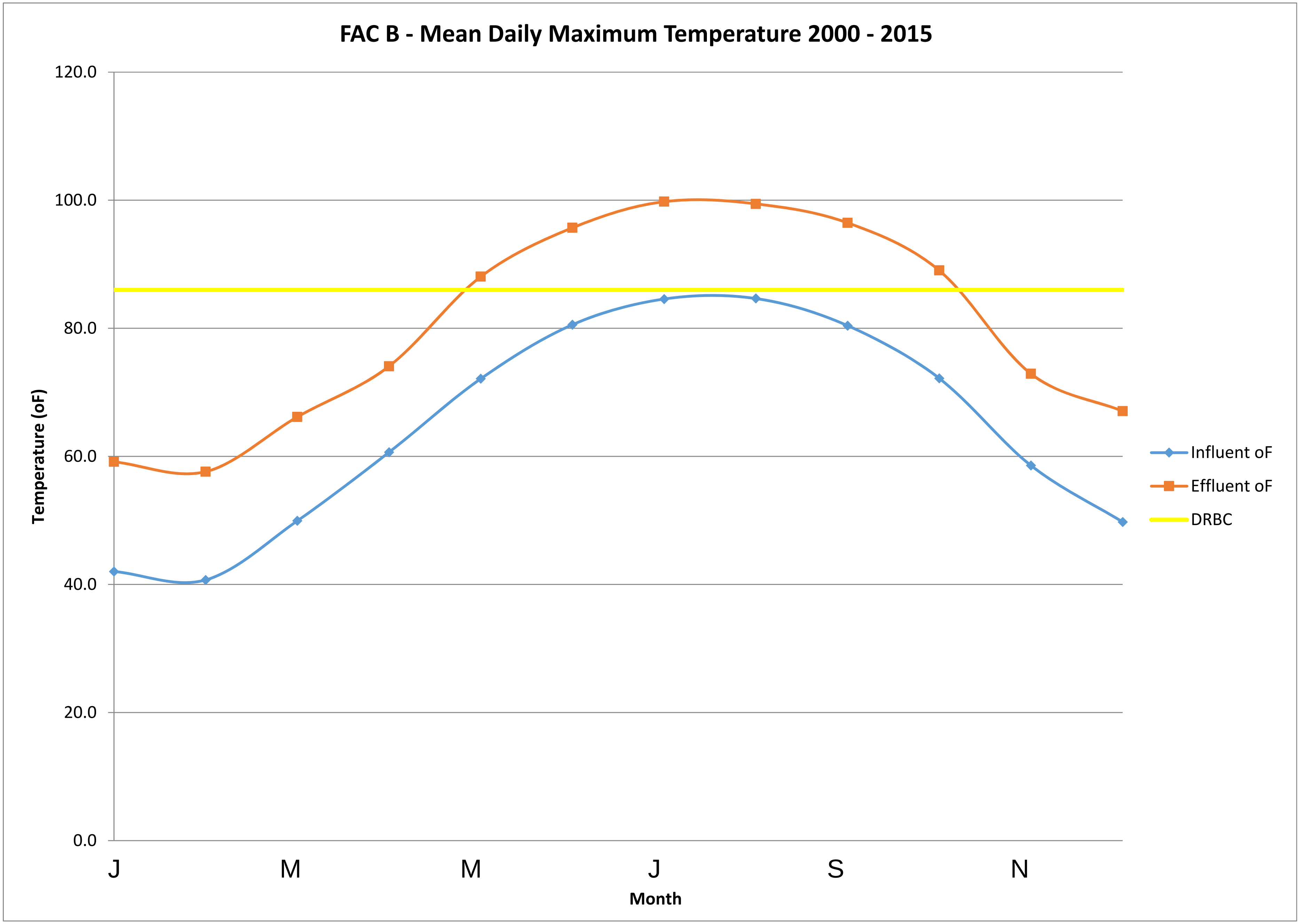
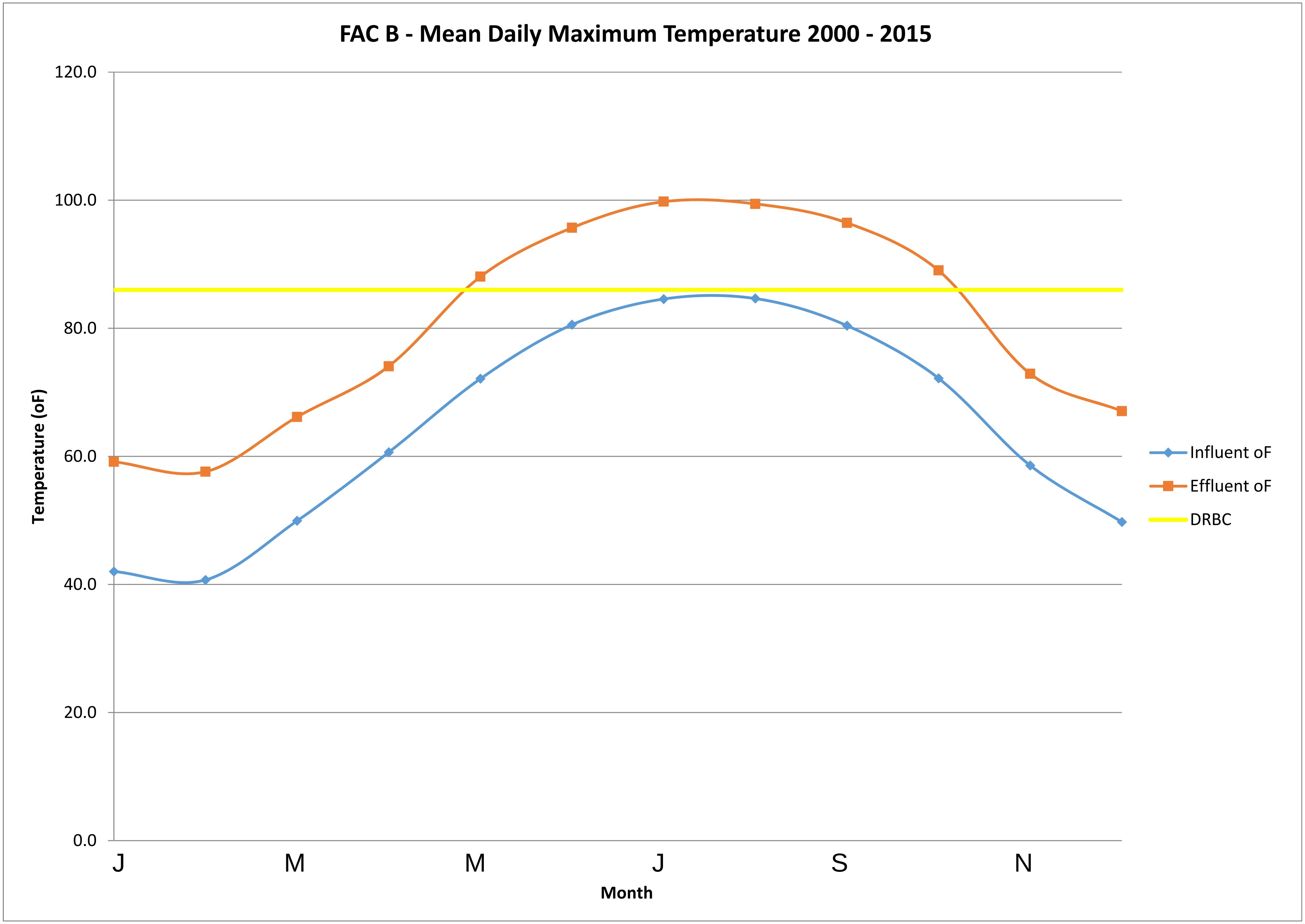
Figure 2



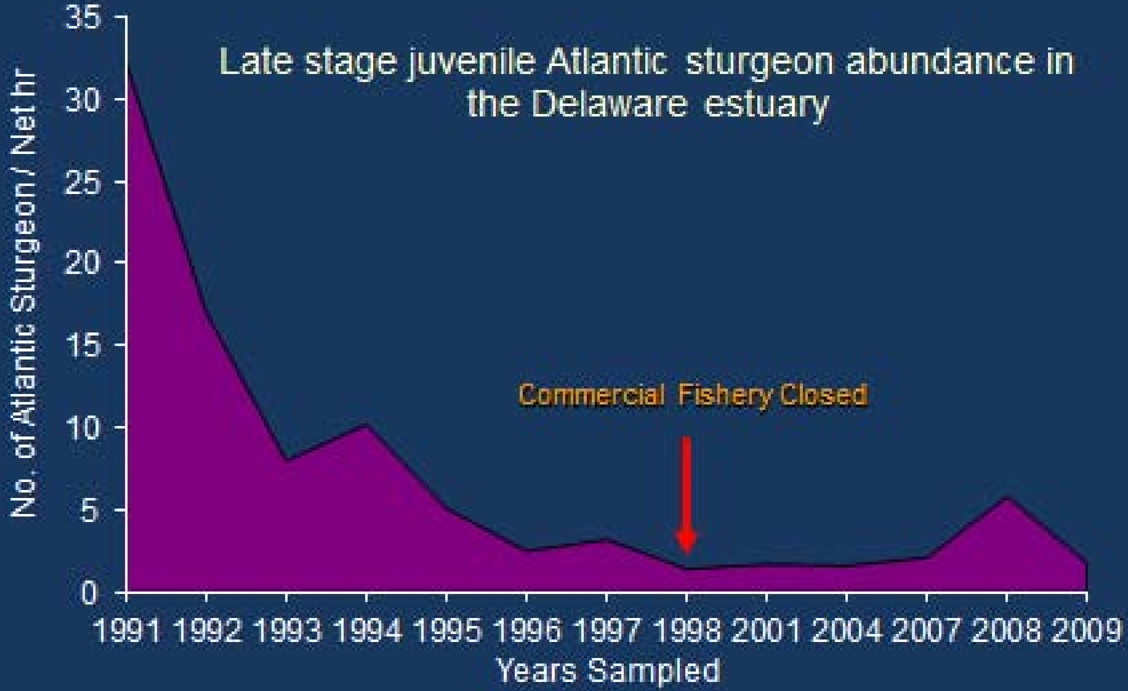
CEA #21527

Figure 3



CEA #21527

Figure 4



Late stage juvenile Atlantic sturgeon abundance in the Delaware estuary
No. of Atlantic Sturgeon / Net hr
35
30
25
20
15
10
5
0
Commercial Fishery Closed
1991 1992 1993 1994 1995 1996 1997 1998 2001 2004 2007 2008 2009
Years Sampled

Figure 5

APPENDIX A

RALPH E. HUDDLESTON, JR.

EDUCATION

- Eastern Kentucky University: Master of Science, Fisheries Biology, 1982
- University of Louisville: Bachelor of Arts, Biology, 1976

CONTINUING PROFESSIONAL EDUCATION

- Rutgers University: Coastal Vegetation Identification
- Methodology of Delineating Wetlands
- Advanced Wetland Delineation
- Wetland Systems of the Northeast

AFFILIATIONS

- American Fisheries Society
- Society of Wetland Scientists

EXPERTISE

- Wetlands and Ecological Investigations
- Delineation
- Enhancement and creation studies
- Permitting, stream sampling and analysis
- Natural Resource Inventories
- Litigation Support

SKILLS AND EXPERIENCE

Ralph E. Huddleston, Jr., has over 30 years of experience in the wetlands and environmental permitting industry. His areas of expertise include environmental impact assessment; wetland delineation, enhancement and creation; flora and fauna studies; natural resource inventories; and environmental permitting. He regularly provides expert witness testimony in the environmental and biological sciences in local, state and federal courts.

REPRESENTATIVE PROJECTS

COOLING WATER INTAKE STRUCTURES

Proposed Athens Generating Project Evaluation, Riverkeeper Inc./Scenic Hudson, Athens, New York.

A new electric generating station was proposed for construction along the Hudson River. Mr. Huddleston assessed the environmental impacts of the proposed facility on the Hudson River, particularly its fisheries. Mr. Huddleston also evaluated the proposed cooling water intake structures for the facility in relation to the Clean Water Act requirement that CWIS reflect the best technology available (BTA) for minimizing environmental impacts. Mr. Huddleston provided testimony at an administrative hearing on the expected adverse impacts of the facility on the Hudson River fisheries, as well as the proposed CWIS.

Fish Entrainment Prevention Barrier Evaluation, Riverkeeper, Inc., Stony Point, New York.

Riverkeeper, Inc. initiated litigation against Orange and Rockland Utilities (O&R) alleging that the cooling water intake structure (CWIS) at the Lovett Generating Station (Lovett) did not reflect best technology available for minimizing adverse environmental impacts as required by the Clean Water Act. A Federal court mandated that Lovett mitigate the CWIS to attain acceptable environmental impact levels. Mr. Huddleston served as a technical advisor to Riverkeeper, Inc. throughout the installation, removal, and performance of the mitigative measures at Lovett. Mr. Huddleston identified several issues of concern, including the high potential for impingement and entrainment of fish larvae and eggs. The issues of concern must be addressed prior to support of the mitigative measures at the Lovett facility.

In the Matter of Mirant Bowline, LLC for a State Pollutant Discharge Elimination System Permit pursuant to Environmental Conservation Law Article 17 and Title 6 of the

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Telephone: (845) 554-6337

Official Compilations of Codes, Rules & Regulations of the State of New York (6NTCRR) Parts 750 et seq., Riverkeeper, Inc. Haverstraw, New York.
The Bowline Generating Station (Bowline 3) proposed the construction of a new unit along the Hudson River with a hybrid cooling and filter fabric Gunderboom around the water intake structure. The Clean Water Act (CWA) requires that cooling water intakes reflect the Best Available Technology (BAT) for minimizing adverse environmental impacts. Mr. Huddleston determined that the Gunderboom was an experimental technology and not a BAT. Mr. Huddleston also directed in-river experiments that were conducted to determine whether the Gunderboom would be subject to clogging by organisms. Mr. Huddleston provided testimony at an administrative hearing, and ultimately the Administrative Law Judge determined that the Gunderboom could not be considered a BAT.

Salem Generating Station Cooling Water Intake Structure Evaluation, Delaware Riverkeeper Network, Salem, New Jersey.
Mr. Huddleston reviewed Salem's permit application, New Jersey Pollutant Discharge Elimination System (NJPDES) permit, and conducted a Best Technology Available (BTA) analysis. Mr. Huddleston determined that each of the technologies designated as BTA by the NJDEP could only serve to reduce fish mortality associated with impingement, while over 99% of fish losses at Salem were associated with entrainment. His conclusions that the intake flow of the facility must be reduced in order to minimize fish entrainment resulted in a recommendation for a closed-cycle cooling system at the Salem facility. Mr. Huddleston prepared comments to the NJDEP detailing the deficiencies in the draft NJPDES permit and Salem's BTA analysis.

Salem Generating Station Wetland Restoration Program Evaluation, Delaware Riverkeeper Network, Salem, New Jersey, Delaware Estuary.
Under a grant received from the United States Environmental Protection Agency (EPA) to evaluate the effectiveness of the wetland restoration and enhancement program in and around the Delaware Estuary, Mr. Huddleston evaluated data provided by PG&E regarding the response of vegetation to PG&E's wetland restoration/enhancement efforts that included restoring the tidal influence to salt hay farms and treatment of Phragmites dominated wetlands to reduce Phragmites densities. Mr. Huddleston also evaluated the possible increase in fish migration and spawning as a result of the installation of fish ladders in tributaries to the Delaware Estuary. He determined that there was little benefit from

Phragmites removal, but vegetation and fish responded positively to mitigation at the former salt hay farm sites. There was no evidence in an Estuary-wide increase in fish populations as a result of the restoration and enhancement program.

Trout Unlimited Catskill Mountain Chapter and Theodore Gordon Flyfishers, et. al. v. The City of New York et. al., Trout Unlimited Catskill Mountain Chapter and Theodore Gordon Flyfishers, Catskill Region, New York.

Trout Unlimited Catskill Mountain Chapter and Theodore Gordon Flyfishers brought a Clean Water Act (CWA) citizen suit against The City of New York for discharge without a permit into the Shandaken Tunnel. The Shandaken Tunnel discharges to Esopus Creek, a well known trout fishery in a separate watershed. The discharge from the City of New York resulted in highly turbid water being discharged into Esopus Creek resulting in a dimished trout fishery. Mr. Huddleston provided litigation support to Trout Unlimited during trial after initial negotiations with New York City were unsuccessful. He presented an opinion based upon historical documentation that flows from the Shandaken Tunnel were critical to the sport fishery of Esopus Creek as claimed by the City. The United States District Court ruled that the City was liable for violations of the CWA for operating the Tunnel without a permit. The Court also assessed penalties and ordered the City to obtain a permit in a timely fashion. The New York State Department of Environmental Conservation (NYSDEC) was ordered to issue a NPDES permit within 18 months. The draft permit was issued and Mr. Huddleston assisted in the preparation of comments to the NYSDEC regarding the lack of enforceable permit conditions for turbidity.

WETLANDS

Chester Industrial Park, Wetland Habitat Restoration. Chester, New York.

As part of a negotiated settlement of a Notice of Violation (NOV) with the New York State Department of Environmental Conservation (NYSDEC), Mr. Huddleston investigated the historical delineation of the wetlands and designed a wetland restoration plan to address 10 acres of concern. After the NYSDEC approval of the plan, Mr. Huddleston oversaw the successful implementation of the restoration effort that included site grading, stormwater management, construction and planting of the wetlands, three years of status reporting, and maintenance recommendations. His efforts resulted in a successful settlement of all outstanding issues and the creation of 10 acres of functional and mapped NYSDEC freshwater wetlands.

Wetlands Delineation/Mitigation, Richmond Valley Estates. Staten Island, New York.
The NYSDEC issued a NOV for the non-permitted clearing of vegetation and earth within regulated freshwater wetland and wetland adjacent area. Mr. Huddleston delineated on-site wetland boundaries to determine the extent of clearing and excavation activities within regulated wetland and adjacent areas. Mr. Huddleston worked directly with the NYSDEC to develop a mitigation plan t. Mr. Huddleston oversaw the implementation of the approved mitigation plan. After one year, the plan was deemed successful, and the violation was closed.

Toys "R" Us Distribution Center. Henry County, Georgia.
Mr. Huddleston delineated on-site wetlands for a one-million-square-foot distribution center proposed on a 157-acre site. . Mr. Huddleston oversaw the design of an 8.75-acre mitigation area/stormwater detention basin for the establishment of new wetlands. The design minimized the disturbance to the on-site wetlands while assuring that usable site area was maximized. In addition to providing new wetlands to offset disturbed wetlands, the mitigation design also provided required stormwater control. CEA prepared and submitted applications for submittal to the Georgia Environmental Protection Division (GAEPD). GAEPD expedited the review and approval of the required Nationwide Permit #26 and a Georgia Stream Encroachment Permit applications.

Waterfront Commons Mitigation Design. Staten Island, New York.
Mr. Huddleston was responsible for overseeing the development of a 4.8-acre wetland mitigation design in conjunction with an Army Corps of Engineers (ACOE) Individual Permit and NYSDEC Tidal Wetlands Permit. The mitigation involved the creation and enhancement of tidal and freshwater wetlands within a 30-acre parcel containing coastal upland, historically disturbed, freshwater wetlands and tidal wetland communities along the Arthur Kill.

Wetland Permitting/Mitigation, C & S Grocers. Chester, New York.
Mr. Huddleston directed efforts for obtaining an ACOE Nationwide Permit and NYSDEC Freshwater Wetlands Permit in conjunction with a warehouse expansion project. The permit

application process included conducting wetland delineations and preparing a wetland mitigation plan. The mitigation plan was designed for the enhancement of adjacent freshwater wetlands associated with historically disturbed, fallow agricultural land. The mitigation plan and the permit application were approved, and the permits were issued for the expansion.

Wetland Permitting, The Shoppes at Union Square. Newburgh, New York.
Mr. Huddleston supervised the preparation of NYSDEC Protection of Waters Permit and ACOE Nationwide Permit applications in conjunction with a stream crossing for a commercial development. The permit application process included conducting a freshwater wetland delineation, a Phase I Bog Turtle site assessment and agency negotiations. Mr. Huddleston worked with the project architects to minimize any potential impacts to the stream and associated wetlands. The project is currently under review.

Wetland Delineation/Mitigation, Proposed Motorsports Entertainment Facility and Retail Center. Staten Island, New York.
Mr. Huddleston supervised coordination efforts with the multi-disciplinary project team to delineate tidal and freshwater wetlands, assess site flora and fauna, and design mitigation plans for a 675-acre parcel in Staten Island, New York. Mr. Huddleston contributed to the composition of environmental impact statements prepared for the proposed facility. He also provided project planning assistance to counsel and played an integral role in agency negotiations to obtain required NYSDEC and ACOE Permits.

Seton Hall Prep, Old Growth Forest Survey. Essex County, New Jersey.
Mr. Huddleston oversaw the development and implementation of field protocols to conduct a survey to determine the presence of old growth forest within a 45-acre parcel. Survey methodologies included the use of grid sampling to assess vegetative strata and clinometer measurements to determine the presence/absence of specimen trees.

ECOLOGICAL ASSESSMENTS

Scenic Development Natural Resource Inventory. Ramapo, New York.

Mr. Huddleston oversaw the design and implementation of a natural resource inventory for the characterization of ecological communities within a 200-acre parcel. Site surveys were conducted over four seasons to assess the native flora and fauna, as well as the presence of threatened and endangered species. Mr. Huddleston directed the composition of the wetland and wildlife sections incorporated into a Draft Environmental Impact Statement (DEIS).

Tetz Asphalt Plant Draft Environmental Impact Statement (DEIS) Review, International Union of Operation Engineers. Middletown, New York.
The Tetz Concrete and Gravel facility proposed the expansion of the current operation to include an asphalt plant. Mr. Huddleston reviewed and evaluated the DEIS under the New York State Environmental Quality Review Act (SEQRA). He determined that the DEIS was incomplete and could not be used as a basis for decisions regarding the environmental impacts for the proposed asphalt plant. Mr. Huddleston prepared comments for submission to the Middletown Planning Board and the US Army Corps of Engineers ACOE, and he also provided oral and written testimony to the local planning board. The ACOE issued a wetlands violation notice to the applicant, and the planning board denied the expansion.

LITGATION SUPPORT

General Electric (GE) Westchester County Hanger Environmental Assessment Form (EAF) Review, Hudson Riverkeeper Inc. Westchester County, New York.
GE proposed the construction of a 75,000-square foot airplane hanger at the Westchester County Airport. Mr. Huddleston reviewed GE's EAF and supporting materials for completeness and adherence to applicable regulations and standards under the SEQRA. After review of the EAF, he determined that the project could have the potential to significantly impact the Kensico Reservoir. The EAF also failed to provide mitigation for wetland disturbances and contained no Stormwater Pollution Prevention Plan (SWPPP). Mr. Huddleston provided litigation support during the lawsuit brought against the Westchester County Legislature for inadequate environmental assessment. The State Supreme Court ruled that the Westchester County Legislature failed to conduct a complete environmental assessment of the effects of the proposed hanger, and they mandated that additional studies be conducted. GE ultimately abandoned the project.

American Canoe Association; Professional Paddlesports Association; Conservation Council of North Carolina; United States of America v. Murphy Farms, Inc., d/b/a Murphy Family Farms and D.M. Farms of Rose Hill, L.L.C., US District Court for the Eastern District of North Carolina Southern Division, 7-98-CV-4-V(1); 7-98-CV-19-F(1); & 5-98-CV-209-F(1).
Mr. Huddleston provided litigation support to the American Canoe Association and US Department of Justice (USDOJ) in a Clean Water Act (CWA) Citizen Suit against five-related hog Confined Feeding Operations (CAFOs) in Rose Hill, North Carolina, that allegedly discharged swine wastes to waters of the US without a National Pollutant Discharge Elimination System (NPDES) Permit. Mr. Huddleston assisted in the evaluation of Murphy's waste management practices and demonstrated that Murphy failed to prevent or mitigate discharges of hog waste to waters of the US. The substance of the suit was settled after the 4th Circuit ruled that a NPDES Permit was required.

New York City Bluebelt Proceedings, The City of New York Law Department, Staten Island, New York.
The city of NY initiated the acquisition of approximately 130 properties located on Staten Island to form a "Bluebelt" of protected wetlands. Mr. Huddleston supervised the analysis and preparation of reports detailing the development potential of each property in the City's Bluebelt eminent domain proceedings based on the interpretation and application of wetland, wetland adjacent area, and zoning regulations. These reports were used by the city's appraiser to determine a fair market value for each property. Mr. Huddleston also provided expert witness testimony during trials.

PUBLICATIONS

1. Bell, B., R. Cardenas, R. Huddleston, and R. Martin, *Procedure for Evaluation of the Impact of Intermittently Discharged Industrial Wastes on Municipal Treatment Facilities*, In: Industrial Wastes, J. Alleman and J. Kavanaugh, Eds., Ann Arbor Science Publishers, Ann Arbor, MI, 1982.

2. Cardenas, R., and R. Huddleston, *Toxicity of Heavy Metals in Anaerobic Digestors*, Presented at the WPCF National Meeting, 1978, In: Proceedings.

APPENDIX B

COURT	TYPE	ACTION NO.	YEAR
United States District Court Southern District of New York	Affidavit	91 Civ. 8688 (GLG)	1993
Supreme Court of the State of New York, County of Albany	Deposition Testimony	01-02-ST-3754	1995
NYSDEC Region 2 Wetlands Appeal Board	Testimony		1996
U.S. District Court for the Eastern District of North Carolina Southern Division	Deposition Testimony	7-98-CV-4-V(1)	1998
State of New York, New York State Board on Electric Generating Siting and the Environment	Testimony	97-F-1563	1999
Supreme Court of the State of New York, County of Richmond (Sitting in County of Kings)	Testimony	2757-94	1999
NYSDEC, New York State Board on Electric Generation Siting and the Environment	Testimony	99-F-1164	2001
State of Florida Division of Administrative Hearings	Deposition Testimony	01-1949/01-0772	2001
United States District Court Southern District of New York	Deposition Testimony	)4 Civ. 2741 (WWC	2001
U.S. District Court, District of Columbia	Deposition Testimony	1:00CV02827	2001
U.S. District Court, S.D.N.Y.	Deposition Testimony	00 Civ. 5395 (JSM)	2002
United States District Court Northern District of New York	Deposition Testimony	00-CV-511 (FJS/RFT)	2002
Texas State Office of Administrative Hearings	Deposition Testimony	582-09-3322	2009
Supreme Court of the State of New York, County of Richmond	Testimony	(CY) 4004/08	2011
Supreme Court of the State of New York, County of Queens	Testimony	18025/07	2011

APPENDIX C

Appendix C - References Relied Upon

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Attachment 4

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