POSITION PAPER ON OYSTER CREEK NUCLEAR GENERATION STATION'S COOLING WATER SYSTEM

Presented by
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Clean Ocean Action is a broad-based coalition of over 170 conservation, environmental, fishing, boating, diving, student, surfing, women's, business, service, and community groups. Our goal is to improve the degraded water quality of the marine waters off the New Jersey/New York coast. Clean Ocean Action (hereinafter "COA") identifies sources of pollution and mounts attacks on each source by using research, public education, and citizen action to convince our public officials to enact and enforce measures that will clean up and protect our ocean.[3]

The reasons against re-licensing are numerous, including inappropriate location, aging and degrading infrastructure, and problematic storage capabilities – issues that our colleagues are currently analyzing. However, given our mission, Clean Ocean Action's current focus is on the marine degradations caused by the plant.

An immediate and significant issue for the marine environment, linked to the re-licensing, is the renewal of the required pollution discharge permit. Oyster Creek Nuclear is currently operating under a New Jersey Pollution Discharge Elimination System permit (hereinafter "NJPDES permit") that expired in 1999 and has been "administratively extended" by the NJ Department of Environmental Protection (hereinafter "NJDEP"). This permit, originally issued in 1994, is outdated (to say the least) and results in significant harm to the marine environment. Fortunately, new Phase II regulations require implementation of the "***best*** *technology available to minimize the adverse environmental impact*."[4] Revising the plant's NJPDES permit to comply with Phase II regulations offers one of the most important opportunities to improve Barnegat Bay.

NJDEP is currently drafting a new NJPDES permit, which will implement the new Phase II regulations. This draft permit must be evaluated and viewed as an essential, rare opportunity to substantially improve the marine environment of Barnegat Bay. COA will analyze and comment on the permit application and will work to ensure that the new permit is consistent with federal

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and state laws, and adequately resolves OCNGS' current marine degradation issues, especially those related to the antiquated once-through cooling system.

Put simply, once through cooling water systems cause substantial negative impacts to waterways. OCNGS' current cooling water intake structure causes severe adverse effects on the Barnegat Bay marine environment due to impingement, entrainment, thermal discharge, and chlorination. These impacts, which can be substantially minimized by installing a closed-cycle cooling system, are described below.

From the outset, it is important to note, that an extensive scientific literature review has revealed that all available data on impingement and entrainment at the plant are the result of studies performed and/or funded by the Oyster Creek Nuclear Generating Station.

Impacts of Oyster Creek Nuclear Generating Facility on Aquatic Organisms

OCNGS currently operates using a once-through cooling system in which approximately 1.4 billion gallons of water passes through daily.[5] OCNGS discharges more water into Barnegat Bay than any other industrial or commercial user.[6] Water is drawn into the plant via the Forked River (Intake Canal) and released via Oyster Creek (Discharge Canal), which drains into Barnegat Bay.[7] Both the river and creek were dredged and the flow of the southern portion of Forked River was actually reversed to accommodate the water needs of the plant.[8] The activities of the plant change the salinity, water temperature and dissolved oxygen levels in and around the facility and release radionuclides that can be detected all the way up the food web.[9] Specific environmental impacts related to the intake and discharge canals follow. The intake canal produces significant flow velocities depending on the number of circulating pumps in operation.[10] The consequence is both impingement and entrainment of aquatic organisms.

Impingement Impacts:

Impingements occur when organisms are too large to pass through the 9.5mm screens and are trapped against the trash racks and intake screens from the force of the water being pumped from the intake canal.

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[5] Assessment of the Impacts of the Oyster Creek Nuclear Generating Station on Kemp's Ridley (*Lepidochelys kempii*), Loggerhead (*Caretta caretta*), and Atlantic Green (*Chelonia mydas*) Sea Turtles. (December 2004), NRC PDR ML# 050060037.

[6] M.J. Kennish, M.B. Roche and T.R. Tatham (1984) Anthropogenic effects on aquatic organisms. In: M.J. Kennish and R.A. Lutz (eds), *Ecology of Barnegat Bay, New Jersey*. NY: Springer-Verlag, pp. 318-338.

[7] M.J. Kennish, (2001) State of the Estuary and Watershed: An Overview. Journal of Coastal Research. SI 32: 243-273.

[8] *Id*.

[9] *Id.*

[10] Assessment of the Impacts of the Oyster Creek Nuclear Generating Station on Kemp's Ridley (*Lepidochelys kempii*), Loggerhead (*Caretta caretta*), and Atlantic Green (*Chelonia mydas*) Sea Turtles. (December 2004), NRC PDR ML# 050060037.

1) Plant records indicate 32 impingement and 14 mortalities of endangered sea turtles since 1992.[11] These data include the following species specific incidents:
   a) 21 impinged Kemp's Ridley Sea Turtles with 9 mortalities.
   b) 7 impinged Loggerhead Sea Turtles with 2 mortalities.
   c) 4 impinged Green Sea Turtles with 1 mortality.

   OCNGS exceeded their annual incidental take in 2004 when 8 juvenile Kemp's Ridley Sea Turtles were impinged and 3 were killed in the 3 month period from July 4 to September 23. An Incidental Take Assessment by the National Marine Fisheries authorized an annual limit of 4 Kemp's Ridley's (with no more than 3 mortalities), 5 Loggerheads (with no more than 2 mortalities) and 2 Green's (no more than 1 mortality).[12]
2) A study conducted from September 1975 through August 1977 reported impingement of 13 million fish and invertebrates during this period.[13]
3) A second study conducted from November 1984 through December 1985 reported impingement of 22 million fish and invertebrates (with 7 million impinged in December 1985 alone).[14]

Entrainment Impacts:

Entrainments occur when small organisms pass through the 9.5mm screens and enter the cooling system. These smaller organisms generally consist of plankton and fish and invertebrates in the many early life stages. The facility increases water usage (and thus flow) during the summer months, which coincides with peak concentrations of eggs, larvae and plankton in the water column.[15] A study conducted from September 1975 through August 1977 reported 9.19×10^{13} microzooplankton (<500 μm in size including several species of copepods and clam, snail, worm and barnacle larvae) and 4.24×10^{11} macrozooplankton (>500 μm in size including jellyfish, sand shrimp, grass shrimp, larvae of sandlance and American eels, eggs and larvae of winter flounder, and several crab species.) were entrained during this time period.[16] Once entrained, the organisms are subjected to numerous and potentially fatal insults including:

1) Thermal shock from the sudden increase in water temperature (12-13ºC).
2) Shear and pressure forces from high water velocity and trapped air.
3) Mechanical stress from contact with machinery, pumps, etc.
4) Lethal levels of chlorine injected daily into the condenser section to reduce biofouling.

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[11] Assessment of the Impacts of the Oyster Creek Nuclear Generating Station on Kemp's Ridley (*Lepidochelys kempii*), Loggerhead (*Caretta caretta*), and Atlantic Green (*Chelonia mydas*) Sea Turtles. (December 2004), NRC PDR ML# 050060037.

[12] National Marine Fisheries Service's Biological Opinion on the impact's of Oyster Creek Nuclear Generating Station located near Forked River, New Jersey, on endangered and threatened species. National Marine Fisheries Service, Northeast Regional Office, July 18, 2001

[13] JCPL (1978) Oyster Creek and Forked River Nuclear Generating Stations 316 (a) and (b) Demonstration, Volumes 1-5. Technical Reports, Jersey Central Power and Light Company, Morristown, New Jersey.

[14] EA (1986) Entrainment and Impingement Studies at Oyster Creek Nuclear Generating Station 1984 - 1985. Technical Report, EA Engineering, Science, and Technology, Inc., Sparks, Maryland.

[15] M.J. Kennish, (2001) State of the Estuary and Watershed: An Overview. Journal of Coastal Research. SI 32: 243-273.

[16] JCPL (1978) Oyster Creek and Forked River Nuclear Generating Stations 316 (a) and (b) Demonstration, Volumes 1-5. Technical Reports, Jersey Central Power and Light Company, Morristown, New Jersey.

Thermal Impacts:

The once-through cooling system used by OCNGS results in an increase in water temperature (between 22-33ºF) between the intake and discharge canals.[17] Water temperature in the discharge canal can reach 110ºF[18], which affects the behavior, physiology and habitat utilization of aquatic organisms in the area.[19] The elevated temperature in the discharge canal and surrounding waters induces behavioral changes that have been documented in important managed species such as bluefish, fluke, winter flounder, and tautogs.[20] Some of these behavioral changes include:

1) Avoidance of parts or all of Oyster Creek by certain species during summer and early fall.
2) Attraction to parts or all of Oyster Creek during winter when they should have migrated out of the area due to cold temperatures. Failure to migrate can lead to large-scale mortality (due to thermal shock) when the plant experiences a planned or emergency shut down.
    a) Records from January 1972 through December 1982 reported 2,404,496 fish were killed due to thermal shock including Atlantic menhaden, bay anchovy, bluefish, striped bass and weakfish.[21]
    b) An emergency shutdown on January 21, 2000 caused a 17ºF drop in the water temperature in the discharge canal in 15 minutes. The rapid drop in temperature to 32ºF resulted in the death of ~3500 fish including 2980 striped bass.[22]
    c) An emergency shutdown on November 11, 2001 caused a 7ºF drop in the water temperature in the discharge canal in 15 minutes. The rapid drop in temperature to 48ºF resulted in the death of ~1407 fish.[23]
    d) A scheduled shutdown on September 23, 2002 caused the water in the discharge canal to increase to 101ºF in less than an hour and resulted in the death of ~6,000 fish.[24] AmerGen recently reached a ~$1 million dollar settlement over this incident.[25]
3) Metabolic rate of organisms increases with increased temperatures resulting in decreased growth and survival,[26]especially during summer months when ambient water temperatures are at their peak.

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[17] M.J. Kennish, (2001) State of the Estuary and Watershed: An Overview. Journal of Coastal Research. SI 32: 243-273.

[18] Effluent limitations and monitoring requirements of the 1994 (most recent) NJPDES/DSW Permit #NJ0005550 for Oyster Creek Nuclear Generating Station, Part III-B/C.

[19] M.J. Kennish, (2001) State of the Estuary and Watershed: An Overview. Journal of Coastal Research. SI 32: 243-273.

[20] O. Donovan, D. Doyle, C. O'Neill and E. Kearns (1977) Thermal Plume Impact on Fish Distributions in Barnegat Bay. Bull. Amer. Lit. Soc. 10(3): 14

[21] M.J. Kennish, M.B. Roche and T.R. Tatham (1984) Anthropogenic effects on aquatic organisms. In: M.J. Kennish and R.A. Lutz (eds), *Ecology of Barnegat Bay, New Jersey*. NY: Springer-Verlag, pp. 318-338.

[22] Oyster Creek Nuclear Generating Station Fish Kill Monitoring Report (January 2000) NRC ML#003684420

[23] Oyster Creek 2001 Annual Environmental Operating Report (February 2002) NRC ML#020660222

[24] A. Cradic, Oyster Creek Generating Station fined for water violations and fish kills: DEP seeks compensation for Natural Resources Damages New Jersey Department of Environmental Protection news release (December 12, 2002), *available for viewing at* http://www.state.nj.us/dep/newsrel/releases/02_0131.htm

[25] P.C. Harvey, New Jersey reaches $1 million dollar settlement with owner of Oyster Creek Nuclear Power Plant regarding fish kills caused by thermal discharge. New Jersey Office of the Attorney General news release (April 8, 2004), *available for viewing at* http://www.state.nj.us/dep/newsrel/2004/04_0408ag.htm

[26] T. L. Beitinger, W. A. Bennett, R. and W. McCauley, (2000) Temperature Tolerances of North American Freshwater Fishes Exposed to Dynamic Changes in Temperature. Environmental Biology of Fishes, 58(3):237 – 275.

4) High water temperature decreases oxygen solubility in water and increases Biological Oxygen Demand ("BOD") resulting in dangerously low dissolved oxygen concentrations in the water.
5) Tropical/subtropical invasive species are able to thrive in the surrounding warm water plume. Two exotic shipworms (*Teredo barschi* and *T. furcifera*) have benefited from the elevated temperatures with an increase in growth rate and length of breeding season along with reduced winter mortality, which lead to a population increase that has created problems for boat owners in the vicinity of the plume.[27]

Chlorine and other Toxic Impacts:

Chlorine is injected through each of the circulating pumps daily to prevent and remove fouling organisms such as bacteria.[28] Maximum chlorination occurs in the summer months when water temperatures peak and fish eggs and larvae are most abundant in the zooplankton and invertebrate and fish numbers peaks.[29]

1) Chlorine directly kills phyto- and zooplankton entrained in the cooling system and can impact organisms residing in the discharge canal and surrounding waters.
   a) Chlorine begins to be lethal to marine organisms at 0.01 mg/L[30] but tolerance is significantly lowered by high temperatures and physiological condition of the organisms.[31]
   b) OCNGS has a permitted daily maximum discharge limit of 0.20 mg/L of chlorine[32] into the discharge canal, 20 times higher than the lethal limit of many estuarine organisms including striped bass, mummichogs and bunker.[33,34] One chlorine related fish kill resulted in the death of 500 Atlantic Menhaden in January of 1974.[35]

[27] M.J. Kennish (2001) State of the Estuary and Watershed: An Overview. Journal of Coastal Research, SI 32: 243-273.
[28] Assessment of the Impacts of the Oyster Creek Nuclear Generating Station on Kemp's Ridley (*Lepidochelys kempii*), Loggerhead (*Caretta caretta*), and Atlantic Green (*Chelonia mydas*) Sea Turtles. (December 2004), NRC PDR ML# 050060037.
[29] M.J. Kennish (2001) State of the Estuary and Watershed: An Overview. Journal of Coastal Research, SI 32: 243-273.
[30] J.S. Mattice and H.E. Zittel (1976) Site-specific evaluation of power plant chlorination. Journal of Water Pollution Control Federation, 48: 2284-2292.
[31] L.W. Hall Jr., D.T. Burton and S.L Margrey (1981) Acclimation temperature: an important factor in power plant chlorination studies with larval white perch, *Morone americana*. Journal of Toxicological and Environmental Health. 7(6): 941-950.
[32] Effluent limitations and monitoring requirements of the 1994 (most recent) NJPDES/DSW Permit #NJ0005550 for Oyster Creek Nuclear Generating Station, Part III-B/C.
[33] J.S. Mattice and H.E. Zittel (1976) Site-specific evaluation of power plant chlorination. Journal of Water Pollution Control Federation, 48: 2284-2292.
[34] W.P. Davis and D.P. Middaugh (1977) A revised review of the impact of chlorination processes upon marine ecosystems: update 1977. In: R.L Jolley (eds) *Water Chlorination: Environmental Impact and Health Effects-Volume 1*, Ann Arbor Science, Ann Arbor, Michigan, pgs. 283-310.
[35] M.J. Kennish (2001) State of the Estuary and Watershed: An Overview. Journal of Coastal Research, SI 32: 243-273.

2) Toxic residual organic compounds (chloramines) are a byproduct of chlorination, which persists in the canal and effluent resulting in long-term exposure to fish and other aquatic organisms residing in the canal and plume area.[36]
3) Radionuclides are released from OCNGS and bioaccumulate through out the estuarine food web. Reactor-released radionuclides (^{60}Co, ^{137}Cs, ^{54}Mn) have been detected in water, bottom sediments, benthic marine algae, seagrass, hard clams, blue crabs, bunker, winter flounder, summer flounder, bluefish and several other fish.[37] Organisms collected near Oyster Creek had the highest levels of radionuclides but detectable levels were found through out the bay.[38] Recent sediments collected near the discharge canal contained levels of ^{60}Co that were up to 63 times higher than sediments collected at other locations within the Barnegat Bay-Little Egg Harbor estuary.[39]
4) The current NJPDES permit for OCNGS indicates a maximum daily limit of 15 ppm of PAH can be discharged from 5 of their outfall pipes.[40] The sources of this contaminant are not clear.[41]

Detectable Impacts of the OCNGS on the Aquatic Community[42]

1) Reduced Phytoplankton abundance at the mouth of Oyster Creek compared to other areas in the estuary. These impacts include lower diversity, a 30% decrease in gross productivity, a 20% decrease in net productivity and a 17.7% drop in biomass.[43,44]
2) Changes in Zooplankton abundance with some organisms showing increased abundance at the mouth of Oyster Creek than in the discharge canal (barnacle and polychaete larvae) while others showed a decrease in abundance (rotifers, snail larvae).[45,46]
3) Reduced Ichthyoplankton abundance in Oyster Creek compared to Forked River including eggs, larvae and juveniles of bay anchovy and goby and pipefish larvae.[47,48]

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[36] Ambient Water Quality Criteria for Chlorine (January 1985), USEPA 440/5-84-030, 57 pgs.
[37] M.J. Kennish (2001) Characterization of the Barnegat Bay-Little Egg Harbor Estuary and Watershed. Journal of Coastal Research, SI 32: 3-12.
[38] R.L. Blanchard and B. Kahn (1979) Abundance and distribution of radionuclides discharged from a BWR nuclear power station into a marine bay. Nuclear Safety 20: 190-205.
[39] F.C. Moser and R.F. Bopp (2001) Particle-associated contaminants in the Barnegat Bay-Little Egg Harbor Estuary. Journal of Coastal Research, SI 32:229-242.
[40] Effluent limitations and monitoring requirements of the 1994 (most recent) NJPDES/DSW Permit #NJ0005550 for Oyster Creek Nuclear Generating Station, Part III-B/C.
[41] COA will be investigating this further.
[42] M.J. Kennish (2001) State of the Estuary and Watershed: An Overview. Journal of Coastal Research, SI 32: 243-273.
[43] K. Mountford (1971) Plankton studies in Barnegat Bay, New Jersey. Ph.D Thesis. Rutgers University, New Brunswick, New Jersey
[44] R.E. Loveland, E.T. Moul, D.A. Busch, P.H. Sandine, S.S. Shafto and J. McCarty (1972) The qualitative and quantitative analysis of benthic flora and fauna of Barnegat Bay before and after the onset of thermal addition. Technical Report, Rutgers University, New Brunswick, New Jersey
[45] T.R. Tatham, D.J. Danila, D.L. Thomas and Associates (1977) Ecological studies for the Oyster Creek Generating Station. Technical Report, Ichthyological Associates, Inc., Ithaca, New York.
[46] T.R. Tatham, D.J. Danila, D.L. Thomas and Associates (1978) Ecological studies for the Oyster Creek Generating Station. Technical Report, Ichthyological Associates, Inc., Ithaca, New York
[47] *Id.*
[48] T.R. Tatham, D.J. Danila, D.L. Thomas and Associates (1977) Ecological studies for the Oyster Creek Generating Station. Technical Report, Ichthyological Associates, Inc., Ithaca, New York.

4) The overall production loss of sand-shrimp due to impingement and entrainment associated mortality resulted in a direct population loss of 16.6% and an estimated annual net predator loss of 7,483 kg associated with the reduced forage production.[49]
5) Economic loss of ~1% of potential hard clam fishery.[50]

The above individual impacts need to be examined from an ecosystem perspective, including cumulative effects, to fully appreciate the overall effect of OCNGS on the surrounding habitat. Ecosystems level impacts include:

1) Impacts at the base of the food web (phytoplankton, zooplankton and ichthyoplankton) affect higher trophic levels with reduced prey availability and/or changes in preferred prey type.
2) Impacts on sensitive life stages such as eggs, larvae and spawning adults have obvious population-level effects.
3) Changes in water quality and temperature induce physiological stress to organisms that utilize the surrounding habitat. Physiological stress can confound the effects of other insults present in the Barnegat Bay estuary such as eutrophication and contaminant exposure.
4) Peak abundance of organisms coincides with increased water usage and chlorination by OCNGS, thus maximizing their impact on the aquatic community.

Because of the numerous adverse impacts sited above, OCNGS' antiquated once-through cooling system must be replaced with a closed-cycle cooling system for OCNGS to continue operations. The abuse of the Forked River and Barnegat Bay waters must be eliminated.

NJPDES Permit Renewal and Phase II Regulations

Under new EPA regulations, OCNGS will be required to comply with Phase II regulations upon the imminent renewal of its NJDPES permit.[51] Since OCNGS' NJPDES permit expired in 1999, the renewal of its permit will hinge on compliance with Phase II regulations.

Phase II Regulations implement § 316(b) of the Clean Water Act (CWA).[52] Section 316(b) of the CWA requires that the "location, design, construction, and capacity of cooling water intake structures reflect the *best technology available for minimizing adverse environmental impact*" (emphasis added).[53]

[49] J.K. Summers, A.F. Holland, S.B. Weisberg, L.C. Wendling, C.F. Stroup, R.L. Dwyer, M.A. Turner and W. Burton (1989) Technical review and evaluation of thermal effects studies and cooling water intake structure demonstration of impact for they Oyster Creek Nuclear Generation Station. Technical Report, Versar, Inc. Columbia, Maryland.
[50] J.K. Summers, A.F. Holland, S.B. Weisberg, L.C. Wendling, C.F. Stroup, R.L. Dwyer, M.A. Turner and W. Burton (1989) Technical review and evaluation of thermal effects studies and cooling water intake structure demonstration of impact for they Oyster Creek Nuclear Generation Station. Technical Report, Versar, Inc. Columbia, Maryland..
[51] National Pollutant Discharge Elimination System – Final Regulations To Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities; Final Rule, 69 Fed. Reg. 41576 (July 9, 2004).
[52] 33 U.S.C. § 1326(b); CWA § 316(b).
[53] 33 U.S.C. § 1326(b); CWA § 316(b).

Phase II Regulations mandate that OCNGS upgrade its system to meet specific performance standard requirements.[54] The performance standards require a decrease in fish mortality due to impingement by 80-95% and a reduction in entrainment by 60-90% (depending on total capacity utilization rates).[55] An existing facility may choose one of five compliance alternatives for establishing the best technology available for minimizing adverse environmental impacts at the site.

COA finds, and strongly urges, that OCNGS install a closed-circuit-cooling system because such systems are the "*best technology available for minimizing adverse environmental impacts."* Any other option simply does not reflect the best technology available for minimizing adverse environmental impacts. Habitat restoration or reductions in the performance standards due to a cost-benefit analysis are particularly inadequate alternatives. In fact, a study of the restoration project at Salem Nuclear Power Plant has shown that such restoration projects do not offset the loss due to the impingement and entrainment of marine organisms.[56] Meeting the best technology available requirement is not only the law, but is also sound and reasonable.

It is also important to note that it is highly unlikely that OCNGS would be located where it is today if it were to comply with current siting laws. The Nuclear Regulatory Commission laws now state that "special precautions should be planned if a reactor is the be located at a site where a significant quantity of radioactive effluent might accidentally flow into nearby streams or rivers or might find ready access to underground water tables."[57] However, special precautions were not taken to ensure against such accidents during the siting of OCNGS.

In short, COA will be urging the NJDEP, as it drafts the NJPDES permit for OCNGS, to mandate the installation of a closed-cycle cooling system as a matter of law, good governance, and good neighbor policy.

1) The law requires implementation of the "*best technology available for minimizing adverse environmental impact."*[58]
2) Good governance requires protection of public resources and the quality of life.
3) A good neighbor enhances a neighborhood's resources and the quality of life.

For additional information, please contact: Nicole Simmons, Water Policy Analyst (policy@cleanoceanaction.org) about regulatory issues, or Jennifer Samson, Principal Scientist (science@cleanoceanaction.org) about science related issues. Or feel free to call Clean Ocean Action at (732) 872-0111.

[54] National Pollutant Discharge Elimination System – Final Regulations To Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities; Final Rule, 69 Fed. Reg. 41590 (July 9, 2004).
[55] National Pollutant Discharge Elimination System – Final Regulations To Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities; Final Rule, 69 Fed. Reg. 41590 (July 9, 2004).
[56] Delaware Riverkeeper, "Evaluation of Special Conditions Contained in Salem Nuclear Generating Station NJDPES Permit to Restore Wetlands, Install Fish Ladders, and Increase Biological Abundance within the Delaware Estuary," Dec. 2003.
[57] 10 C.F.R. 100.10(c)(3)
[58] 33 U.S.C. § 1326(b); CWA § 316(b).