APPENDIX 17.1
COASTAL ZONE POLICY 7

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COASTAL ZONE CONSISTENCY DETERMINATION

EXPANDED NARRATIVE FOR POLICY #7

FOR THE

HAVERSTRAW WATER SUPPLY PROJECT

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Prepared for:

United Water New York
700 Kinderkamack Rd
Oradell, New Jersey 07649

Prepared by:

Henningson, Durham & Richardson
Architecture and Engineering, P.C.
One Blue Hill Plaza
Floor 12
Pearl River, New York 10965

LIST OF ACRONYMS

BMP	Best Management Practices
CMP	Coastal Management Plan
CMR	Conditional Mortality Rate
DEIS	Draft Environmental Impact Statement
ESA	Endangered Species Act
ETM	Empirical Transport Model
kg	Kilograms
mg/L	Milligrams per liter
MLW	Mean low water
MP	Mile Post
NYCDEC	New York State Department of Environmental Conservation
NYSDOS	New York State Department of State
ppt	Parts per thousand
PST	Passenger Ship Terminal
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service

1.0 INTRODUCTION

The proposed water treatment plant would affect coastal zone resources of the State of New York. A federal Coastal Assessment Form was prepared which confirms that the proposed activity interacts with coastal resources. The New York State Department of State (NYSDOS) administers the state's Coastal Management Program (CMP) and has established 44 coastal policies which are the basis for determining if an action is consistent with the State's program. Each policy was reviewed in the context of the proposed conceptual plan and where an interaction occurred a responsive statement was prepared which evaluated the plan's consistency with that policy. The information, studies and analyses conducted for the preparation of the Draft Environmental Impact Statement (DEIS) were the foundation of the consistency determination.

The primary interaction between the proposed project and coastal resources would be construction and operation of a water intake in the Hudson River. The intake would be within an area of the Hudson River designated as the Haverstraw Bay Significant Coastal Fish and Wildlife Habitat. For such designated areas, there is an impairment test which forms the basis for the consistency determination. The response to Policy #7 which follows, evaluates the proposed action in terms of specific physical, chemical and biological elements of the impairment test. This appendix is the full response to Policy #7. The responses to all 44 policies and a summary of this response to Policy #7 can be found in the body of the DEIS in Chapter 17.

Policy #7

Significant coastal fish and wildlife habitats will be protected, preserved, and where practical, restored so as to maintain their availability as habitats.

Response

A. Habitat Designation

Haverstraw Bay has been designated as a Significant Coastal Fish and Wildlife Habitat (NYSDOS 1987). Significant Coastal Fish and Wildlife Habitats are evaluated, designated and mapped out under the authority of the Waterfront Revitalization and Coastal Resources Act. The New York State Department of Environmental Conservation (NYSDEC) evaluates the significance of coastal fish and wildlife habitat (e.g., ecosystem rarity, species vulnerability, and human use) and recommends habitat designations to NYSDOS for inclusion in the Coastal Management Plan (CMP). The extensive shallow estuarine habitat areas; the occurrence of commercial and recreational fisheries; the use of the Bay as a nursery, feeding and/or overwintering area for marine and anadromous species; and the presence of vulnerable or sensitive species (i.e., endangered or threatened) qualifies Haverstraw Bay as a Significant Coastal Fish and Wildlife Habitat under the CMP.

Haverstraw Bay is also included in the United States Fish and Wildlife Service's (USFWS) "Significant Habitats and Habitat Complexes of the New York Bight Watershed" as "Lower Hudson River Estuary, Complex #21." The Lower Hudson River was selected because it is a regionally significant nursery and wintering habitat for a number of anadromous, estuarine and marine fish species and a migratory and feeding area for birds. The USFWS program encompasses a larger area than the Significant Coastal Habitat designation, but it is a parallel designation recognizing the same significant values of Haverstraw Bay as the Significant Coastal Habitat designation (USFWS 1997).

Haverstraw Bay is also an Essential Fish Habitat (EFH) as designated under the Magnuson-Stevens Fishery Conservation and Management Act [Section 305(b)(2)]. Haverstraw Bay is identified as a mixing zone which is contiguous with coastal waters which have been designated in the New York Bight area. EFH applies to species for which there are approved management plans. NOAA Fisheries (formerly the National Marine Fisheries Service), the agency which administers the EFH program, has identified Atlantic butterfish, Atlantic herring, bluefish, red hake, summer flounder, windowpane and winter flounder as species having EFH in Haverstraw Bay (See Appendix 9.5 to the DEIS, Essential Fish Habitat Assessment). The Federal Energy Regulatory Commission (FERC) recently conducted an EFH assessment for the proposed Millennium Gas Pipeline project, which was to install a gas pipeline across Haverstraw Bay in a dredged trench. FERC concluded that the Millennium Pipeline would not have an adverse impact on EFH.

Located approximately 25 miles north of New York City, Haverstraw Bay extends from Stony Point south to Croton Point for approximately 6 miles, and varies in width from two miles to almost 4 miles. Much of the Bay is shallow, less than 15 feet deep at mean low water (MLW), and is the widest portion of the Hudson River Estuary. A federal navigation channel, maintained at a depth of approximately 32 feet below MLW is located west of the center of Haverstraw Bay.

B. Hudson River Resources

The Hudson River is approximately 315 miles in length extending from its source at Lake Tear of the Clouds in the Adirondack Mountains to the Battery at the southern end of Manhattan Island (Limburg et al. 1986). The lower Hudson River, defined as that section of the Hudson River between the Battery and Federal Dam at Troy, New York, is approximately 154 miles long. The Federal Dam, constructed in 1832 as part of the New York State canal system, forms the boundary between the tidal estuarine lower Hudson River and the riverine upper Hudson River. An estuary is defined as a semi-enclosed coastal body of water that has a free connection with the open sea and within which seawater is measurably diluted with fresh water from land drainage (Pritchard 1967). The Hudson River Estuary is a drowned river valley (i.e., bottom elevation at Federal Dam is below sea level), with saltwater intrusion (defined as the northernmost location of 50 milligrams per liter (mg/L) chloride concentration restricted to the southern portion of the estuary. The geographical position of the salt front ranges over several kilometers during a tidal cycle.

High spring flows move the salt front down to the Tappan Zee region [mile point (MP) 27]; summer low flows allow the salt front to intrude toward Poughkeepsie (MP 71). Salinity in Haverstraw Bay generally varies between 0 and 10 parts per thousand (ppt), depending on the location of the salt front. Intrusion of salt water from the ocean brings about stratification of the estuary. Denser, more saline water follows deeper areas of the Hudson River channel. Irregularities, such as sills in the river bottom or constrictions in shorelines, cause changes in flow direction and velocity, which results in mixing between freshwater and saltwater layers. The slower flows in shallow shoreline areas, often coupled with tributary inflows, bring about lower salinities in shore zones. The intrusion of salt from the ocean into the Hudson River is the primary cause of density-induced circulation in the estuary. This net non-tidal movement of water seaward in the upper layer and landward in the lower layer of the salinity-intruded river affects the transport of energy, mass and plankton through the Hudson River.

Despite past disturbances and development, Haverstraw Bay contains considerable fish and wildlife habitat, and provides the most extensive area of shallow estuarine habitat in the lower Hudson River. Extensive areas of shallow bottom create areas of estuarine tidal marshes that contain salinity-tolerant species of submerged and emergent aquatic vegetation, such as saltwater cordgrass, saltmeadow cordgrass, and spike grass.

The shallow estuarine waters of Haverstraw Bay create favorable habitat for benthic and epibenthic fauna. The benthic macroinvertebrate infauna (organisms living within bottom sediments) feed primarily on detritus (organic materials together with associated bacteria, fungus, and other meiofauna). The distribution of macroinvertebrate fauna on a large scale is determined by salinity with oligochaete and polychaete worms being most abundant in brackish water areas such as Haverstraw Bay. Epibenthic fauna live near the surface of the bottom sediments and often migrate up into the water column at night to feed where they function as part of the zooplankton community. In Haverstraw Bay, epibenthic macroinvertebrate collections are typically dominated by mysid shrimp, especially the opossum shrimp (*Neomysis americana*). These benthic and epibenthic populations serve as important food resources for larger macroinvertebrates and many important fish species.

Haverstraw Bay provides nursery habitat for numerous fish species, including striped bass, American shad, white perch, Atlantic tomcod, and Atlantic sturgeon. Other species, including anadromous blueback herring and alewife, move through Haverstraw Bay to upstream spawning areas. Certain marine species, notably bay anchovy, Atlantic menhaden and blue crab, also use Haverstraw Bay as a major nursery and feeding area.

The shortnose sturgeon occurs only along the East coast of North America and is an important component of the fish community. It is a federally listed and New York State listed endangered species. It has been recorded as occurring from central Florida to southern New Brunswick, Canada (Dadswell et al. 1984). The shortnose sturgeon generally occupies freshwater to brackish water reaches of its natal river and estuaries, remaining primarily in deep river channels. Shortnose sturgeon spawn in the upper Hudson River, returning downstream immediately afterward. Some adults may leave the Hudson over the summer, but the majority remain dispersed in the estuary during summer and fall, and then overwinter in either the Kingston or Haverstraw bay region (Dovel et al. 1992, Geoghegan et al. 1992). Adults that will not spawn in the following spring congregate in a downstream section of the Hudson River in and around Haverstraw Bay. Adults that will spawn in the following spring are thought to migrate upstream and congregate near Kingston, New York.

With the arrival of spring, non-spawning adults disperse from Haverstraw Bay throughout the summer range of the species. Spawning adults ascend the river to spawn in the reach of river between the Federal Dam (Troy, New York) and Coxsackie, New York approximately at river MP 118. Spawning occurs from late April to early May in the Hudson River.

Juvenile shortnose sturgeon grow rapidly and gradually disperse downstream in the estuary. By late fall, most surviving juvenile fish have moved into deeper channel portions of the Haverstraw Bay. Shortnose sturgeon are benthic feeders. Adults are reported to feed on insect larvae, crustaceans, and mollusks. In winter, shortnose sturgeon generally remain in deeper waters to feed, with feeding occurring on an infrequent basis.

The Atlantic sturgeon is anadromous and dependent on coastal waters. Mature Atlantic sturgeon enter the Hudson Estuary by early April before water temperatures rise above 6.1°C, followed by the mature females several weeks later (Dovel and Berggren 1983). Spawning begins when gravid females appear in upper Haverstraw Bay (MP 38) about mid-May when temperatures are approximately 12.8°C, when the salt front is in the vicinity. Females remain in the estuary four to six weeks after spawning, while males may remain in the area up to eight months.

During spawning season, Atlantic sturgeon migrate to deep areas of the river where they can move back and forth across the channel (Dovel and Berggren 1983), Males in the Hudson River reach maturity at age 12, with weights ranging from 5.4 to 47.6 kilograms (kg), and lengths of 1.2 to 2.0 meters. Females are older and larger when they mature, the youngest female in the Hudson was found to be 18 or 19 years old and weighed 32.6 kg. The fish contained 3.6 kg of eggs which appeared to be ripe (Dovel and Berggren 1983). Spawning moves upriver with the salt front as the season progresses, but no further than Catskill (MP 113). Most spawning occurs between Croton Point (MP 35) and Hyde Park (MP 76) from May to August, in water over 25 feet deep. Kahnle et al. (1998) reported spawning migration beginning in May.

Immature Atlantic sturgeon migrate downstream in the Hudson river when water temperatures drop below 20°C. By the time the water temperature reaches 9°C, most sturgeon have reached the location where they will remain until spring. Immature Atlantic sturgeon remaining in the Hudson River Estuary over the winter months usually congregate between the Bear Mountain Bridge and the George Washington Bridge in channel holes or pockets. Other Atlantic sturgeon leave the Hudson Estuary. Emigrating fish are usually between the ages of one year and six years of age (Dovel and Berggren 1983).

Several commercially and recreationally important fisheries occur in Haverstraw Bay, including striped bass, American shad, and blue crab. Historically, oyster beds were prevalent in brackish areas of the Hudson River, including Haverstraw Bay and the Tappan Zee. However, a combination of over-harvesting, habitat alteration and pollution led to the demise of the oyster beds more than a century ago.

Haverstraw Bay also provides habitat for migrating waterfowl during spring (March to April) and fall (September to November) migrations, although the actual number of waterfowl using the area is not well known.

The bald eagle (*Haliaeetus leucocphalus*), a federal and New York State listed threatened species, utilizes areas of the lower Hudson River Estuary, including Haverstraw Bay, during winter months for feeding. The federal navigation channel is kept open throughout the winter months to allow ships and barges access to upriver ports and terminal facilities. During recent years, primarily as a result of the successful bald eagle restoration activities of NYCDEC's Endangered Species Unit, bald eagles are commonly observed along the shore and on ice floes in Haverstraw Bay.

C. Project Effects on Significant Habitat

1. The standard for protecting significant habitat.

Once an area is designated as a Significant Coastal Fish and Wildlife Habitat, Policy No. 7 of the CMP applies. NYSDOS has chosen to evaluate consistency with this policy by utilizing habitat rating forms and the "habitat impairment" test set forth by NYSDEC in guidance documents. Specifically, NYSDEC's guidance documents state that (1) "[a] habitat impairment test must be met for any activity that is subject to consistency review;" (2) the "test that must be met is as follows – In order to protect and preserve a significant habitat, land and water uses or development shall not be undertaken if such action would: destroy the habitat; or, significantly impair the viability of the habitat." Habitat destruction is defined as the "loss of fish or wildlife use through direct physical alteration, disturbance, or pollution of a designated area or through the indirect effects of these actions on a designated area." Significant impairment is defined as "reduction in vital resources (e.g., food, shelter, living space) or change in environmental conditions (e.g., temperature, substrate, salinity) beyond the tolerance range of an organism," with indicators being reduced carrying capacity, changes in community structure, reduced productivity, or increased disease/mortality.

2. Project Impacts

The relationship between the size of the area affected by the water intake and the total available habitat in the estuary is an important general consideration for the following discussion of specific physical processes and ecological functions. The estuarine environment of the lower Hudson River is influenced by forces beyond the boundaries of the estuary or the designated significant habitat. These forces control the processes which maintain physical habitat and the daily variations in many of the important habitat characteristics such as water circulation, flushing rates, erosion and sedimentation, and the chemical parameters associated with water mass movements. Many of the biological characteristics of the estuary are strongly influenced by migratory behavior of many of the most abundant species in the estuary. In addition, the designated significant habitat in Haverstraw Bay is only a portion of a larger area which includes Croton Bay and Tappan Zee south to Piermont Marsh. There is a similar functional habitat throughout this larger area (Buckley 1979), thus the larger area represents the appropriate baseline for the relationship of intake effects to available habitat.

The footprint of the bottom disturbance area is an extremely small percentage of the designated significant habitat in Haverstraw Bay and of the contiguous functional habitat in Haverstraw Bay, Croton Bay and Tappan Zee.

Intake construction will have a temporary effect on a very small portion of the designated habitat and the total available functional habitat. Because the construction activities occupy a very small portion of the water column and estuary bottom, and the effects are limited to temporary disturbance and subsequent restoration of the substrate, there is no mechanism which could cause a significant change in the physical, biological and chemical characteristics of Haverstraw Bay.

The intake screen assembly for the water treatment plant will consist of an intake screen and a 3630-inch pipe extending vertically from the river bottom into the water column. At an elevation of up to 10 feet above the river bottom, a horizontal wedgewire screen assembly approximately 15 feet long will be attached to the 36" vertical pipe to form a tee-shaped intake.Two 12" pipes will rise parallel to the 36" pipe to supply air for the air cleaning system. This intake structure is all that will remain above the river bottom when installation is completed.

All in-water construction work would be done using a barge-based crew using barge-mounted cranes. The work would be performed from a floating work platform created by connecting four barges1 together at the work zone. The barges would be in place for approximately 10 weeks. To create the cofferdam, sheet piling would be driven through the overburden to rock using a pile hammer or vibratory hammer. The in-water construction period for the raw water intake would be only 10 weeks, and the length of time during which sheet pile driving would occur for the cofferdam would expected to last no more than two weeks. The enclosed area, or cell, would have a 30-foot diameter. Once the cofferdam is in place, a bucket dredge would excavate the river bottom within the cell to rock. Dredged material would be transported by boat back to the shore, where it would be stockpiled and then trucked off-site.

Once all earth material is removed from the cofferdam, a concrete seal would be placed at the bottom and then the water would be pumped out. River water recovered during dewatering would be treated by a filter system to remove suspended particulates prior to discharge back into the Hudson River. Once the cofferdam is in place and dewatered, the trenchless tunneling techniques used to install the 60-inch steel casing and wedge-wire screen would be completed inside the cell and would have little potential to result in significant adverse impacts to water quality. Upon completion of raw water intake system, the steel sheets would be removed. A small portion of the dredged material would be stored and replaced within the cofferdam to create substrate on top of the concrete. The dredged material will be replaced prior to removal of the sheetpile walls.

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[1] It is anticipated the construction barges would comprise four 10.3- by 41.3-foot barges linked together to form a 41.3- by 41.3-foot work area (1,705.7 sf, 0.04 acres). Barge draft would be 16.5 inches with no load and up to 60 inches with 59 ton load.

During directional drilling, a “blowout” may occur, in which there is a break in the overburden of the drill shaft which allows drilling mud and excavated material to escape into the river. Drilling will be halted and the blowout repaired before drilling resumes. The drilling mud and excavated material are inert and would settle to the bottom a short distance from the blowout.

The intake structure will influence tidal flow and sedimentation in the near vicinity of the structure. When the tide is running in either direction, the wedgewire screen intake assembly will create a break in the current in the form of turbulence around these structures. Near the bottom, the reduced current velocity may induce sedimentation around the base of the upright structures. However, because the vertical riser pipes are small, little change in bottom contours or substrate type is expected. The turbulence created by the upright structures would be limited to a small area of the water column and would not be noticeable at the surface. The underwater structure will be colonized by a variety of marine invertebrates that live attached to hard surface structures. This would represent a minor change in biological activity. The high pressure, air cleaning system for cleaning the wedgewire intake screen would minimize invertebrates colonization on the screen surface.

The intake structure will have minimal effects on the ecology of Haverstraw Bay. Some fish may be attracted to the structure and the turbulence it creates. Baitfish may at times congregate near the structure, which could then attract predatory fish. Other fish may be attracted to the food potential of the invertebrate community growing on the structure. The structural elements of the intake would function similar to a waterlogged tree that is embedded in the bottom, altering tidal flow and providing a hard surface for invertebrate growth. These minor modifications in distribution and behavior of organisms would have no effect on the ecological relationships of Haverstraw Bay.

The sections below provide detailed evaluation of how the new intake will interact with the physical, biological and chemical characteristics of the estuary. These characteristics are summarized in an evaluation of ecosystem effects.

Physical Effects

Living space includes the river bottom (substrate) and the water column. Benthic life lives buried in the substrate (infauna) or in close association with the surface of the substrate (epibenthos). Fish occupy the water column, but are often in close association with the substrate for feeding and reproduction. Infauna use only a small depth zone, generally on the order of a few inches and remain in one location, unless natural or human induced factors cause a disturbance to the substrate. Epibenthos and fish are mobile and change their location in response to many environmental factors, such as water mass movement, temperature, salinity and food density.

Living space will be unchanged in the long term by intake construction. During dredging and intake placement, the physical habitat will be disturbed and the total living space will be reduced by the bottom and water column occupied by the intake structure. Although the intake structure will occupy existing habitat, it will provide additional habitat for attached invertebrates.

Circulation, flushing and tidal amplitude in the Hudson River Estuary are controlled by river discharge and tidal flow. These water mass movements interact so that circulation, flushing rates and tidal amplitude vary in accordance with predictable changes in the tidal flow and the less predictable changes in river discharge caused by climactic conditions. These physical parameters would not be affected by the intake because the construction activities would have no influence on the forces which control these parameters. During construction, the physical equipment in the river would have a minimal temporary effect on a localized area.

Water temperature will not be influenced by the intake because the construction will not influence the factors which determine water temperature in the estuary. Construction activities will neither add to, or extract heat from, the water, nor will these activities influence water mass movements which can affect temperature distributions in the Bay.

The shape (morphology) and depth of the Bay within the cofferdam cell will be altered on a temporary basis, but there will be no change in these characteristics in the long term. Dredging will temporarily deepen the Bay within the cofferdam cell. The dredged area under the intake screen will be filled with concrete, and the last few feet will be backfilled with excavated material. The natural processes of scour and deposition will return the substrate to its original contours after the removal of the cofferdam. The forces which control scour and deposition will not be altered by intake construction; thus these forces will begin to act on the minor changes to the substrate immediately after construction is completed. The shape and depth of the Bay in the vicinity of the intake will return to pre-construction conditions quickly because scour and deposition work to maintain the morphology of the Bay in a long-term equilibrium.

The backfilling operation will create an uneven bottom at the substrate surface due to bulking of the sediments caused by the excavation and the uneven distribution of material as it redeposits in the cell. Because the sediment is fine-grained, the sediment is expected to spread rather uniformly in the cell and will be distributed as uniformly as possible during placement. Natural scour and deposition would smooth the remaining unevenness at the surface after the sheetpile cell is removed. In the process of smoothing the substrate surface, there would be a sorting of sediment particles which would produce a substrate surface similar to existing conditions.

There would be minor, temporary, localized changes in erosion and sedimentation rates, but no long-term effects on these processes which could affect Haverstraw Bay. Because dredging and backfilling would not change the quantity of sediments already in the estuary, there would be no significant changes in sedimentation rates. Similarly, the construction activity does not introduce a mechanism to significantly modify erosion rates. In a short period of time, the Bay substrate would reach a new equilibrium in which the intake structure would create minor changes in substrate in the near vicinity of the structure.

Biological Effects

The effects of intake construction on living resources would be a temporary reduction of benthic infauna and some epibenthos in the footprint of the construction cell and a temporary redistribution of epibenthos and fishes during construction. The vast majority of Haverstraw Bay and the contiguous functional habitat in Croton Bay and Tappan Zee would not experience any effects on living resources. Because the area affected is very small and because construction effects are temporary, there is no mechanism for change which could alter the community structure or the relationships built on that structure. The physical habitat after construction would be altered by the presence of the intake structure.

Rapid recovery of the disturbed habitat would occur because the organisms present (benthos and fish) are adapted to living in highly variable and naturally disruptive environments. Oliver et al. (1977) documented that shallow water habitats experiencing natural disturbances recover more quickly from dredging and dredged material disposal than deeper, more stable environments. Haverstraw Bay is typical of a shallow estuarine environment that experiences natural disturbances.

Food chain relationships and predatory/prey relationships would not be altered because there would be no significant change in population size of any species in Haverstraw Bay as a result of intake construction. The very small temporary reduction of benthic infauna and epibenthos due to dredging within the construction cell would not alter feeding relationships, which are ecosystem wide characteristics. The increase in mortality represented by dredging would be offset very quickly by an increase in survival in the benthos as the disturbed substrate is recolonized. Epibenthic organisms would return to the intake footprint soon after the removal of the construction cell, providing a food resource for fish which may enter the area.

The behavioral and migratory patterns of the organisms living in Haverstraw Bay occur in response to a combination of innate behavior and cues from the environment. Migration and habitat selection are innate, but the timing of migration or the selection of habitat on a day-by-day basis is controlled by water temperature, salinity, food density and potentially many other factors. The effects of intake construction would not significantly alter the environmental cues to which organisms respond. The habitat disturbance associated with cell construction would cause fish to flee the immediate area, but the increased turbidity and the presence of displaced benthic organisms may attract fish to the periphery of the construction cell to take advantage of increased food density. These changes in behavior represent minor, short-term effects on behavior which would cease when the construction is completed.

Migratory behavior is important for many fish, particularly during late winter and early spring. Migratory species must reach upstream spawning areas and be able to migrate downstream to complete their reproductive cycles. The construction activity will limit disturbance to a small fraction of the overall river width. This will provide adequate, uninterrupted migratory pathways for fish during construction of the intake.

In its EFH assessment of the Millennium Pipeline dredging, FERC evaluated the effects of increased suspended sediment concentrations, increased sedimentation and the potential for effects related to the resuspension of contaminants contained in the sediments. With regard to these potential effects, FERC found that impacts would be minimal due to the temporary nature of the effects, the small area effected, the avoidance behavior displayed by fish, the limited population segment exposed to the effects and the recolonization of the habitat that would occur when construction is completed. FERC concluded that there would be no substantial adverse impact (individual or cumulative) on EFH in Haverstraw Bay. The Millennium Pipeline crossing of Haverstraw Bay involved much greater amounts of sediment disturbance and resuspension than will occur with the installation of the pumping station.

Operation of the raw water intake would entrain the early life stages of fish species spawning in the area or the pelagic early life stages that are carried by tidal currents to the near vicinity of the intake. Entrainment through water systems is a recognized potential adverse impact for early life stages of fish that has been thoroughly evaluated for the power plants on the Hudson River. The studies associated with this issue provided a large database of information on the distribution and abundance of selected important species that can be used to evaluate the potential for entrainment at the pumping station. (See Appendix L for the full report of the entrainment analysis.)

Two modeling approaches are used to assess effects of entrainment at the proposed water treatment plant. The first modeling method computes the estimated number of eggs, larvae and juvenile fish lost to entrainment (Direct Losses). Early life stages, however, typically have very high natural mortality rates; rates which frequently differ vastly from one stage to the next. As a result, losses of juveniles, with a higher probability of survival to adulthood, are more critical to population maintenance than are losses of post-yolk-sac young, which in turn are more critical than losses of yolk-sac young, and so on.

This difference in survival probability results in an inability to directly compare losses across life stages. To help overcome the influence of the high natural mortality rate, direct losses of early life stages are often re-expressed as equivalent Age 1 fish (Equivalent Losses). This process allows for a straightforward comparison among various life stages and places the losses in a frame of reference more familiar to fisheries managers.

The second modeling method expresses entrainment losses relative to the size of the source population. This is done through the computation of the conditional mortality rate (CMR), i.e., the fraction of the population lost due to entrainment in the absence of all other sources of mortality. The calculations are carried out using a modification of the Empirical Transport Model (ETM) (Boreman et al. 1978).

The entrainment modeling results were summarized for two data sets for early life stage abundance and for two water treatment plant operating scenarios. The modeling results show a very small population level effect on the species analyzed (see **Table 1**). This minimal effect reflects the very small flow rate of the water withdrawal. In addition, because the intake would use wedgewire screens, impingement losses that can occur on conventional wire mesh water screens would not occur at the pumping station. The direct mortality due to plant operations would not have a significant adverse impact on fish populations and, in combination with the temporary physical effects of intake construction, would not represent a threat to the fish community in the designated Significant Coastal Fish and Wildlife Habitat.

Chemical Effects

The levels of chemical parameters, such as dissolved oxygen, carbon dioxide, acidity, dissolved solids, nutrients, organics, salinity and pollutants are controlled by processes that are not specific to the project area, with the possible exception of pollution in the sediments. The distribution of the chemical parameters are controlled by the water mass movements under the influence of river discharge and tidal flow. The intake construction will not alter the existing pattern of water mass movements. A tidal excursion in Haverstraw Bay is approximately four miles, thus the majority of water within the six-mile designated habitat would be exchanged during each tidal cycle. In addition, the water movement would cause extensive mixing, which limits the potential for localized water quality conditions.

The U.S. Army Corps of Engineers (USACE) monitored the water quality during channel maintenance dredging in 1986 in Haverstraw Bay (Houston et. al 1992). Under worst case conditions of open bucket dredging and unrestricted lift speed, reductions in dissolved oxygen were less than 1 mg/L and that suspended solids concentrations returned to near ambient conditions between 1250 and 1500 feet down current from the dredge. The potential for suspended sediments during intake construction is limited to the installation and removal of the sheetpile cell and the occurrence of a blowout during directional drilling. To the extent that chemical contaminants occur in the sediments dredged from within the construction cell, they will be isolated from the river within the cell during dredging or while being held in a scow during the construction work. At the end of construction, the surface sediments will be returned to the bottom prior to removal of the construction cell. These potential sources of sediment resuspension are extremely small in comparison to maintenance dredging in the navigation channel. The sediment disturbance at the intake would not have an adverse effect on chemical characteristics of the Bay.

TABLE 1
ESTIMATED ENTRAINMENT IMPACTS FOR AGE 1 EQUIVALENTS OF SELECTED FISH SPECIES

	10 MGD ALL YEAR				**10 MGD MAY 1 - SEP 30 (8 MGD OTHER MONTHS)**			
	Number of Age 1 Equivalents (Total)		**Conditional Mortality Rate (%)**		**Number of Age 1 Equivalents (Total)**		**Conditional Mortality Rate (%)**	
Species	**Mean 1974-2006**	**Mean 2000-2006**	**Mean 1974-2006**	**Mean 2000-2006**	**Mean 1974-2006**	**Mean 2000-2006**	**Mean 1974-2006**	**Mean 2000-2006**
Bay Anchovy	36,971	32,248	0.104290%	0.086029%	36,906	32,080	0.104288%	0.086023%
American Shad	1	1	0.000312%	0.000342%	1	1	0.000310%	0.000342%
Striped Bass	3,028	5,681	0.096667%	0.113301%	3,028	5,681	0.096665%	0.113300%
Atlantic Tomcod	35	60	0.065003%	0.155111%	28	48	0.052114%	0.124299%
White Perch	1,005	894	0.025849%	0.025086%	1,005	894	0.025845%	0.025085%
River Herring	254	264	0.006520%	0.008147%	254	264	0.006496%	0.008136%

Ecosystems Effects

In designating Haverstraw Bay as Significant Coastal Fish and Wildlife Habitat, the area was characterized as having low habitat diversity, but good quality despite extensive previous disturbances. Low diversity reflects the fact that there are generally uniform habitat conditions throughout this broad area of the estuary. As discussed above, the functional habitat extends beyond the designated habitat.

The values of Haverstraw Bay were established through a variety of sampling programs on the lower Hudson River starting in the late 1960s. These programs were designed primarily to assess power plant impacts, but in order to perform these assessments, an extensive sampling program throughout the estuary was needed to establish baseline conditions. These data permit a comparison among segments of the estuary, which over time has shown the importance of Haverstraw Bay as a nursery and overwintering habitat. In addition, these studies provide a long-term database on the seasonal occurrence of various life stages of important fish species, which can be used to establish a construction window. The power company-sponsored studies are supplemented by many other study programs of specific areas and selected species (shortnose sturgeon, for example) providing additional information to establish the importance of Haverstraw Bay.

HDR was directly involved in many of these studies beginning in the 1960s and has assimilated much of the total information base for various impact assessments. HDR's long-term experience and familiarity with and accumulated knowledge of the Hudson Estuary study programs is the basis for the evaluation of the effects of intake construction.

The evaluation of the significance of the effects of intake construction must consider the process and rate of habitat restoration. If the habitat's functional value is restored in a short time interval (relative to the life spans of the components of the biological community), then the effects would not be significant in a short- or long-term sense. There are no mechanisms which would cause effects beyond the localized effects in the vicinity of the intake. As discussed above, none of the physical, biological or chemical parameters would be altered to a degree that would bring about long-term changes to the ecology of the Hudson River. In fact, the effects that will occur will be very limited spatially and temporarily so that the physical, biological and chemical processes of the estuary would continue unaltered during and immediately after construction.

Habitat restoration following dredging has been documented for estuarine environments, such as Haverstraw Bay. Studies conducted at the Passenger Ship Terminal (PST) on the western side of Manhattan Island have shown rapid recovery of the benthic and fish communities following dredging. PST is dredged annually to remove an accumulation of four to six feet of soft sediment. Sampling of benthos and fish before and after dredging showed that the abundance of these organism groups were as great or greater than in nearby undredged areas. These data, which showed habitat recovery in less than one year, are relevant to Haverstraw Bay because they involved a similar fine-grained substrate and similar benthic species.[2]

In 1988, NYSDEC published its draft assessment of a proposed hard clam transplant from Raritan Bay to other New York waters (NYSDEC 1988). This assessment is relevant to the pumping station because the clams would be harvested with a hydraulic dredge, which causes a disturbance of the benthic habitat in the process of collecting the clams. The clam dredge uses high pressure water jets to loosen the bottom to a depth of up to 24 inches; which is then raked to a depth of three to four inches by the device. The clams are collected in a screened box and most of the sediment and small organisms are redeposited on the bottom. The dredge is approximately 28 inches wide, but repeated passes of the dredge across the bottom can disturb a substantial area over many days of fishing. The bottom disturbance increases turbidity, has the potential to resuspend contaminants contained in the sediment, causes a loss of benthic life and displaces mobile aquatic life in the path of the dredge. Those are the same effects associated with intake construction. NYSDEC concluded that the hard clam transplant program using a hydraulic dredge did not constitute a significant adverse impact to aquatic life.

The former channels and existing ship channels in Haverstraw Bay are direct evidence of the restoration of habitat after dredging in the designated area. Shipping channels represent a substantially greater level of habitat disturbance than dredging for intake placement because ship channel dredging not only disturbs the substrate, but removes the material, altering water depth, current regimes, and substrate type.

Channels extending from the shoreline to the main channel for former brick making operations and to accommodate caisson construction for the Tappan Zee Bridge have filled in and provide habitat for aquatic life equivalent to undredged areas of the Bay. These former channels have filled naturally so that they match surrounding water depths and substrate type.

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[2] These studies were conducted originally for the proposed Westway project. The sequential sampling for Westway provided before and after, as well as reference station data, with regard to the effects of annual dredging. The data were summarized for an Environmental Impact Statement which was never published. The data on which these observations are based are available from HDR, who conducted these studies.

U.S. Gypsum maintains a 31-foot deep channel extending from the northern end of the federal channel to its facility on the west shore at Stony Point. This channel intersects the federal channel just south of where the intake will be located. The U.S. Gypsum channel has been maintained for many years through periodic dredging, with the sediment disposed of outside of Haverstraw Bay. Within the period of time that this channel has been present, striped bass and shortnose sturgeon have recovered from historically low levels and the aquatic community of Haverstraw Bay has flourished. Previous assessments associated with permitting of this channel did not find significant adverse impacts.

The nursery habitat provided by Haverstraw Bay has high ecological value because the combination of a broad expanse of shallow productive substrate in a salinity zone appropriate for the juveniles of migratory marine and estuarine species occurs rarely along the Atlantic Coast. The presence of a deep channel for overwintering in this same salinity zone adds ecological value to this area. The species, which depend on this habitat for all or a portion of their life cycles, have generally maintained substantial population levels despite environmental changes, pollution effects, and overfishing. The endangered species (shortnose sturgeon) which occur in this area, while experiencing reduced population levels over broad areas of their range, maintain substantial populations in the Hudson Estuary. Habitat loss in the vicinity of Haverstraw Bay is not recognized as a factor in the special status of this species.

Many of the abundant and ecologically important species of fish and invertebrates (particularly blue crab) which use the designated habitat rely on other extensive areas of habitat in the estuary and marine environment. Their population levels can be controlled by environmental factors and habitat-related effects occurring outside of the designated habitat. The current status of the habitat in Haverstraw Bay can be characterized as good with no significant threats to the quality and quantity of habitat.

Human use of the designated habitat includes extensive recreational activity, primarily boating and fishing, industrial activities such as shipping and power plant cooling, and assimilation of municipal waste discharges. These uses will continue in the future, probably at somewhat increased levels. As long as the quantity of physical habitat remains undiminished, the natural processes which created and maintain the productivity of the designated habitat can be expected to maintain the living resources of the estuary.

While the designated habitat may be irreplaceable in certain respects, the functional values of the habitat will be restored after they are temporarily reduced by intake construction with the exception of the area occupied by the intake pipe and support piles, none of the habitat will be physically altered. The restoration of the habitat through backfilling of the dredged area and natural processes, which will reconstitute the substrate, will assure maintenance of the existing habitat and it functional values in the long term.

As discussed previously, the total substrate disturbance area is an extremely small percentage of the designated habitat. As discussed above, contiguous functional habitat extends well beyond Haverstraw Bay and includes Croton Bay (also designated habitat) and Tappan Zee south to Piermont Marsh (non-designated habitat). Buckley (1979) characterized similar physical habitat throughout this large area, with no significant differences which would distinguish an area the size of the intake from other areas. In fact, it is the broad expanse of similar productive habitat which is the most important factor in the designation of Haverstraw Bay as significant habitat. HDR's experience with sampling aquatic life and physical parameters in Haverstraw Bay confirms this general observation.

The distribution of important fish species in Haverstraw Bay and similar contiguous habitat is, to a great extent, determined by the seasonal movements and migrations of these species. The occurrence of important species in the area of the intake is determined by the innate migratory behavior of these species and other factors such as temperature, salinity, food density and schooling behavior which control daily activity. There are no features of the intake which could take precedence over these natural factors in determining fish distribution in Haverstraw Bay.

Benthic fauna lack mobility; thus they generally do not select habitat or make daily adjustments in location. These organisms or their early reproductive stages settle and establish themselves when they encounter suitable habitat as they are moved about by water mass movements. The physical conditions of the substrate at the intake are similar to surrounding areas of the Bay. Thus the distribution and abundance of benthic infauna on the route would be similar to surrounding habitat areas.

As discussed above, innate behavior and environmental factors determine the occurrence of fish in the vicinity of the intake. Many important species which use Haverstraw Bay are present on a seasonal basis that varies with the lifestage of most species. Migratory species such as American shad, blueback herring, alewife, rainbow smelt, striped bass, shortnose sturgeon and Atlantic sturgeon pass through the Bay (or migrate from the Bay) from late winter through spring enroute to upstream spawning areas. These adults return downstream through the Bay in late spring. The adults of some species, such as shortnose sturgeon, may remain in the Bay for much of an annual cycle. The early life stages of the fish spawned upstream will move into Haverstraw Bay throughout summer and fall.

The early life stages of striped bass enter the Bay in early summer and remain in the nursery habitat provided by the extensive shallows and shoals. Juvenile sturgeon would be present over a long period of time (years) because of their slow maturation.

Resident species which are important in the Bay include white perch, Atlantic tomcod and hogchoker. These species are abundant in the Hudson Estuary, representing a significant portion of the fish biomass. Juveniles through adults of these species are present throughout most of the year. Adults of these species move upstream of Haverstraw Bay to spawn during winter (tomcod), spring (white perch), and summer (hogchoker), and then redistribute themselves in the estuary. Early life stages of tomcod are present in spring due to the winter spawning of this species. Early life stages of white perch and hogchoker are present in summer.

The resident species and the adults and juveniles of striped bass and sturgeon overwinter in Haverstraw Bay and adjacent areas. Their distribution within Haverstraw Bay during winter can vary depending on temperature and salinity conditions. The presence of some of these species in the navigation channel is controlled primarily by innate habitat preferences.

The intake construction has been designed to minimize effects on the significant habitat. There will be no loss of habitat quantity and only a temporary reduction of functional value during and immediately after construction. Restoration of the disturbed area through natural processes will result in a complete restoration of the functional values of the designated habitat. The construction activities will not alter the physical, biological and chemical processes of Haverstraw Bay, thus the habitat will recover as it has from the previous dredging operations which were not designed and conducted with the care applied to the pumping station.

Measures to protect aquatic life and aquatic habitat during construction of the intake include the use of a sealed sheetpile cell, recontouring of the bottom in the area dredged and a wedgewire screen intake to minimize the entrainment of aquatic life. The sealed sheetpile cell will contain the dredging and all construction work in the river. The replacement of surface substrate within the sheetpile cell will eliminate sediment loss to the surrounding area and will permit the recontouring of the bottom before the cell is removed. The use of a wedgewire screen intake represents the best technology available to protect aquatic life at a water intake of this size. In addition, construction work would be undertaken during the selected construction window to minimize effects on a seasonal basis.

D. Endangered Species

The shortnose sturgeon (*Acipenser brevirostrum*) is the only federally or state listed endangered or threatened species in the Hudson River in the vicinity of the proposed intake. However, there is evidence that the Atlantic sturgeon (*Acipenser oxyrinchus*) has experienced a significant decline in abundance in the Hudson (Kahnle et al. 1998, Peterson et al. 2000). Therefore, it is possible that Atlantic sturgeon could be listed in the future. The following discussion addresses the question of taking under the federal Endangered Species Act (ESA), but the technical rationale presented applies to both species of sturgeon in the Hudson.

Section 9 of the ESA prohibits the "taking" of any endangered species of fish and wildlife. [ESA §9(a)(1); 16 USC §1538(a)(1)]. The USFWS has promulgated regulations prohibiting the "taking" of any threatened species of wildlife (50 CFR §17.31). Similarly, NOAA Fisheries (formerly NMFS) promulgated a regulation that forbids the taking of any threatened species of fish or wildlife for which the ESA §9(a)(1) prohibitions have been applied by regulation. [50 CFR §222.301(b)].

The term "take" is defined in the ESA as meaning to harass, harm, pursue, hunt, shoot, kill, trap, capture or collect, or attempt to engage in any such conduct. [ESA §3(19); 16 USC §1532(19)]. Both the USFWS and NMFS have in turn defined the word "harm," within the context of ESA Section 9, as an act which actually kills or injures fish or wildlife, <u>including significant habitat modifications or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding or sheltering</u> [50 CFR §17.3, 222.102] (emphasis added). It is clear from these definitions and accompanying agency discussions, that an actual injury to a listed species must be found in order for a "taking" to have occurred under ESA Section 9 and that these regulations do not create liability for hypothetical, speculative or conjectural injury. [See 46 FR 54748 (November 4, 1981); 64 FR 60729 (November 8, 1999)].

To determine whether a certain act will constitute harm, the act must result in, or be reasonably certain to result in, the death or injury of listed fish or wildlife (see 64 FR 60729). Thus a causal link or relationship between a specific activity or series of activities and the injury or death of listed species must be demonstrated, in order for an act to raise to the level of harm. (See 64 FR 60728.) To demonstrate such a causal link can be more challenging in situations where the nexus between a cause and effect are nebulous or where there is a substantial lag period between the cause and effect, as in habitat modification.

The ESA and corresponding regulations are ambiguous that habitat modification or degradation alone, is not a taking pursuant to ESA Section 9. To be subject to Section 9, the modification or degradation must be significant, must impair essential behavioral patterns and must result in actual injury to protected species. The occurrence of taking would depend on situation-specific conditions and can be shown through a variety of methods and types of evidence. These include, but are not limited to, field surveys and assessments, populations studies, laboratory studies, model based procedures, information and data in the scientific literature, or expert witness testimony consisting of inferences or opinions drawn from facts pertaining to a given act(s) of habitat modification or degradation (64 FR 60728).

Based upon this analytical framework, it is not anticipated that the pumping station will result in an ESA Section 9 take of any listed species of fish or wildlife.

The construction of the intake in Haverstraw Bay does not constitute a “taking” because there would be no loss or harm to individual sturgeon, no loss of physical habitat for any listed species and no long-term loss of the functional value of the habitat involved in intake construction. The construction equipment operating in the river will not kill or harm sturgeon and the temporary habitat disturbance related to the construction would not impair essential behavioral patterns which would cause injury to individual sturgeon. In fact, both species of sturgeon show a preference for deep channel habitats during all life stages (Bain 1997). Most of the deep channel in the Hudson is subjected to periodic maintenance dredging, thus sturgeon in the Hudson have been exposed to a repeated habitat disturbance much more extensive than the dredging and backfilling associated with intake installation.

There is extensive experience with dredges of the type proposed for intake construction (closed clamshell bucket) that shows that fish are very rarely enclosed in the bucket during dredging and subsequently dumped in the scow which will retain the dredge material. The localized disturbance caused by the dredging and the relatively slow movement of the dredge bucket allows free swimming fish to avoid capture in the bucket. Because dredging will take place within an enclosed cell, the potential for fish capture in the dredge bucket is extremely small. The disturbance created by driving sheetpile to create the cell is expected to cause fish to flee the area. Observations of the discharge of individual bucket loads of dredged material into scows shows that fish are rarely picked up by a clamshell bucket dredge. Slow moving life stages of fishes, such as eggs and larvae, may be vulnerable, but sturgeon spawn well upstream of Haverstraw Bay (Bain 1997), thus their eggs and larvae would not be exposed to such dredging.

Shortnose sturgeon are reported to cease feeding in freshwater during winter, but to continue feeding during winter in the saline portions of estuaries (Dadswell 1979). There is little information on feeding habits in the Hudson. Overwintering sturgeon in Haverstraw Bay would be near the salt front, which would vary in location depending on freshwater runoff conditions. The extent to which sturgeon would feed during overwintering is uncertain, but they are capable of surviving with little or no feeding for up to six months. The diminished food supply in the area dredged for intake installation would be recolonized rapidly and would be available for feeding by sturgeon and other species.

The effects of dredging on aquatic habitat and its use by sturgeon have been previously tested as a result of maintenance dredging of the shipping channel in the Hudson. In contrast to the intake installation, which will restore the bottom to its original contours with native sediment, channel maintenance dredging removes accumulated sediments, which deepens the channel and begins a cycle of sediment build-up which will continue until the next episode of maintenance dredging. The channel benthic habitat is thus maintained in a state of long-term flux. Also in contrast to the intake installation, maintenance dredging is a recurring habitat disturbance affecting a much larger area than the intake footprint. Whereas the intake installation is a one-time effect on a small area at the edge of the channel, maintenance dredging would affect a reach involving many miles and up to the full width of the channel each time this dredging occurs.

The fact that the shortnose sturgeon population has apparently increased since the last episode of maintenance dredging in Haverstraw Bay (see discussion below) is strong evidence that dredging in this habitat is not an adverse impact. The decline in Atlantic sturgeon is reported to be primarily the result of overfishing, and dredging has not been implicated in the decline of this species. In addition to the channel maintenance operations, the shoal habitat has been previously disturbed for the installation and use of channels which connect with the main shipping channel. These channels, some of which are no longer maintained, apparently have not adversely affected habitat use by sturgeon in the Haverstraw Bay area.

The shortnose sturgeon population in the Hudson has been estimated at 38,024 adults (Bain et al. 1995). There is no indication of a decline in this stock since intensive studies of this population began in the 1970s. In fact, the 1995 estimate suggests a two- to four-fold increase in the adult population. A more recent estimate indicates a total population (adults and juveniles) in excess of 61,000 individuals (Bain quoted in *Washington Post*, October 2, 2000). While the population is listed as an endangered species, it is not in imminent danger of extinction in the Hudson River. Activities such as dredging and backfilling for intake installation, while they are an intrusion into a very small portion of the sturgeon habitat, do not represent a level of effect which could alter the status of this robust population.

As noted above, with regard to Atlantic sturgeon, while the population is not listed as endangered or threatened, the observed decline in the stock is cause for concern. However, there is substantial data which suggest strongly that this population decline is due to overfishing and not to habitat disturbance or loss. Adult Atlantic sturgeon spend the bulk of their life in the sea and while in freshwater for spawning are primarily upstream of the intake location and have completed spawning (spring) and left the river by fall.

Intake installation represents a very small, one-time physical disturbance of habitat. Based on the lack of significant effects from maintenance dredging of the main shipping channel, intake installation in the Hudson River does not represent a taking with regard to the ESA. Long-term maintenance of the sturgeon populations is not threatened by the proposed construction because there is no loss of long-term functional value of the habitat which could harm sturgeon. There is no evidence that sturgeon have been harmed by dredging in the past and, in fact, dredging may help maintain the preferred habitat of sturgeon in the Hudson.

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