New Jersey Department of Environmental Protection
Water Monitoring and Standards
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PARTIAL SANITARY SURVEY REPORT OF

SHELLFISH GROWING AREA NE-1

RARITAN & SANDY HOOK BAY

2001-2008

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EXECUTIVE SUMMARY

Shellfish growing area NE-1 is located in northern New Jersey between Middlesex and Monmouth Counties, and situated within the Hudson-Raritan Estuary (also know as the New York/New Jersey Harbor Estuary). The Hudson-Raritan Estuary is one of the most diverse places on the east coast. It is home to millions of residents, ports, industries, and transportation complexes. This estuary is one of the larger estuaries on the East coast, with over 10 millions acres and is divided into four major complexes: Raritan-Sandy Hook Bay, Newark Bay, Upper/Lower New York Bay, and Jamaica Bay. Growing Area NE-1 lies within the Raritan-Sandy Hook Bay complex. This complex is the largest complex in the Hudson-Raritan Estuary, with a surface area of approximately 69,188 acres and includes two major waterbodies - Raritan Bay and Sandy Hook Bay.

The approximate size of this shellfish growing area is 33,080 acres, which is roughly half of the Raritan-Sandy Hook Bay complex. The general outline of this growing area includes a portion of the Raritan River, a portion of the Raritan Bay and Arthur Kill that lies south of the New Jersey/New York boundary, Sandy Hook Bay, and a portion of the Shrewsbury River. The current shellfish classifications are *Special Restricted* and *Prohibited*. There are no *Approved* or *Seasonal* waters assigned to this growing area. Sandy Hook Bay is classified as *Special Restricted*, except for a small buffer zone that surrounds the Atlantic Highland Municipal Marina, which is classified as *Prohibited*. The *Prohibited* areas can be found in the Raritan River, portions of Raritan Bay, Union and Belvedere Beaches, Atlantic Highlands Municipal Yacht Basin, and Keyport Harbor. Because this growing area is classified as *Special Restricted* and *Prohibited*, there is no direct market of shellfish harvested from this area. Shellfish that are harvested must undergo either depuration or relay before they are marketable. Depuration is used for 100 percent of hard clams harvested from the *Special Restricted* waters of this growing area. The relay program was suspended in this area due to a lack of interest of the baymen, which was likely due to the fact that depuration produces marketable shellfish in less time than relay.

Due to the abundance of shellfish found in this area and their economic benefit to the state, it is important to identify the pollution sources that are contributing to the poor water quality found in this growing area. Some of the contributing factors include stormwater outfalls, marinas and boating activities, wastewater treatment facilities, illegal disposal, and spills. The water quality of this shellfish growing area is not only influenced by the discharges that occur within this area, but is also affected by other discharges that occur outside of the growing area. Due to the direction of tidal flows, discharges from New York and the Shrewsbury River can also affect the Raritan and Sandy Hook Bay. Besides the ordinary impact from stormwater outfalls, this area is also affected by discharges from Combined Sewer Overflows (CSOs). CSOs are a combination of raw sewage and pollution runoff that overflow into nearby waterbodies without treatment. This usually occurs during heavy rainfall, when the sewer systems are unable to handle the increased capacity of water mixed with sewage. It is estimated that approximately 27 billion gallons of combined raw sewage and polluted runoff discharges into the New York Harbor each year from at least 460 CSOs sites.

For this reason, Water Monitoring & Standards, Bureau of Marine Water Monitoring (WM&S' BMWM), is constantly find ways to improve water quality through continuous sampling and source tracking in this area as well as throughout the state. From 2001 through 2008, approximately 3,164 water samples, from 53 sampling sites located throughout this growing area, were collected. Based on the data pool assessed in this report, the majority of stations in this growing area do not meet NSSP MPN 5-tube "Approved" criteria based on year-round, summer, and winter evaluation. When evaluating these data against the NSSP MPN 5-tube "Special Restricted" criteria, all stations were found to meet their current shellfish classifications.

However, several sampling stations, located in Sandy Hook Bay, do meet the NSSP MPN 5-tube"Approved" criteria. This area, which would have the most potential for an upgrade, would be the area slightly north of Horseshoe Cove. The current limited data supports the classification of *Seasonally Approved*; however, no upgrade is recommended at this time due to the need for additional seasonal samples. It is therefore recommended that more samples are collected during the winter months, especially in the Sandy Hook area.

There was enough data to support an upgrade in Keyport Harbor from *Prohibited* to *Special Restricted*. WM&S' BMWM began sampling in this area in 2004. From 2004 through 2008, approximately 44 samples were collected from four sampling sites located in Keyport Harbor. Statistical data show that these stations do meet the NSSP MPN 5-tube "Special Restricted" criteria. Therefore, it is recommended that approximately 1,050 acres of waters in Keyport Harbor be upgraded from *Prohibited* to *Special Restricted.*

Tissue and sediment data collected within this growing area from various agencies were evaluated against available FDA criteria or the sediment guidance values, Effect Range Low (ERL) and Effect Range Median (ERM). Based on the sediment data collected by the EPA National Coastal Assessment Program, only one parameter was found to exceed the ERM, which was mercury. Concentrations of mercury above the ERM value were found at two monitoring sites. Historical data indicated that mercury concentrations have always been higher and above the ERM value at these sites. Data collected from the NOAA Mussel Watch Program indicates that the concentration of lead in tissue samples were also higher than FDA criteria. In response to this finding, WM&S' BMWM began analyzing shellfish tissue samples collected in the Sandy Hook Bay for heavy metals (mercury, lead, cadmium, nickel, and arsenic). The levels of heavy metals found in the clam samples were very minimal, and coincided with the results from a study conducted back in the 1980's, which investigated heavy metals in shellfish tissue collected in this growing area.

An overall summary of the proposed classification changes for NE-1 can be found on the following map.

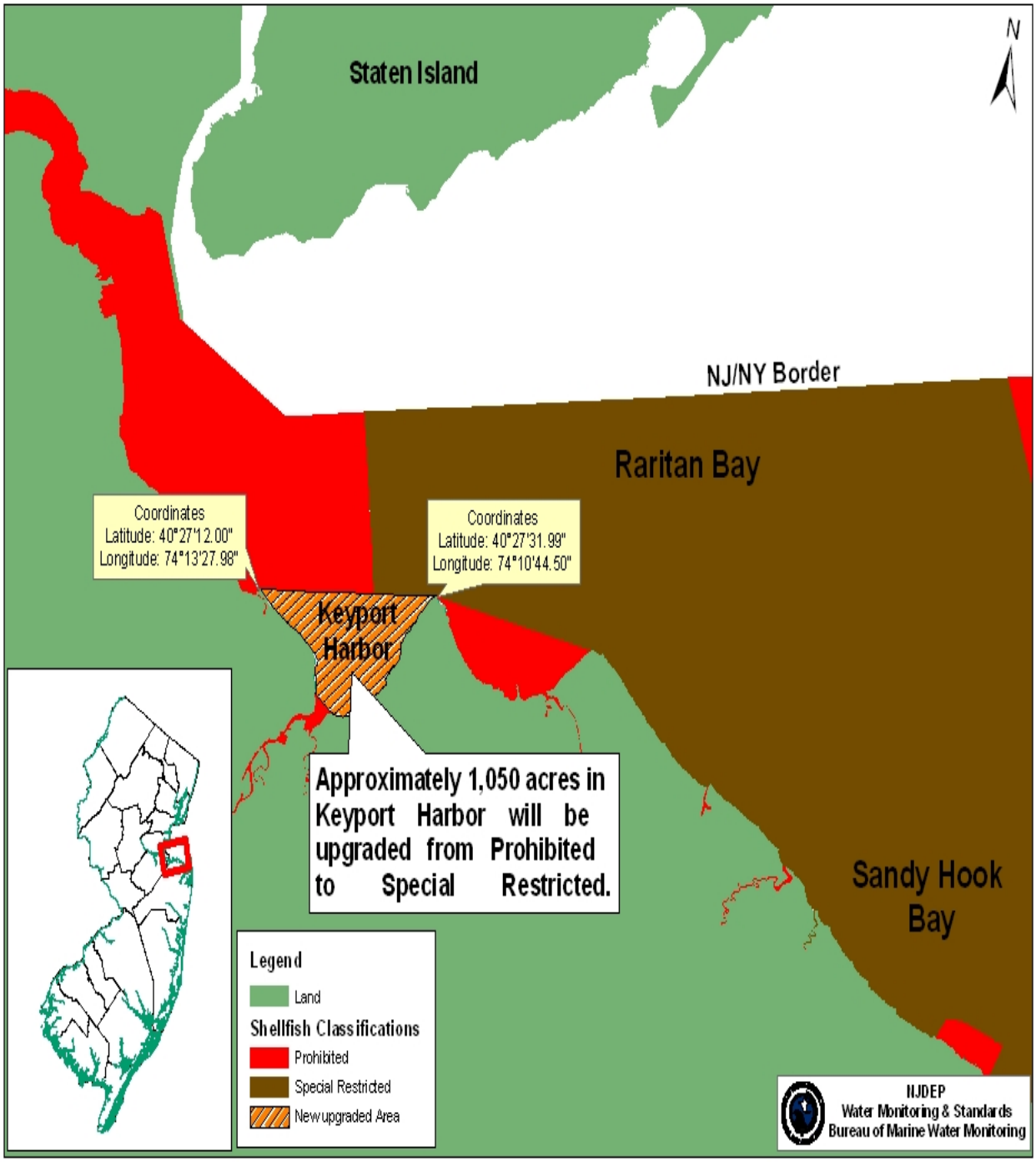


Figure ES-1: Proposed Shellfish Classification Upgrades for Shellfish Growing Area NE-1.

INTRODUCTION

PURPOSE

The primary purpose of this report is to comply with the guidelines of the National Shellfish Sanitation Program (NSSP) that are established by the Interstate Shellfish Sanitation Conference (ISSC). Reports generated under this program form the basis for classifying shellfish waters for the purpose of harvesting shellfish for human consumption. As such, they provide a critical link in protecting human health.

FUNCTIONAL AUTHORITY

The authority to carry out these functions is divided between the Department of Environmental Protection (DEP), the Department of Health and Senior Services and the Department of Law and Public Safety.

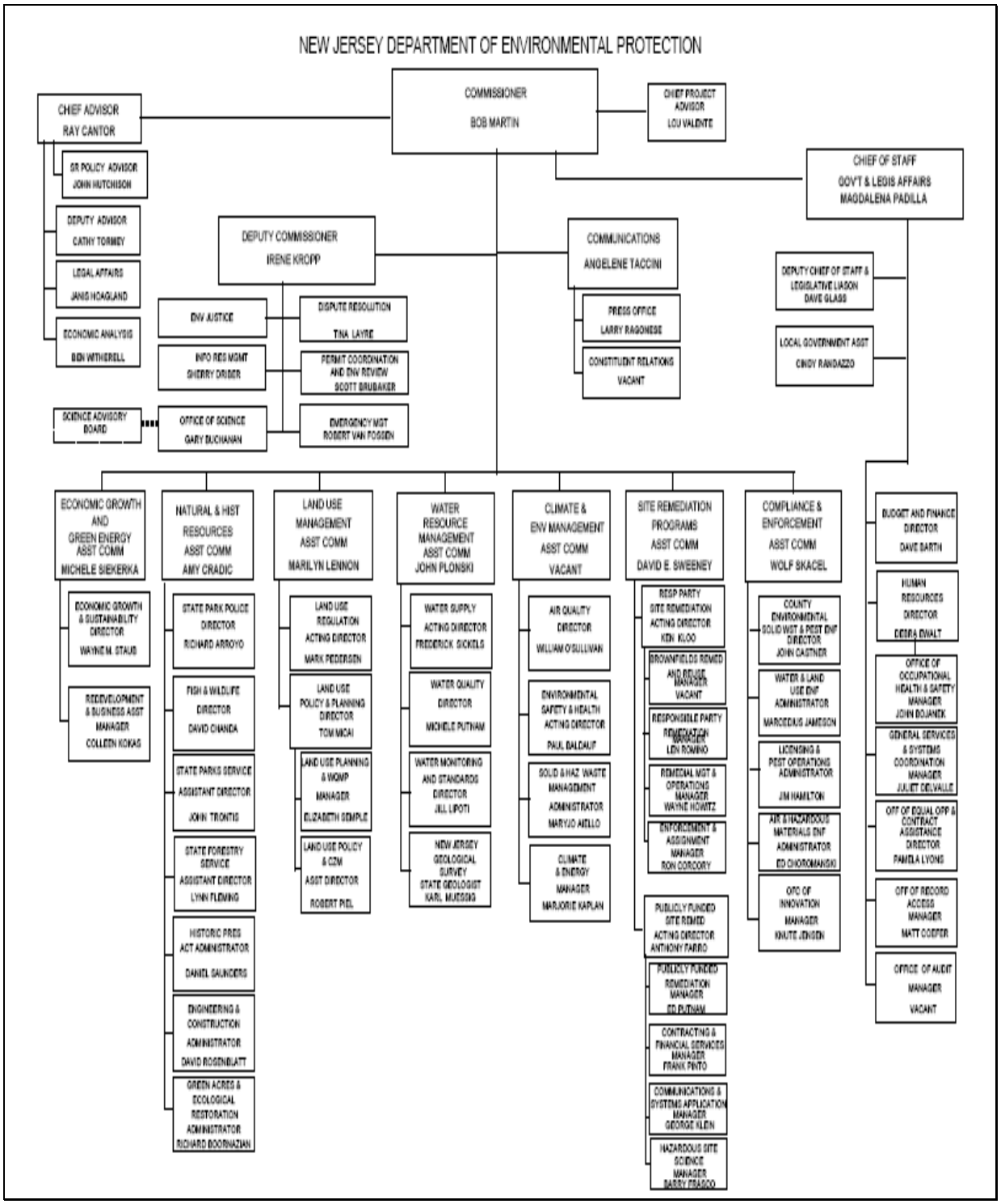
The Bureau of Shellfisheries, in the Division of Fish and Wildlife, issues harvesting licenses and leases for shellfish grounds under the Authority of N.J.S.A. 50:2 and N.J.A.C. 7:25. This Bureau, in conjunction with the Water Monitoring and Standards' Bureau of Marine Water Monitoring (WM&S/BMWM), is responsible for administering and or suspension of the Hard Clam Relay Program.

The Bureau of Law Enforcement, in the DEP (Division of Fish and Wildlife), and the Division of State Police, in the Department of Law and Public Safety, enforce the provisions of the statutes and rules mentioned above.

The Department of Health and Senior Services is responsible for the certification of wholesale shellfish establishments and, in conjunction with the WM&S/BMWM, administers the depuration program.

The division of authority between the three agencies can be seen in Figure 1.

FIGURE 1: STATE OF NEW JERSEY SHELLFISH AGENCIES



INTRODUCTION TO THE SANITARY CONTROL OF SHELLFISH

Emphasis is placed on the sanitary control of shellfish because of the direct relationship between pollution of shellfish growing areas and the transmission of diseases to humans. Shellfish-borne infectious diseases are generally transmitted via a fecal-oral route. The pathway is complex and quite circuitous. The cycle usually begins with fecal contamination of the shellfish growing waters. Sources of such contamination are many and varied. Contamination reaches the waterways via runoff and direct discharges.

Clams, oysters and mussels pump large quantities of water through their bodies during the normal feeding process. During this process the shellfish also concentrate microorganisms, which may include pathogenic microbes, and toxic heavy metals/chemicals. It is imperative that a system is in place to reduce the human health risk of consuming shellfish from areas of contamination.

Accurate classifications of shellfish growing areas are completed through a comprehensive sanitary survey. The principal components of the sanitary survey report include:

1. An evaluation of all actual and potential sources of pollution,
2. An evaluation of the hydrography of the area and
3. An assessment of water quality. Complete intensive sanitary surveys are conducted every 12 years with interim narrative evaluations completed on a three year basis. If major changes to the shoreline or bacterial quality occur, then the intensive report is initiated prior to its l2 year schedule.

The following narrative constitutes WM&S/BMWM's assessment of the above mentioned components to comply with the three year reappraisal. Additionally, a partial shoreline survey was completed for the purpose of upgrading and reclassifying a portion of the shellfish growing waters.

GROWING AREA PROFILE

LOCATION

Shellfish growing area NE-1 is located in northern New Jersey and is situated within the Hudson-Raritan Estuary (also know as the New York/New Jersey Harbor Estuary). The Hudson-Raritan Estuary is one of the most diverse places on the east coast. It is home to millions of residents, ports, industries, and transportation complexes. This estuary is the largest estuary on the East coast, with over 10 millions acres and is divided into four major complexes; Raritan-Sandy Hook Bay, Newark Bay, Upper/Lower New York Bay, and Jamaica Bay. This growing area is within the Raritan-Sandy Hook Bay Complex (Figure 2).

The Raritan-Sandy Hook Bay Complex forms the southeastern portion of the New York - New Jersey harbor between the southern shoreline of Staten Island, New York, and the northern shoreline of Middlesex and Monmouth Counties, New Jersey. The Raritan-Sandy Hook Bay Complex is the largest complex in the Hudson-Raritan Estuary, with a surface area of approximately 69,188 acres and includes two major waterbodies - Raritan Bay and Sandy Hook Bay. This complex receives inflow from the Raritan River, Shrewsbury River, Navesink River, and smaller tributaries along the shoreline of Staten Island and New Jersey.

The approximate size of this shellfish growing area is 33,080 acres, which is roughly half of the Raritan-Sandy Hook Bay Complex. The general outline of this growing area includes a portion of the Raritan River, a portion of the Raritan Bay and Arthur Kill that lies south of the New Jersey/New York boundary, Sandy Hook Bay, and a portion of the Shrewsbury River (Figure 3). The location of this growing area can also be found on the "2009 State of New Jersey Shellfish Growing Water Classification" Chart 1 or online at http://www.state.nj.us/dep/bmw.

This growing area borders Middlesex and Monmouth Counties. Monmouth County is one of the fastest growing counties in New Jersey and is ranked 6th largest in the state. There are 53 municipalities in Monmouth County, with Middletown Township having the largest population and Keansburg Borough as one of three municipalities that are most densely populated. Middlesex County is located north of Monmouth County. It is the 3rd largest county in the state, with an area of about 318 square miles and is divided into 25 municipalities (Census Bureau).

The locations of the adjacent municipalities can be found in Figure 3, and the population statistics for each municipality are shown in Table 1.

FIGURE 2: HUDSON-RARITAN ESTUARY

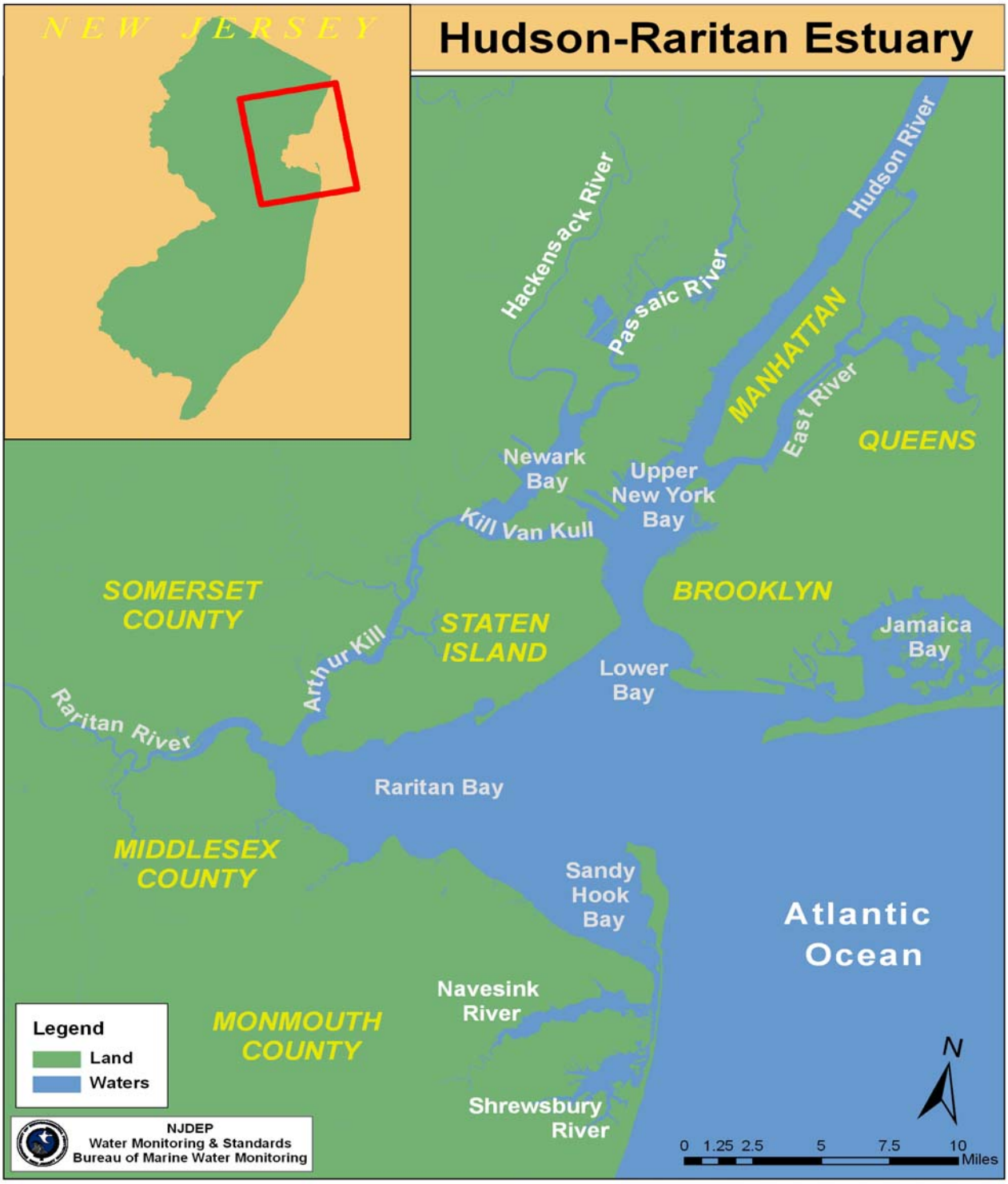


FIGURE 3: LOCATION OF NE-1 & ADJACENT MUNICIPALITIES

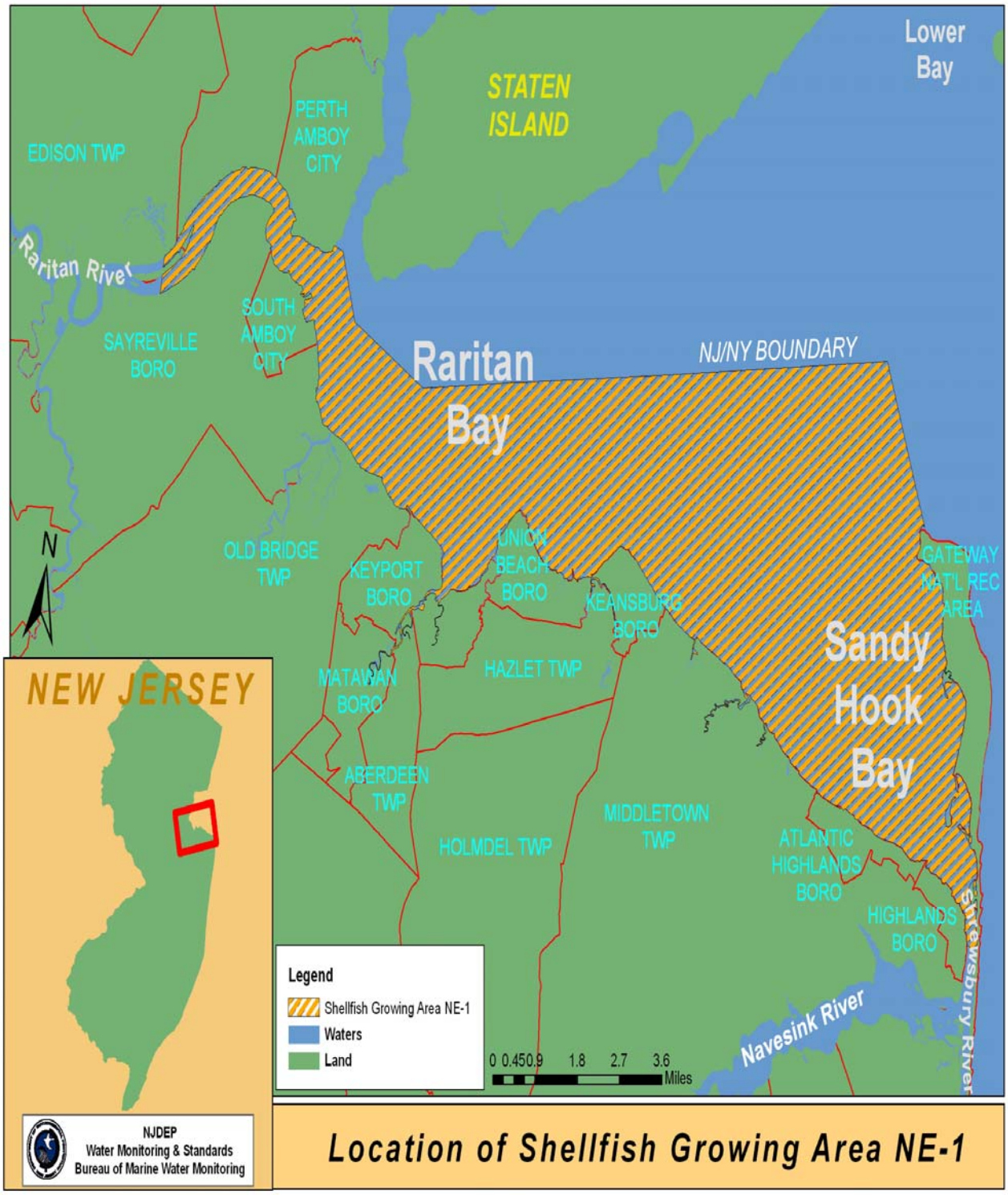


TABLE 1: POPULATION STATISTICS

Communities	2009 Est. Population	2000 Census Count	Est. Population Growth (%)	Population Density (person/sq mile)
Monmouth County (Source: Monmouth County Planning Board)				
Highlands Borough	5,189	5,097	1.8%	6,530
Middletown Borough	70,062	67,479	3.8%	1,641
Atlantic Highlands Borough	4,717	4,705	0.3%	3,729
Keansburg Borough	10,793	10,732	0.6%	9,825
Union Beach Borough	6,800	6,649	2.3%	3,531
Hazlet Twp	21,555	21,378	0.8%	3,543
Keyport Borough	7,688	7,568	1.6%	5,275
Aberdeen Twp	18,875	17,454	8.1%	3,326

Communities	2010 Est. Population	2000 Census Count	Est. Population Growth (%)	Population Density (person/sq mile)
Middlesex County (Source: Middlesex County Dept. of Planning)				
Old Bridge Twp	69,573	62,032	12.2%	1,721
Sayreville Borough	45,584	39,193	16.3%	2,671
South Amboy City	8,061	7,861	2.5%	5,078
Perth Amboy City	48,397	45,415	6.6%	10,172
Woodbridge Twp	100,969	98,441	2.6%	4,310
Edison Twp	102,825	95,128	8.1%	3,305

DESCRIPTION

This shellfish growing area is larger than most of the growing areas in the state. The approximate size of this growing area is about 33,118 acres. The current shellfish classifications are: *Special Restricted and Prohibited.* The majority of waters are classified as *Special Restricted* (Chart 1). Areas that are classified as *Special Restricted* include Sandy Hook Bay (except for the buffer zone that surrounds the Atlantic Highlands Municipal Yacht Basin, which is classified as *Prohibited*.) The *Prohibited* areas can be found in the Raritan River, portions of Raritan Bay, Union and Belvedere Beaches, Atlantic Highlands Municipal Yacht Basin, and Keyport Harbor (Figure 4).

Because this growing area is classified as *Special Restricted* and *Prohibited*, there is no direct market of shellfish harvested from this area. Shellfish that are harvested must undergo depuration before they are marketable. The Depuration program was established in 1973 to help purify shellfish from contaminants in the Raritan and Sandy Hook Bays. Depuration is a process that purifies the shellfish by pumping UV treated bacteria-free water through clams in holding tanks for a minimum of 48 hours, which will "render the depurated shellfish alive, and microbiologically acceptable within the meaning of State statutes and regulations" (N.J.A.C. Chapter 12 7:12-1.2, 1994-2005). There are assigned areas for shellfish harvesting (Figure 5). Clammers with appropriate licenses and permits are allowed to harvest shellfish from these assigned areas (Figure 6). Harvesting of shellfish outside the assigned areas is illegal.

Today, depuration constitutes approximately 100 percent of hard clams harvested from the *Special Restricted* waters in this area. This is because depuration produces marketable shellfish in less time than the Relay program (Figure 7). Under the Relay program, hard clams harvested in *Special Restricted* waters, must be replanted in Approved waters on special leased lots for a minimum of 30 days for the purposes of natural purification prior to marketing.

CHART 1: 2009 SHELLFISH CLASSIFICATION STATISTICAL BREAKDOWNS

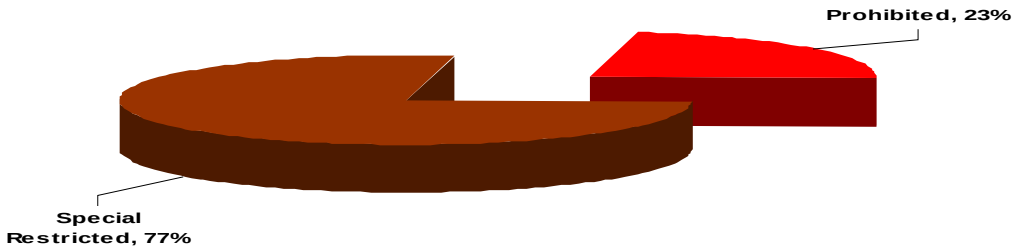


FIGURE 4: 2009 SHELLFISH CLASSIFICATIONS FOR GROWING AREA NE-1

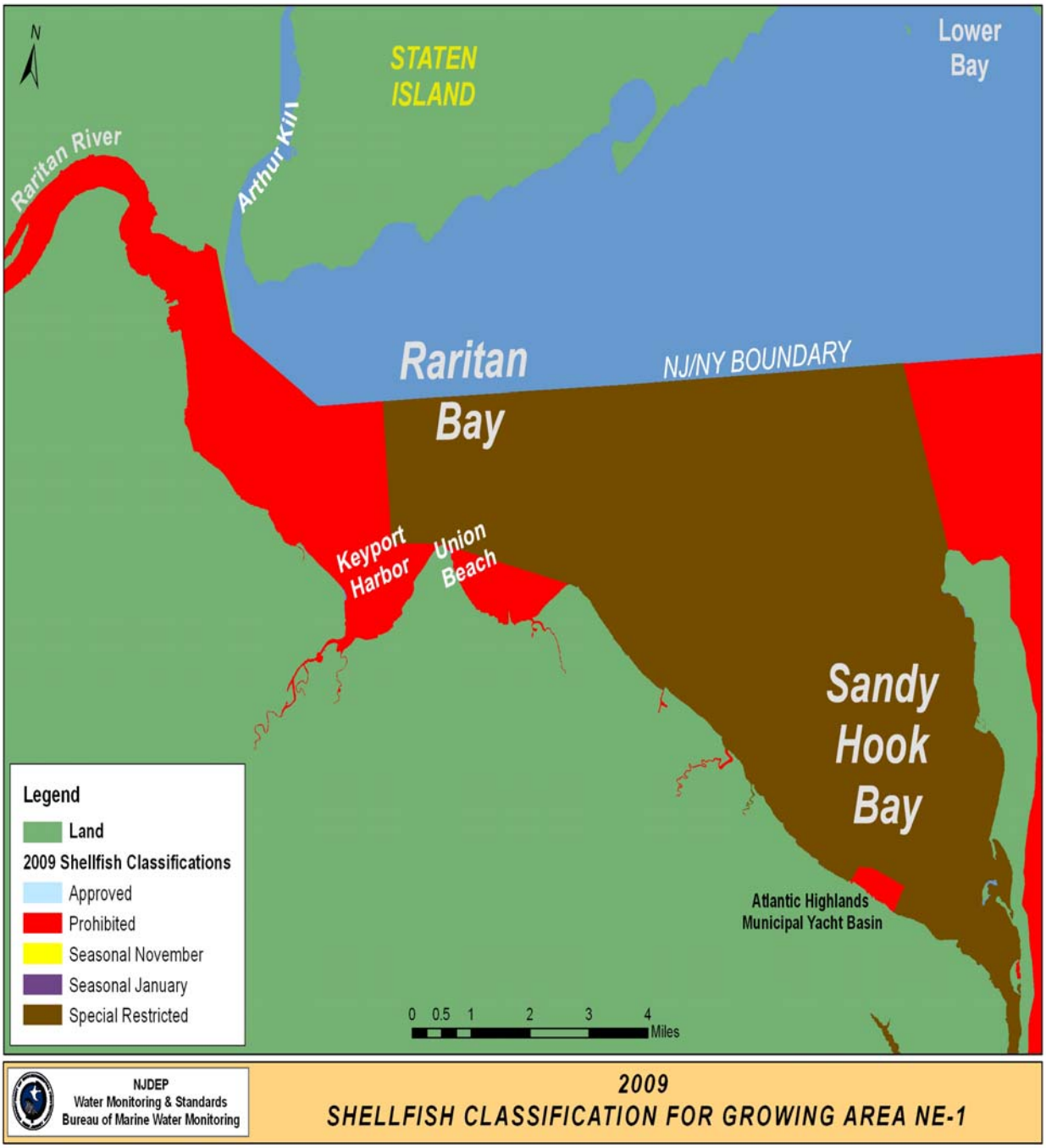


FIGURE 5: SHELLFISH HARVEST AREAS ASSIGNED FOR DEPURATION

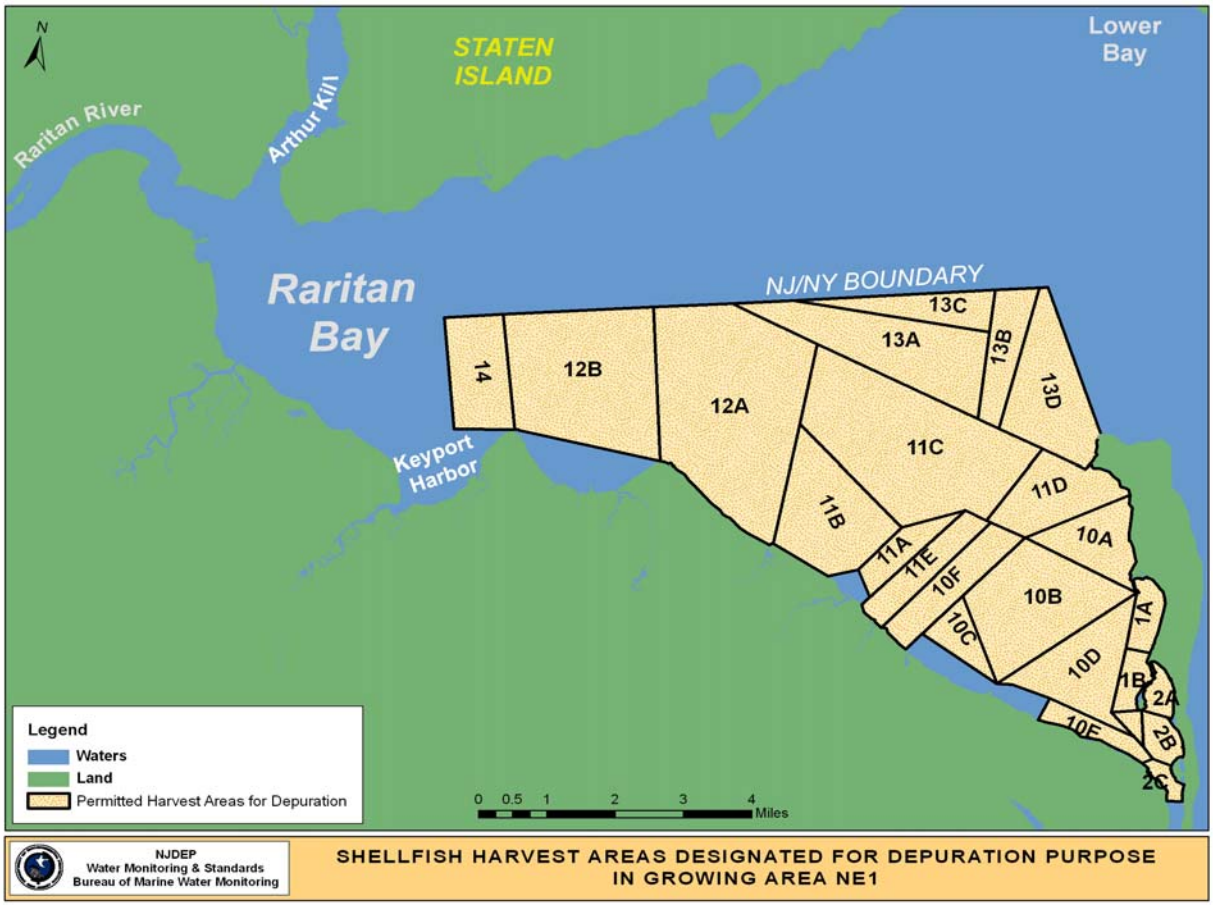


FIGURE 6: CLAMMERS DIGGING FOR CLAMS IN THE RARITAN/SANDY HOOK BAYS

FIGURE 7: CLAMS ARE BROUGHT TO THE DEPURATION PLANT FOR PURIFICATIONS

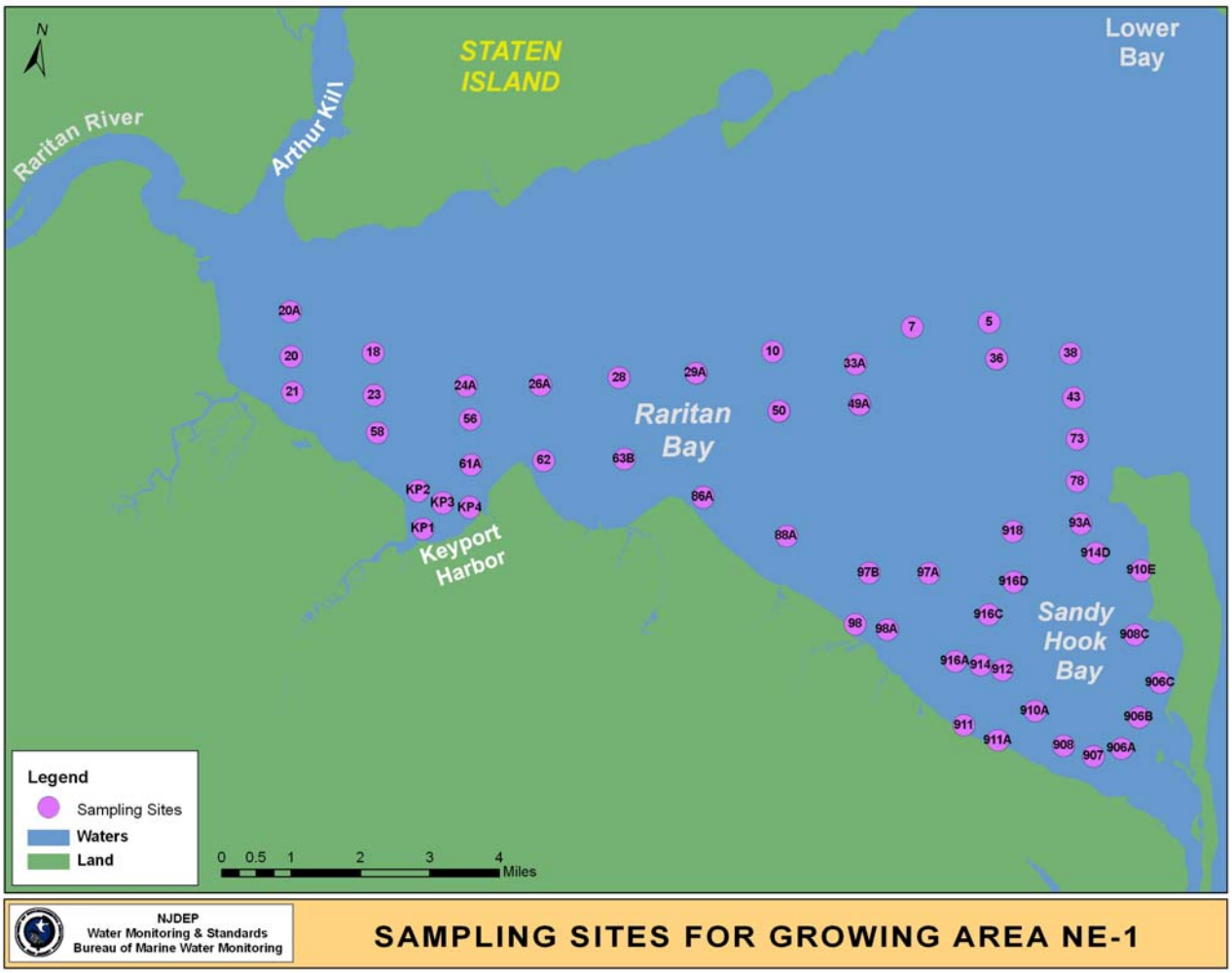
METHODS

Water sampling was performed in accordance with the Field Procedures Manual (NJDEP, 1992).

Approximately 3,164 water samples were collected for total coliform bacteria between 2001 and 2008 and analyzed by the standard three tube MPN method, standard three tube four dilution method, and/or the MPN 5 tube-3 dilution method (APHA, 1970). Figure 8 shows the monitoring stations in for this growing area. Approximately 53 stations are monitored during each year. Water quality sampling, shoreline and watershed surveys were conducted in accordance with the NSSP *Guide for the Control of Molluscan Shellfish*, 2003 Revision.

Data management and analysis was accomplished using database applications developed for WM&S/BMWM. Mapping of pollution data was performed with the Geographic Information System (GIS: ARC map).

FIGURE 8: SAMPLING STATIONS FOR SHELLFISH GROWING AREA NE-1



BACTERIOLOGICAL INVESTIGATION AND DATA ANALYSIS

SAMPLING STRATEGY

The State Shellfish Control Authority has the option of choosing one of two water monitoring sampling strategies for each growing area. For additional information on the types of sampling strategies see the *Shellfish Growing Area Report Guidance Document, 2007.* This shellfish growing area was sampled using Adverse Pollution Condition Sampling Strategy for the sampling stations listed under Assignments 017 and 027.

NSSP CRITERIA

Each shellfish-producing state is directed to adopt either the total coliform criterion, or the fecal coliform criterion. While New Jersey bases its growing water classifications on the total coliform criterion, it does make corresponding fecal coliform determinations for specific growing areas. These data are viewed as adjunct information and are not directly used for classification.

The criteria were developed to ensure that shellfish harvested from the designated waters would be free of pathogenic (disease-producing) bacteria. Each classification criterion is composed of a measure of the statistical 'central tendency' (geometric mean) and the relative variability of the data set. For the Adverse Pollution Condition sampling strategy, variability is expressed as the percentage that exceeds the variability criteria (Table 2). For the Systematic Random Sampling Strategy, variability is expressed as the 90^{th} percentile. Areas to be approved under the *Seasonal* classification must be sampled and meet the criterion during the time of the year that it is approved for the harvest of shellfish.

TABLE 2: CRITERIA FOR ADVERSE POLLUTION SAMPLING STRATEGY

	Total Coliform Criteria		Fecal Coliform Criteria	
	Geometric mean (MPN/100 mL)	**No more than 10% can exceed (MPN/100 mL)**	**Geometric mean (MPN/100 mL)**	**No more than 10% can exceed (MPN/100 mL)**
Approved Water Classification	70	330	14	49
Special Restricted Water Classification	700	3300	88	300

SHORELINE SURVEY

CHANGES SINCE LAST SURVEY

The most recent shoreline survey of this area was conducted in September 2008 and January 2009. There have been no significant changes to the shoreline except for the construction of new town homes in Port Monmouth near Belford (Figure 9). This development has about 60 town homes and all are connected to city sewer. Impacts to shellfish waters from this development will be minimal to none.

The Route 36 Highlands Bridge over the Shrewsbury River, that connects the Highlands Borough to Sea Bright, was still under construction (Figure 10). This 35' movable bridge was built in 1932 and is now rated the worst movable bridge in New Jersey (NJDOT). During a shoreline survey conducted in 2006, it was noted that the metal frames of the bridge were corroded and had begun to deteriorate (Figure 11). It is being replaced with a 65' fixed bridge and is estimated to cost roughly $124 million. The overhaul to this bridge began in 2008 and is projected to be complete in 2011.

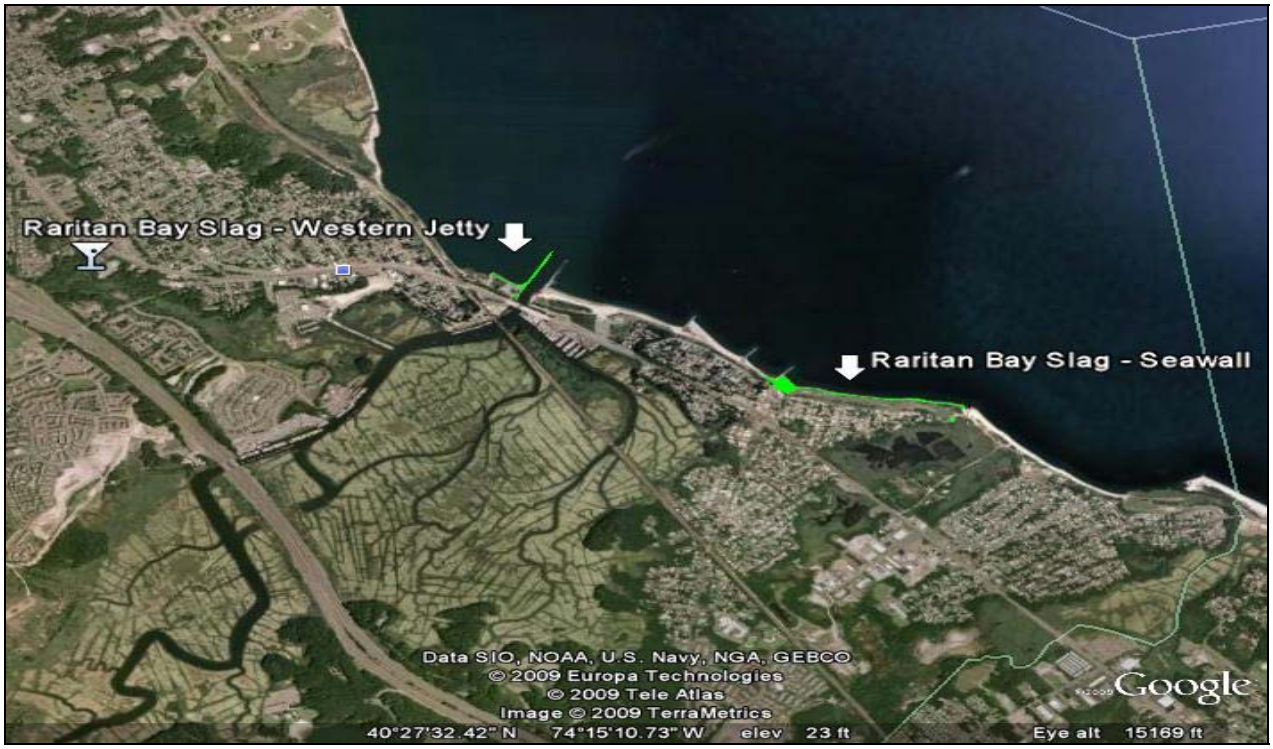
In 2007, NJDEP began surveying and collecting samples at the Cheesequake Creek Inlet and Laurence Harbor beachfront. At these sites, they found old batteries casing and exceptionally high lead concentration. To protect the public's health, Old Bridge Township has placed a temporary fence around the area of concern. NJDEP and EPA are working on a resolution and remediation action. In April 2009, these sites along the shoreline on the Raritan Bay were added onto EPA Superfund National Priorities List (NPL). The locations of these sites are shown in Figure 12.

FIGURE 9: NEW TOWN HOMES, PORT MONMOUTH

FIGURE 10: RT. 36 HIGHLANDS BRIDGE

FIGURE 11: RT. 36 HIGHLANDS BRIDGE (VIEW FROM BENEATH)

FIGURE 12: RARITAN BAY SLAG SITES



LAND USE

There are several different categories of land use. Land use can be identified as *Urban, Barren, Agriculture, Forest, Water,* and *Wetlands*. Land uses are categorized by using the USGS Anderson Classification System.

Agriculture consists of agricultural wetlands, confined feeding operations, cropland and pastureland, orchards, vineyard nurseries, horticultural areas, and any other agricultural areas. Examples of barren lands are beaches and or vacant land. Forest area includes brushland/scrubland and coniferous forest. Urban lands are identified as athletic fields, commercial service, industrial uses, military reservations, recreational land, residential use, transportation, communication, utilities, and any other build-up land. Land classified as water includes artificial lakes, dredged lagoons, natural lakes, streams and tidal waters. Wetlands consist of fresh water tidal marshes, herbaceous, managed wetland, mixed forested and saline marshes.

Shellfish growing area NE-1 is adjacent to the Arthur Kill (WMA 07), Lower Raritan (WMA 09), and Monmouth (WMA 12) Watershed Management Areas (Figure 13). These areas are highly developed, with industrial, commercial, and residential uses. Table 3, lists the land usage from the 1995 and 2002 surveys. It also lists the net change between 1995 and 2002 for each land use type. Figure 14 shows the land use pattern adjacent to shellfish growing area NE-1. Urban development takes up the majority of land usage in this area. As population grows and more urban lands are needed, forest, wetland, and agriculture landscape are used to develop urban areas (Figure 15).

FIGURE 13: WATERSHED MANAGEMENT AREAS

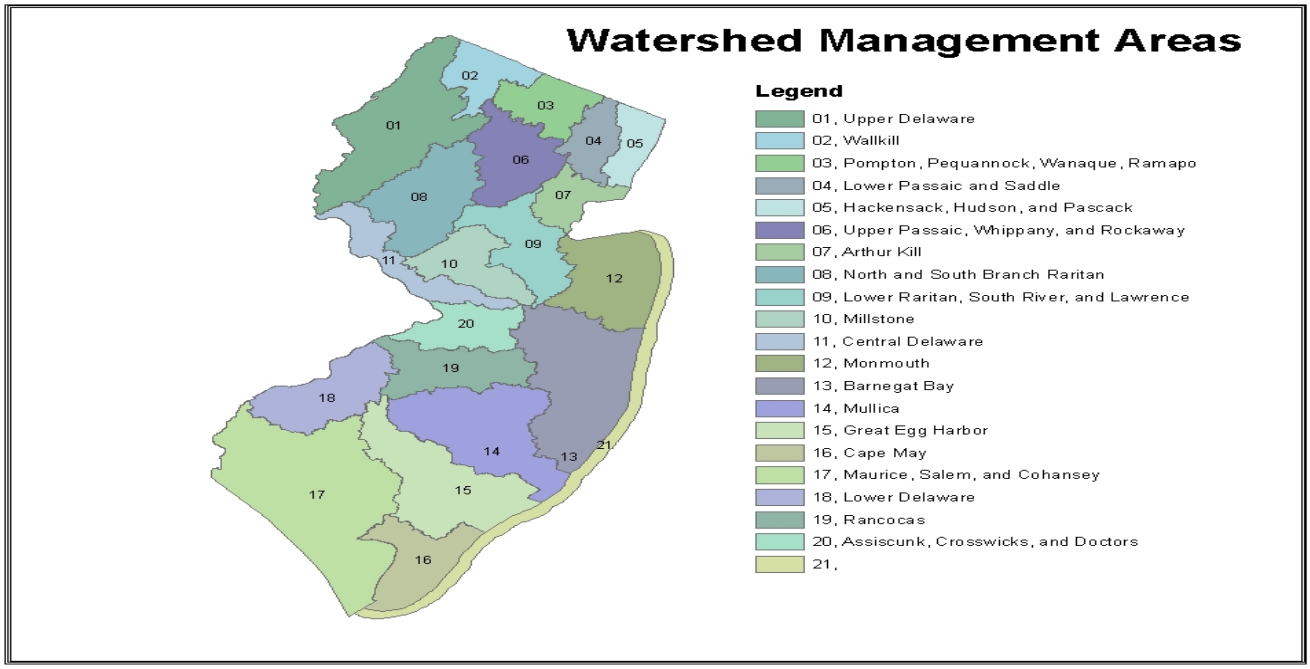


TABLE 3: LAND USE/LAND COVER STATISTICS (SOURCE: NJDEP)

Land Use Type	1995 (Acres)	2002 (Acres)	Net Change (Acres)
	WMA 12 (MONMOUTH)		
Agriculture	16,776	12,781	-3,995
Barren Land	4,045	5,192	1,147
Forest	36,399	33,686	-2,713
Urban Land	99,237	106,975	7,738
Water	97,554	97,061	-492
Wetlands	43,593	41,907	-1,685
	WMA 9 (LOWER RARITAN, SOUTH RIVER, AND LAWRENCE)		
Agriculture	15,644	12,606	-3,038
Barren Land	4,707	4,368	-338
Forest	40,575	37,912	-2,662
Urban Land	114,638	122,757	8,119
Water	5,683	5,685	1
Wetlands	43,794	41,713	-2,081
	WMA 7 (ARTHUR KILL)		
Agriculture	123	116	-7
Barren Land	694	1,490	796
Forest	10,367	9,196	-1,170
Urban Land	88,108	88,722	614
Water	10,679	10,672	-7
Wetlands	4,939	4,713	-226

FIGURE 14: LAND USE PATTERNS FOR GROWING AREA NE-1

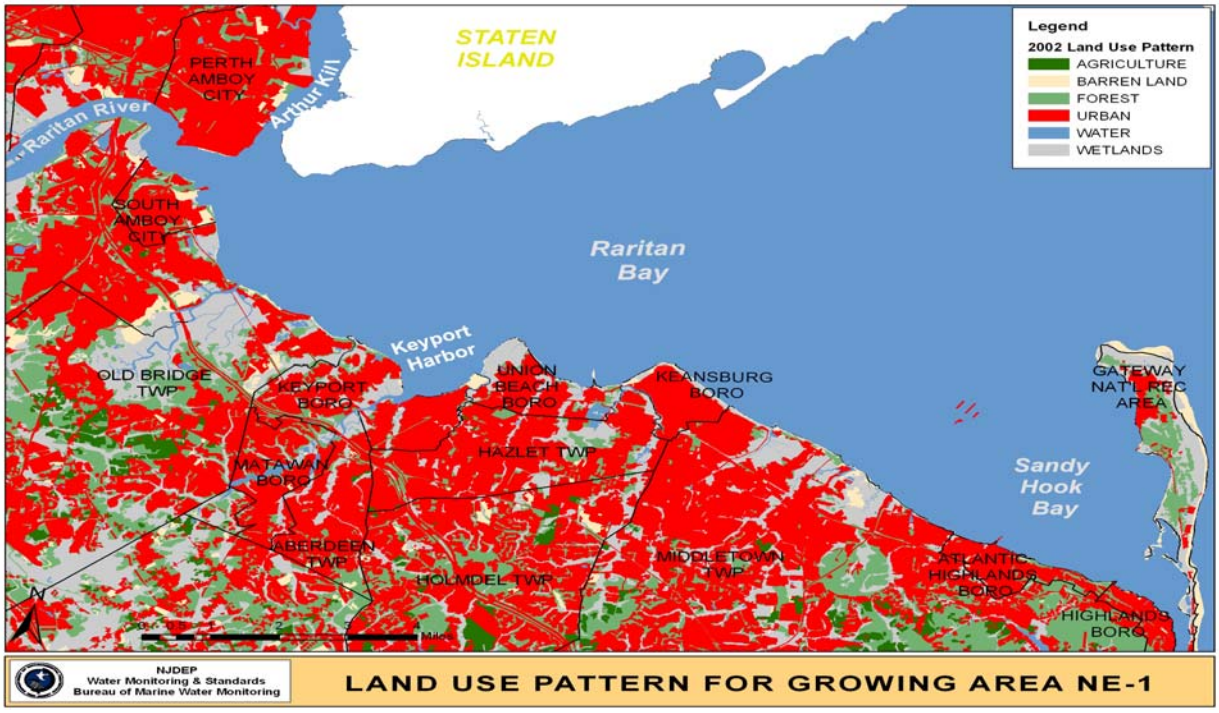


FIGURE 15: GROWING AREA NE-1 LANDSCAPE

EVALUATION OF BIOLOGICAL RESOURCES

According to the National Marine Fisheries Service (NMFS), New Jersey is considered as one of U.S. major ports for commercial fishery landings. There are five major fishing ports in New Jersey: Belford, Point Pleasant, Barnegat Light, Atlantic City, and Cape May (Figure 16). Four of these ports are ranked among the top 50 ports in the nation based on harvest value. Cape May is the leading port in New Jersey (Chart 2), and in 2007, it ranked eighth in the nation with a harvest value of over $57.7 million. Table 4 lists the different types of shellfish harvested in New Jersey waters between 2004 and 2007. In 2007, approximately 80 million pounds of shellfish were harvested from New Jersey, which was estimated to be worth over $114 million dollars.

Data generated from NMFS indicated that New Jersey waters contain an abundance of biological resources that are beneficial to the state economy. In 2000, NJDEP Fish & Wildlife conducted a shellfish survey of the Raritan/Sandy Hook Bays and the results indicated the populations of shellfish like the northern quahog (*Mercenaria mercenaria*) and soft clams (*Mya arenaria*) do exist. They also estimated the densities of the different types of shellfish species that were nested in these waters. Their finding show that hard clams (*Mercenaria mercenaria*) exist in moderate to high densities. There are also blue mussels (*Mytilus edulis*), eastern oysters (*Crassostrea virginica*), and Atlantic surf clams (*Spisula solidissima*) that were found in deeper water north of Sandy Hook Bay (Figure 17).

Beside shellfish, there are over 90 different species of fish found in the Raritan and Sandy Hook Bays. The most abundant are the mummichogs (*Fundulus heteroclitus*), white perch (*Morone americana*), and hogchoker (*trinectes madcatus*). Due to its geographic locations and ecosystem, Raritan and Sandy Hook Bays provide support for a large number of rare and endangered species. This includes shorebirds, raptors, waterfowl, landbirds, and a variety of migratory insects. Species like the leatherback sea turtle (*Dermochelys coriacea*), piping plover (*Charadruis melodus*), black skimmer (*Rhynchops nigher*), great blue heron (*Ardea herodias*), and osprey (*Pandion haliaetus*) are examples of some of the species that can be found in the Raritan and Sandy Hook Bay that are listed as endangered species [www.csc.noaa.gov].

FIGURE 16: NEW JERSEY'S COMMERCIAL FISHING PORTS

CHART 2: HARVEST VALUE BY NEW JERSEY COMMERICAL FISHERY PORTS (SOURCE: MNFS)

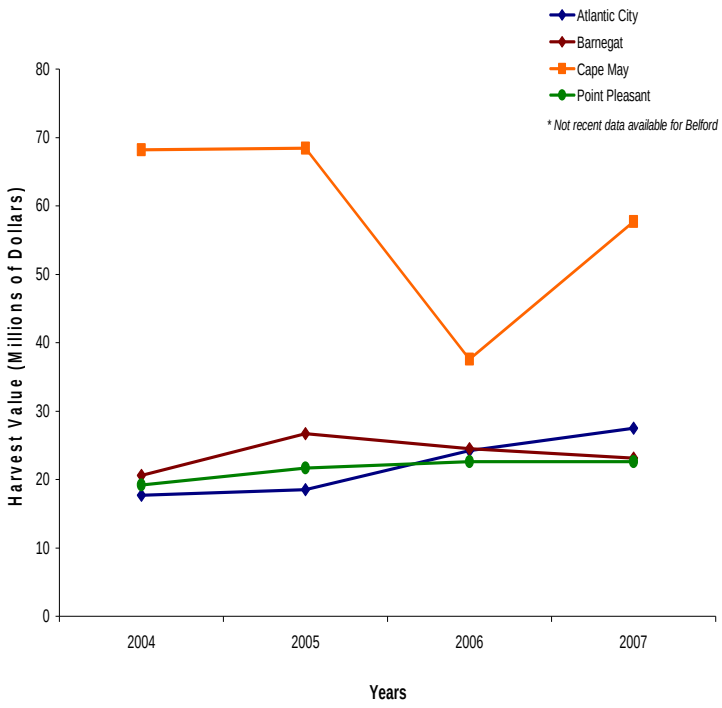
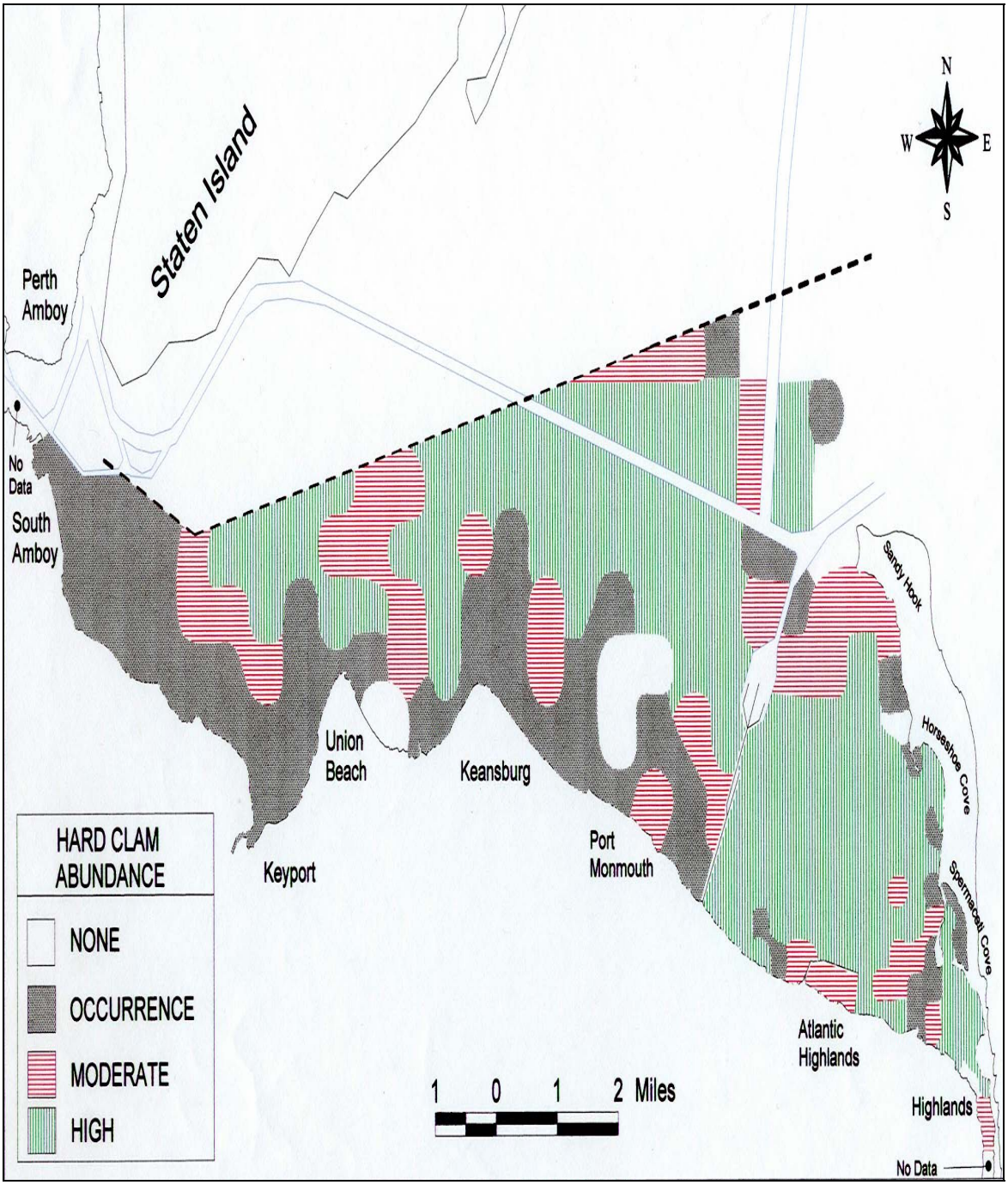


TABLE 4: NEW JERSEY HARVEST VALUE BY SHELLFISH SPECIES BETWEEN 2004-2007

Species	2004		2005		2006		2007	
	Pound	Value	Pound	Value	Pound	Value	Pound	Value
Clam, Atlantic Surf	43,521,704	22,284,335	38,967,993	20,028,662	43,643,726	25,107,029	44,791,212	26,546,602
Clam, Ocean Quahog	17,633,600	9,094,961	10,881,280	5,538,074	11,642,560	5,930,919	239,733	968,308
Clam, Quahog	1,795,538	7,409,304	1,852,108	7,555,885	1,843,991	7,614,520	10,954,880	5,815,130
Oyster, Eastern	323,049	1,558,136	161,526	822,609	350,391	2,287,598	444,227	2,230,835
Scallop, Bay	379	2,970	NR	NR	NR	NR	NR	NR
Scallop, Sea	13,737,471	67,498,391	11,832,083	88,494,268	8,440,365	57,471,205	11,808,426	77,365,575
Shellfish	123	39	7,339,355	2,051,726	10,672,426	1,843,916	11,713,908	1,882,483
Total	**77,011,864**	**$107,848,136**	**71,034,345**	**$124,491,224**	**76,593,459**	**$100,255,187**	**79,952,386**	**$114,808,933**

**NR = Not Reported*

FIGURE 17: 2000 SHELLFISH SURVEY OF THE RARITAN/SANDY HOOK BAYS



IDENTIFICATION AND EVALUATION OF POTENTIAL POLLUTION SOURCES

The discharge of pollutants from a point source is authorized under New Jersey Pollutant Elimination System (NJPDES), and the regulations are found at N.J.A.C. 7:14A. The main purpose of the NJPDES program is to ensure proper treatment and discharges of wastewater. By doing so, the permit limits the amount or concentration of pollutants that can be discharged into ground water, streams, rivers, and the ocean. Facilities regulated under this program include mines, schools, hospitals, large corporate office buildings, industrial manufacturing facilities, campgrounds, mobile home parks, food processors, potable water treatment plants, sewage treatment plants, or any dischargers that may have the potential to impact water quality.

As of January 2008, there were 5,581 active permits. The number of active permits includes permits for all NJPDES permit classes, including Discharge to Surface Water (DSW), Discharge to Groundwater (DGW), Significant Indirect User (SIU), Discharge of Stormwater (DST), and Residuals (RES), (NJDEP, Division of Water Quality).

DIRECT DISCHARGES

Direct discharges have the greatest potential to impact water quality. Examples of direct discharges are surface water discharge, storm water discharge, and marinas.

Surface Water Discharges

A surface water discharge involves the release of treated effluent from various municipal and industrial facilities directly into a river, stream, or the ocean.

According to the NJPDES program, there is only one surface discharger found in this shellfish growing area, which is the Middlesex County Utilities Authority (MCUA). This facility's discharge point is located in the *Prohibited* waters of the Raritan Bay, approximately three miles west of the *Special Restricted* waters (Figure 18). The most recent inspection for this facility was completed in June 2008. Several violations were reported for this facility between 2000 and 2008. Most of these violations were minor with the exception of one that occurred in March 2003.

In March 2003, the 102 Sayreville Relief Force Main ruptured causing an unpermitted discharge of raw sewage to a tributary of the Raritan River (Figure 19). According to the report sent to WM&S/BMWM, approximately 570 million gallons of raw sewage spilled into the Raritan Bay. The discharge continued while repairs were being done. As a result, 29,427 acres of shellfish beds in the Raritan Bay, Sandy Hook Bay, Navesink River, and Shrewsbury River were closed due to this unpermitted discharge. For further detail, see section on "*Spills & Unpermitted Discharges*".

FIGURE 18: MIDDLESEX COUNTY UTILITIES AUTHORITY DISCHARGE POINT

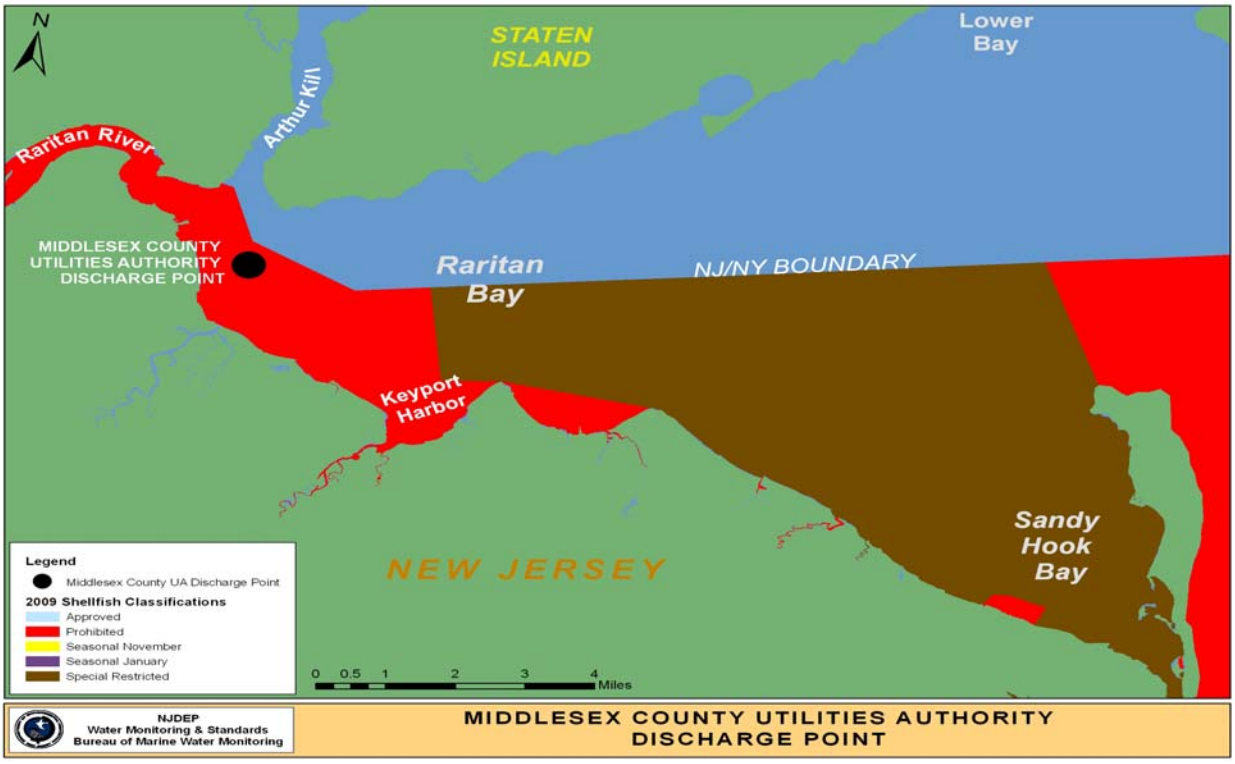
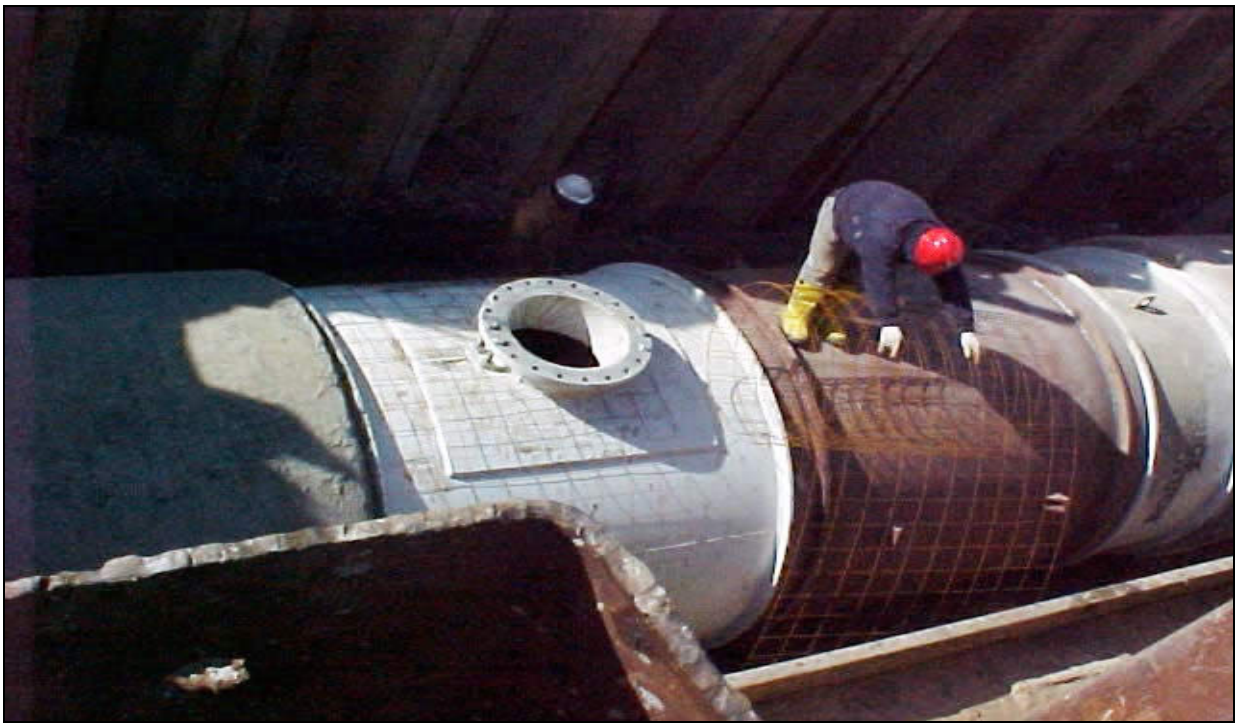


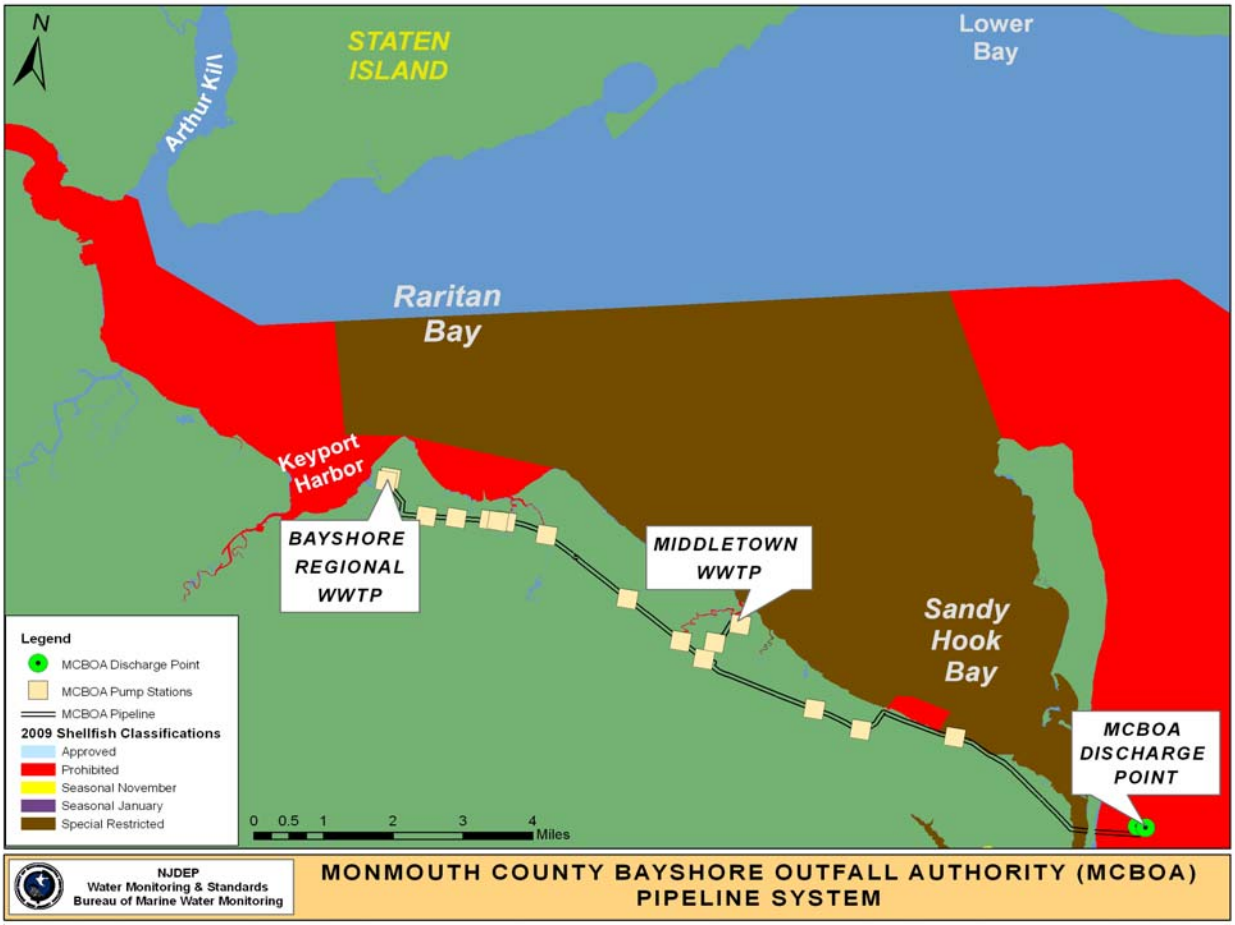
FIGURE 19: MCUA 102 SAYREVILLE RELIEF FORCE MAIN REPAIR (SOURCE: MCUA)



The Monmouth County Bayshore Outfall Authority (MCBOA) was established in 1969, with the intention of taking effluent away from the Raritan Bay which was being contaminated by local sewage treatment plants. MCBOA operates a 14-mile long pipeline from Union Beach to Sandy Hook, which conducts treated effluent from Bayshore Regional Sewerage Authority and Middletown Sewage Authority to the ocean floor, approximately 1 mile east of the beach (Figure 20). Bayshore Regional Sewerage Authority and Middletown Sewage Authority provide service to 12 nearby municipalities. Several violations were reported from these facilities. Some were serious violations, however, none resulted in the closure of shellfish waters. Serious violations include exceeding the Effluent Gross Value Limit. Violation Reports for these facilities can be found through the NJDEP Data Miner database http://datamine2.state.nj.us/dep/DEP_OPRA/.

MCBOA is not a direct discharger to this shellfish growing area. However, there is always a potential risk of raw sewage inadvertently discharging to shellfish waters from the Bayshore Regional and Middletown Sewage Authorities. Therefore, MCBOA is mentioned in this section of the report.

FIGURE 20: MCBOA PIPELINE SYSTEM AND DISCHARGE POINT



Storm Water Inputs

Stormwater runoff is generated when precipitation from rain and snowmelt flows over land or impervious surfaces and does not percolate into the ground. As the runoff flows over the land or impervious surfaces (paved streets, parking lots, and building rooftops), it accumulates debris, chemicals, sediment or other pollutants that could adversely affect water quality if the runoff is discharged untreated. Table 5 lists the typical pollutants that are associated with stormwater run-off. Figure 21 show the location of the stormwater outfalls that are in Monmouth County. Stormwater outfalls located in Middlesex County were not depicted on this map because no data is yet available.

Major emphasis is placed on the outfalls situated in close proximity to shellfish growing waters. Most of the outfalls in this area discharge to nearby creeks. However, there are some that discharge directly to the Raritan and Sandy Hook Bays.

TABLE 5: TYPICAL STORMWATER POLLUTANT (SOURCE WWW.NJSTORMWATER.ORG)

Pollutant	Typical Concentration
Total suspended solids [a]	80 mg/l
Total phosphorus [b]	0.30 mg/l
Total nitrogen [a]	2.0 mg/l
Total organic carbon [d]	12.7 mg/l
Fecal coliform bacteria [c]	3600 MPN/100ml
E. Coli bacteria [c]	1450 MPN/100ml
Petroleum hydrocarbons [d]	3.5 mg/l
Cadmium [e]	2 ug/l
Copper [a]	10 ug/l
Lead [a]	18 ug/l
Zinc [e]	140 ug/l
Chlorides [f] (winter only)	230 mg/l
Insecticides [g]	0.1 to 2.0 ug/l
Herbicides [g]	to 5.0 ug/l

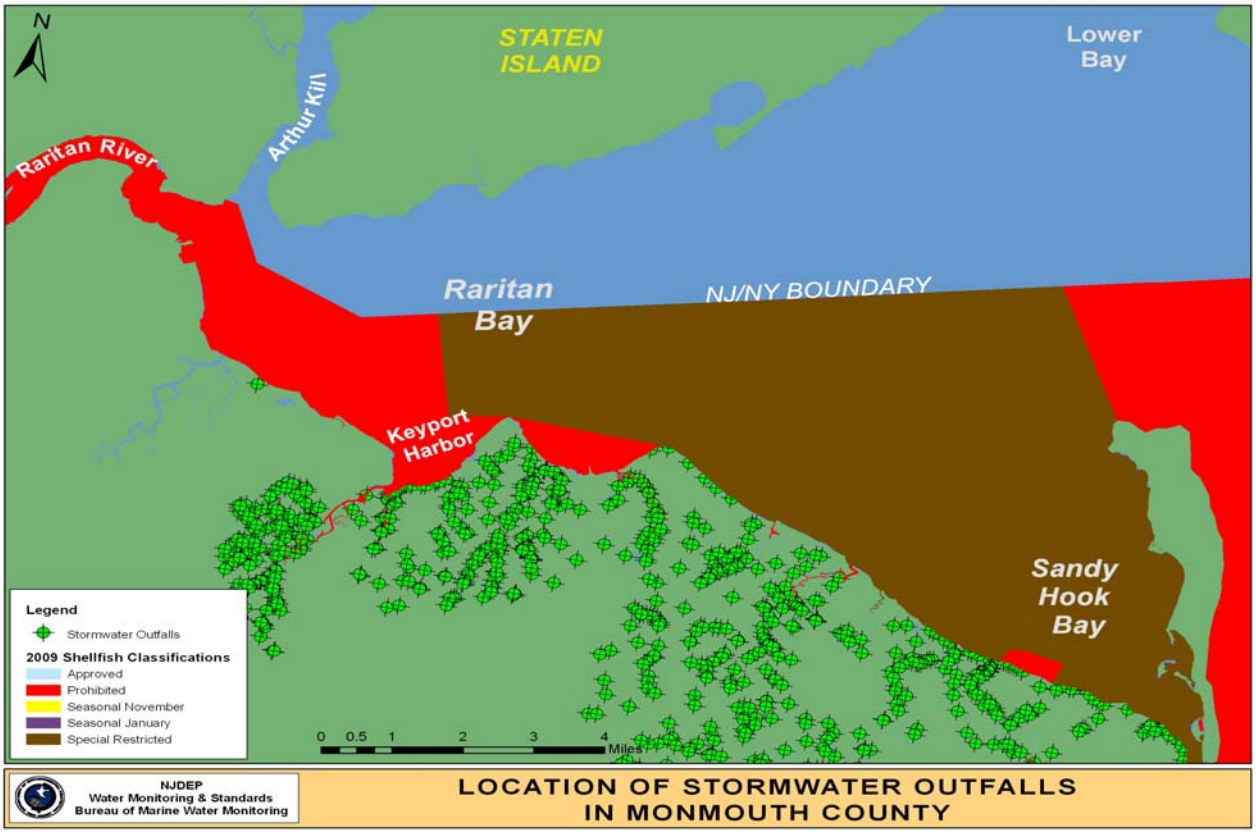
Notes

1. Data sources: [a] Schueler (1987), [b] Schueler (1995), [c] Schueler (1997), [d] Rabanal and Grizzard (1996), [e] USEPA (1983), [f] Oberts (1995), [g] Schueler (1996).

2. Concentrations represent mean or median storm concentrations measured at typical sites and may be greater during individual storms. Mean or median runoff concentrations from stormwater hotspots are higher than those shown

3. Units: mg/l = milligrams/liter ug/l = micrograms/liter MPN = Most Probable Number

FIGURE 21: LOCATION OF STORMWATER OUTFALLS IN MONMOUTH COUNTY

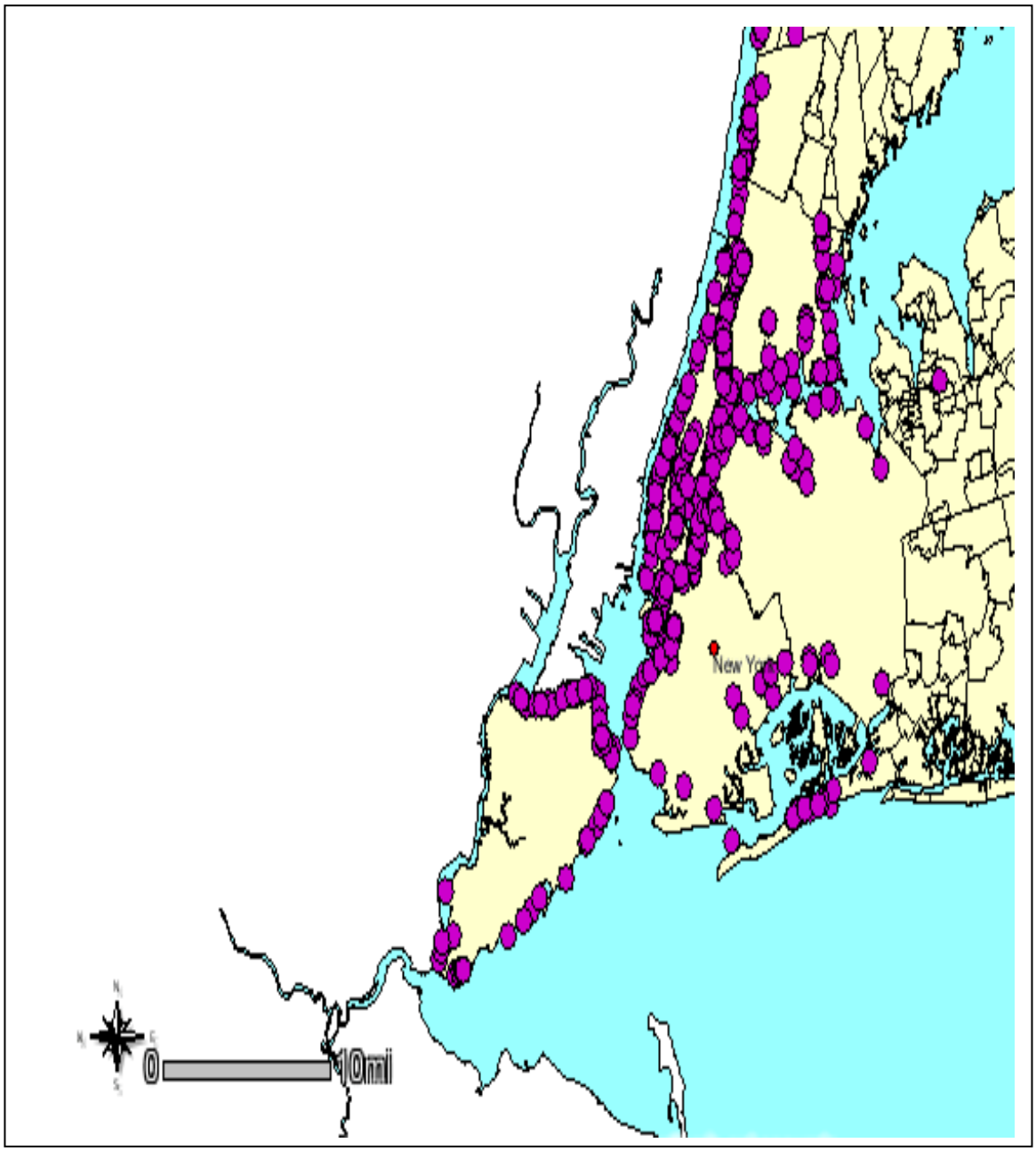


The water quality of this shellfish growing area is not only influenced by the outfalls located within this area, but is also affected by other discharges that occurred outside the growing area. Due to the direction of tidal flows, discharges from New York and the Shrewsbury River can also affect the Raritan and Sandy Hook Bays.

Besides the ordinary impact from stormwater outfalls, this area is also impaired by Combined Sewer Overflows (CSOs). CSOs are a combination of raw sewage and pollution runoff that overflow into nearby waterbodies without treatment. This usually occurs during heavy rainfall, when the sewer systems are unable to handle the increased capacity of water mixed with sewage. CSOs contain untreated human waste, ammonia, pesticides, nutrients, petroleum products, and potential toxins and pathogenic microorganisms associated with human disease, such as hepatitis, gastrointestinal disorders, dysentery, and swimmer's ear infection.

CSOs can be found along the tidal portion of the Raritan River, along the Passaic River in Paterson, and throughout the New York-New Jersey Harbor Complex (Figure 22). There are approximately 280 CSO discharge points located throughout the state. NJDEP is working with treatment facilities to develop new plans and solutions to reduce CSOs throughout the state.

FIGURE 22: LOCATION OF CSOS IN NJ/ NYC (SOURCE: NEW YORK STATE DEPT. OF ENVIRONMENTAL CONSERVATION)



Marinas

Marina facilities have the potential to affect the suitability of shellfish growing areas for the harvest of shellfish. The biological and chemical contamination associated with marina facilities may be of public health significance. The discharge of sewage from vessels into the waterways can contribute to the degradation of the marine environment by introducing disease-causing microorganisms (pathogens), such as bacteria, protozoan and viruses, into the marine environment. In addition, sewage released in the vicinity of shellfish beds poses a public health problem. Because shellfish are filter feeders, they concentrate the pathogens in their tissue, thereby causing the shellfish to be unsafe for human consumption. The most notable diseases potentially transmitted by the ingestion of shellfish contaminated with pathogens are gastroenteritis, dysentery, infectious hepatitis, and typhoid fever. Chemical compounds, such as oil and gasoline resulting from spills or leaks from vessels, can poison fish and other marine organisms. Research has shown that by-products from the biological breakdown of petroleum products can harm fish and wildlife and pose threats to human health if ingested.

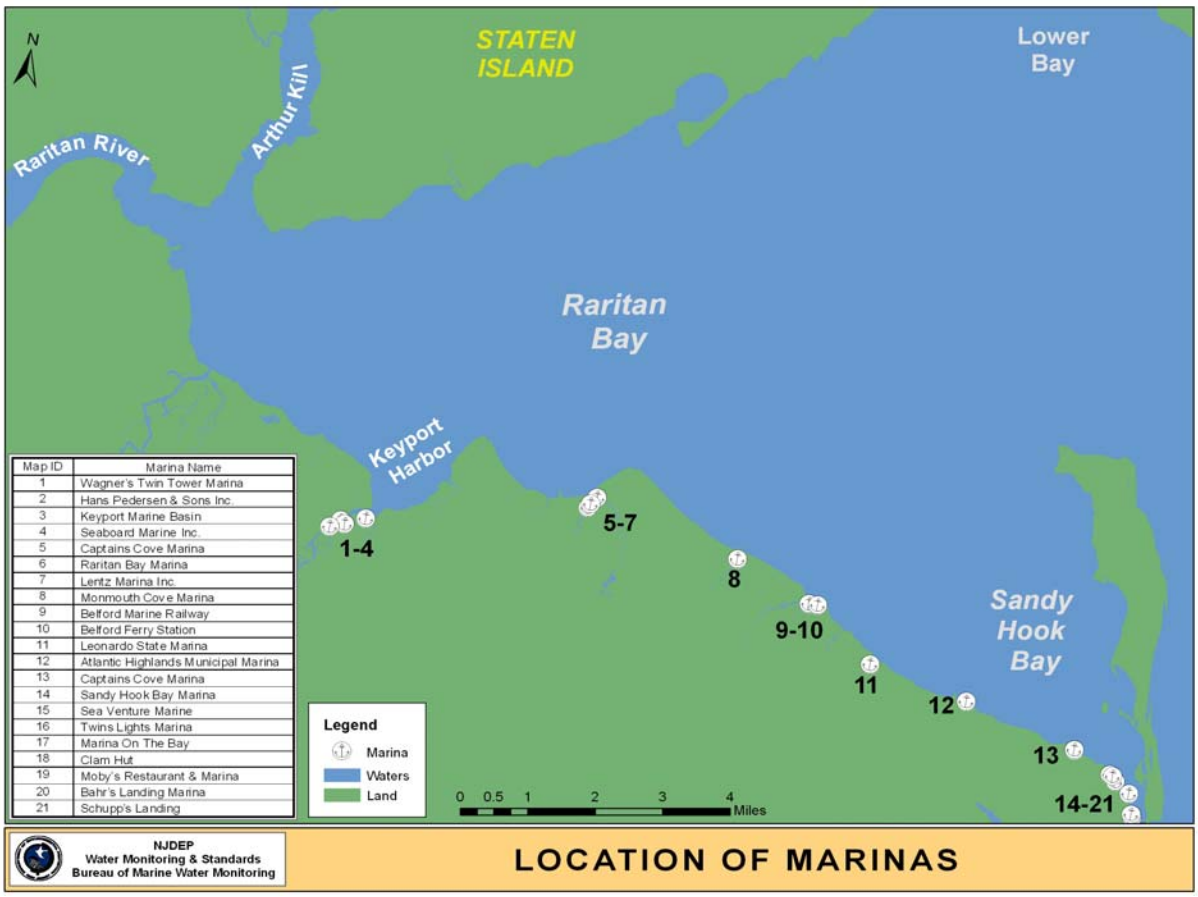
There are 21 marinas in shellfish growing area NE-1, as shown in Table 6. The location of these facilities can be found on Figure 23. The waters enclosed by the marina (the marina basin) are classified as *Prohibited*. Depending on the size of the marina, the water quality, flushing rates, and the depth of the water, shellfish waters immediately adjacent to each marina may be classified as *Prohibited*, *Special Restricted*, or *Seasonally Approved* (no harvest during summer months when the marina is normally active).

NJDEP implemented the New Jersey Clean Marina Program to protect waters from being polluted by marina activities. This is a volunteer-based program for marinas. The program provides assistance and guidance to marina owners as well as boaters on ways to reduce pollution, including sewage facility management, fueling operations, fish and solid waste management and boat cleaning. Currently, there are only a small percentage of marinas in the state that participate in this program. A list of marinas that are certified and/or have pledged under this program are listed on the New Jersey Clean Marina Program website (www.njcleanmarina.org).

TABLE 6: MARINA INFORMATION FOR NE-1

Map ID	Marina Name	Total Slips	Clean Marina Certified
1	Wagner's Twin Tower Marina	190	No
2	Hans Pedersen & Sons Inc.	90	No
3	Keyport Marine Basin	273	Yes
4	Seaboard Marine Inc.	50	No
5	Captains Cove Marina	60	No
6	Raritan Bay Marina	96	No
7	Lentz Marina Inc.	10	No
8	Monmouth Cove Marina	130	No
9	Belford Marine Railway	10	No
10	Belford Ferry Station	1	No
11	Leonardo State Marina	175	Yes
12	Atlantic Highlands Municipal Marina	600	Yes
13	Captains Cove Marina	50	No
14	Sandy Hook Bay Marina	100	No
15	Sea Venture Marine	20	No
16	Twins Lights Marina	20	No
17	Marina On The Bay	130	No
18	Clam Hut	24	No
19	Moby's Restaurant & Marina	5	No
20	Bahr's Landing Marina	30	No
21	Schupp's Landing	9	No

FIGURE 23: LOCATION OF MARINAS IN SHELLFISH GROWING AREA NE-1



INDIRECT DISCHARGES

Indirect discharges are any type of discharges that do not normally impact shellfish growing water, but do have some potential to affect water quality if and only if improper disposal was done.

Examples of indirect discharges are ground water discharge, known contaminated sites, spills, and dredging projects.

Ground Water Discharges & Ground Water Contaminated Sites:

The Department of Environmental Protection is responsible for issuing the NJPDES permit that regulates the quantity and type of pollutants that can be discharged into the State's ground water system. The sources of indirect groundwater discharges into this shellfish growing area can include municipal complex and small commercial businesses.

There were three facilities within this growing area that posses a groundwater discharging permits (Figure 24). All three facilities are currently active. There were several violations reported between 2001 and 2006. The most serious violations were issued to the Monmouth County Bayshore Outfalls Authority. See Table 6 for the description of these violations.

Groundwater contaminated sites have been identified throughout the state. Adjacent to this growing area are several known groundwater contaminated sites. The largest and closest known contaminated site to shellfish waters is the International Flavors & Fragrances located in Union Beach Borough. It is estimated that approximately 77 acres were found to be contaminated with Benzene, Trichloroethylene, Toluene, Ethyl benzene, and Xylenes.

FIGURE 24: INDIRECT GROUNDWATER DISCHARGES & GROUNDWATER CONTAMINATED SITES

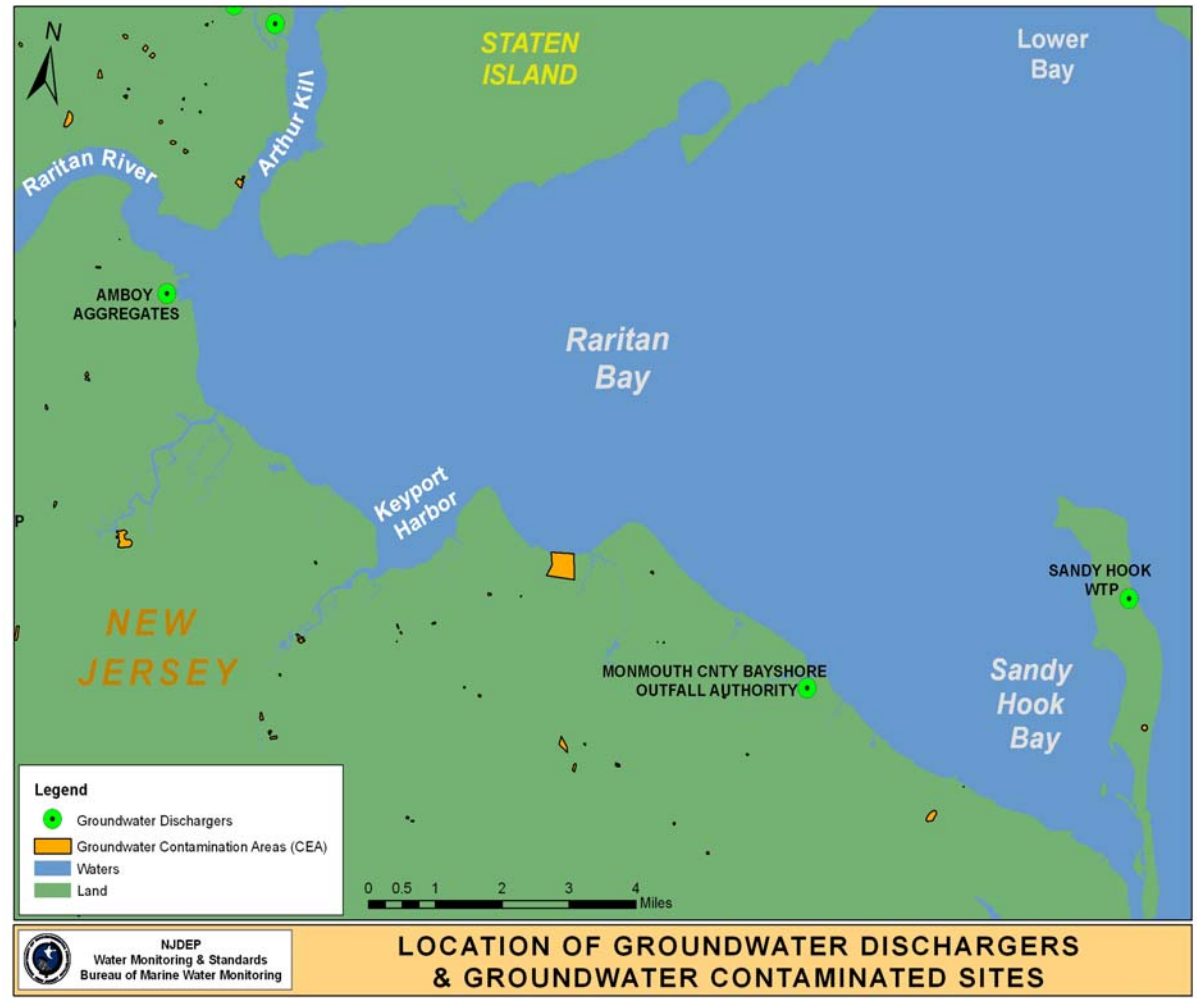


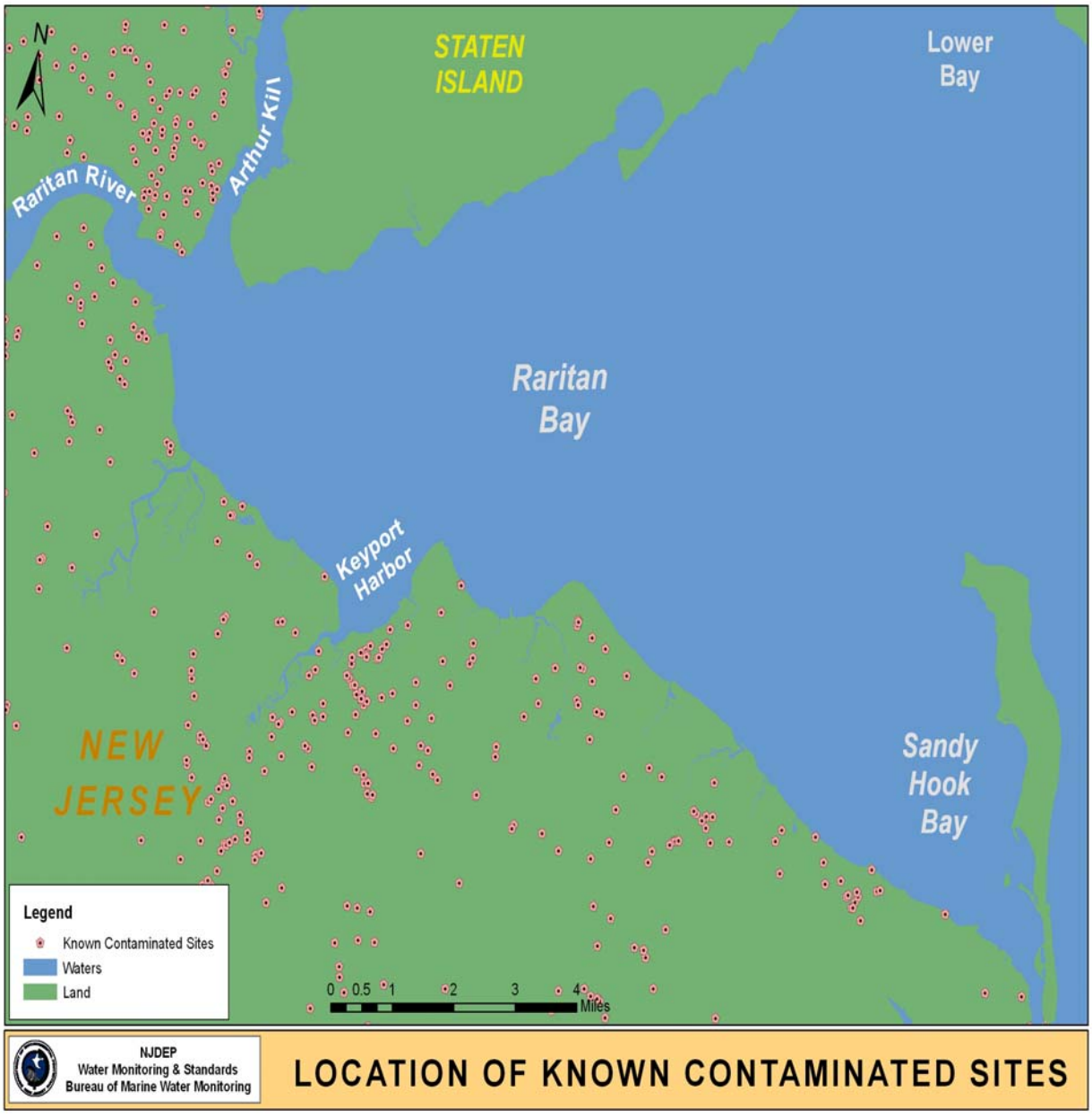
TABLE 6: GROUNDWATER DISCHARGERS INSPECTION

Facility Name	License Status	Date of Violation	Violation Descriptions
Sandy Hook WTP	Active	May 2001	Up gradient well(s) were not sampled first.
Amboy Aggregates	Active	May 2003	Monitoring Report not in compliance with [N.J.A.C.7:14A-6.2(a)1]
Monmouth County Bayshore Outfalls Authority	Active	February 2006	Unpermitted discharge of secondary effluent to the surface waters of the state in the slump block area of Atlantic Highlands
		August 2006	Unpermitted discharge of secondary effluent to marsh ~100 yards East of Pew's Creek and ~100 yards North of Route 36 in Middletown Township, Monmouth County

Known Contaminated Sites:

Figure 25 displays the known contaminated sites located adjacent to this shellfish growing area. The highest concentrations of these known contaminated sites are located in Keyport and Perth Amboy City. The primary causes of these known contaminated sites are from leaking underground storage tanks from gas stations and private properties. Most of these known contaminated sites are now repaired or closed.

FIGURE 25: LOCATION OF KNOWN CONTAMINATED SITES



Dredging Projects:

The process of dredging can impair water quality and contaminate shellfish beds that are living near dredging and disposal sites. When sediments are stirred up so are the bacteria and metals that are present in these sediments. For this reason, WM&S/BMWM is given the opportunity to review the CAFRA. A denial letter is sent out, if the proposed dredging or disposal site can potentially contaminate shellfish beds or impair water quality. WM&S/BMWM's comments are taken into consideration by the NJDEP Division of Land Use Regulation (DLUR) when approving or denying a permit.

Between 2001 and 2008, 26 CAFRA permits were submitted to DLUR (Table 7). Most of these applications were approved or conditionally approved by WM&S' BMWM, with the exception of one that was submitted by Dept. of Navy for dredging and construction.

TABLE 7: CAFRA APPLICATIONS

Date	County	Applicant	Application Type	Work Site	BMWM Response
8/20/2003	Middlesex	Chevron Products	Dredging	Chevron - Arthur Kill	Waiver
8/30/2003	Middlesex	Bayshore Recycling Facility	Dredging & Construction	Bayshore Recycling	Approval
9/26/2003	Monmouth	NJDEP Division of Engineering & Construction		Keansburg	
10/14/2003	Middlesex	Christopher Garbooshian	Marina Modification / Expansion	Sea-Tea Marina	Waiver
10/15/2003	Middlesex	Motiva Enterprises	Dredging	Motiva Enterprises	Waiver
12/5/2003	Monmouth	John Lloyd	Dredging & Construction	Lot 3.01 Block 70	
1/6/2004	Monmouth	George Harms	Dredging	Block 87, Lot 5	Conditionally Approved
1/12/2004	Monmouth	Bald Eagle Power	Other	Ocean > 3 miles out	Waiver
4/2/2004	Monmouth	US Army Corp of Eng	Dredging	Wills Hole Thorofare	Approval
4/28/2004	Monmouth	Borough of Union Beach	Dredging	Flat Creek	Conditionally Approved
6/8/2004	Monmouth	Oyster Point Hotel Marina	Dredging	Oyster Point Marina	Conditionally Approved
6/8/2004	Monmouth	NJDEP - Bureau of Coastal Engineering	Dredging	Compton's Creek	Conditionally Approved
8/6/2004	Middlesex	Jay Cashman, Inc.	Other	Arthur Kill	Waiver
8/6/2004	Monmouth	Mr. Anthony Diaco	Dredging	97 Buena Vista Ave	Conditionally Approved
8/18/2004	Middlesex	William J. Lockwood	Dredging & Construction	Old Spye Marina	Approval
9/2/2004	Middlesex	Middlesex County Improvement Authority	Dredging & Construction	New Brunswick Landing Waterfront	Conditionally Approved
9/15/2004	Middlesex	Borough of Sayreville	Dredging	River Road Waterfront Park	Waiver
9/22/2004	Middlesex	Neptune RTS	Other	River Rd.	Conditionally Approved
9/23/2004	Monmouth	Dept of Navy	Dredging & Construction	Earle Naval Base	Denial
10/26/2004	Monmouth	Total Marine at Seaview	Dredging	Total Marine	Approval
11/9/2004	Monmouth	Atlantic Highlands Municipal Harbor	Dredging	1 Simon Lake Blvd	Approval
1/24/2005	Monmouth	NJDEP Bureau of Coastal Engineering	Dredging	Wreck Pond	Approval
4/12/2005	Monmouth	Shark River Yacht Club	Dredging	Shark River Yacht Club	Conditionally Approved
3/21/2007	Monmouth	NJ Natural Gas Company	Other	Troutmans Creek Remediation	Approval
8/31/2007	Middlesex	Morgan Creek Boat works	Marina Modification / Expansion	Cheesequake Creek	Approved
8/27/2008	Monmouth	Najarian Associates	Other	Navesink River	Approved

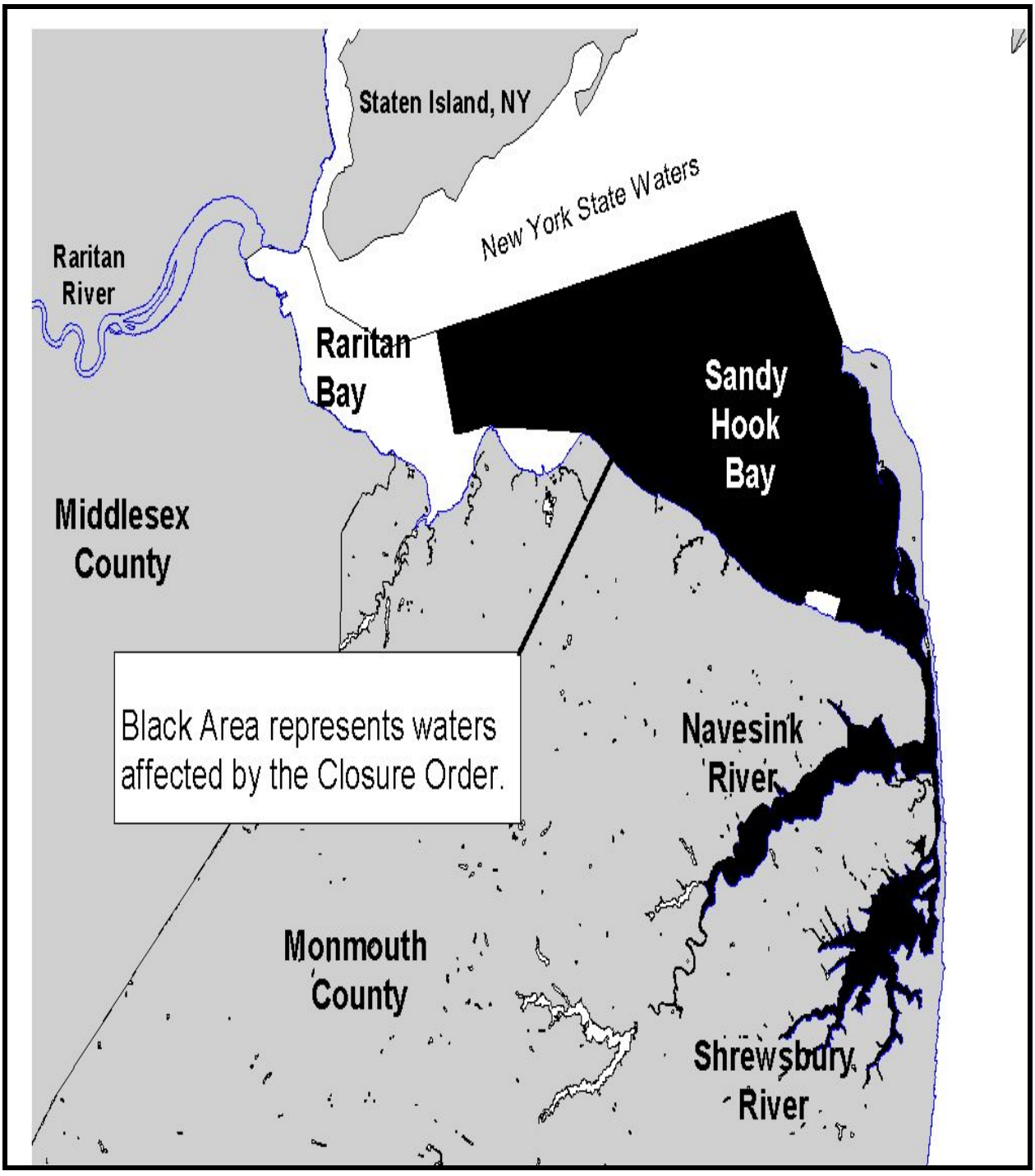
Spills or Other Unpermitted Discharge

Between 2001 and 2008, many spills were reported to WM&S/BMWM. However, only two resulted in the closure of shellfish beds in growing area NE-1.

On March 3, 2003, a sewer line break was identified in the Sayreville Pumping Station. According to the report sent to WM&S' BMWM, approximately 570 million gallons of raw sewage spilled into the Raritan Bay. An emergency closure was issued by the NJDEP for shellfish beds in the Raritan Bay, Sandy Hook Bay, Navesink River and Shrewsbury River, effective March 3, 2003. Approximately 29,427 acres of shellfish beds in these waters were closed (Figure 26). WM&S/BMWM began sampling in these areas for fecal coliform bacteria, when high levels of fecal coliform were observed in the Raritan and Sandy Hook Bays. Shellfish beds were closed until April 4, 2003. At which time, 6,000 acres of shellfish beds were re-opened for depuration purposes; clam-relaying activities remained closed. By November 2003, all of the shellfish beds were re-opened for harvesting.

The second closure resulted from a power outage in New York City on August 18, 2003. The power outage allowed raw sewage from New York City to bypass some treatment facilities. As a precaution, NJDEP closed 25,000 acres of shellfish beds in the Raritan and Sandy Hook Bays. Tests conducted in the area found water samples exceeding the NSSP standard for fecal coliform. Subsequent testing revealed that only a third of the harvestable shellfish beds in Raritan and Sandy Hook Bay were affected by the spill. As a result, on August 20th, the NJDEP lifted the closure of shellfish beds in much of Sandy Hook Bay where the data never exceeded the fecal coliform standard. However, shellfish beds in the Raritan Bay and a portion of Sandy Hook Bay remained closed pending further testing results. These waters remained closed until September 4, 2003.

FIGURE 26: AREA AFFECTED THE SAYREVILLE SPILL AND NYC BLACKOUT



PATTERNS OF PRECIPITATION

Due to New Jersey's middle latitude coastal location, precipitation is relatively abundant and consistent (Chart 3). A similar pattern of precipitation is found for almost every month of the year throughout New Jersey. The maximum precipitation is found in the north central Highlands, with a minimum along the southern coast. Summer precipitation is most abundant in inland portions of the state, particularly in the west central counties.

Precipitation inputs to this area are from data collected at Station RA001 & RA002 for the period 2001 through 2008. Figure 27 shows the location of these two rain stations. The estimated precipitation data are provided by Middle Atlantic River Forecast Center (MARFC), an office in the National Weather Service (NWS). The MARFC provides 24 hour estimated precipitation based on a Multi-Sensor Precipitation Estimation (MPE) calculation using data collected from NWS' NEXRAD radar, together with rain gage observations and recordings. Chart 4 displays the annual precipitation for Station RA001 & RA002.

CHART 3: NEW JERSEY STATEWIDE ANNUAL PRECIPITATION (SOURCE: HTTP://CLIMATE.RUTGERS.EDU)

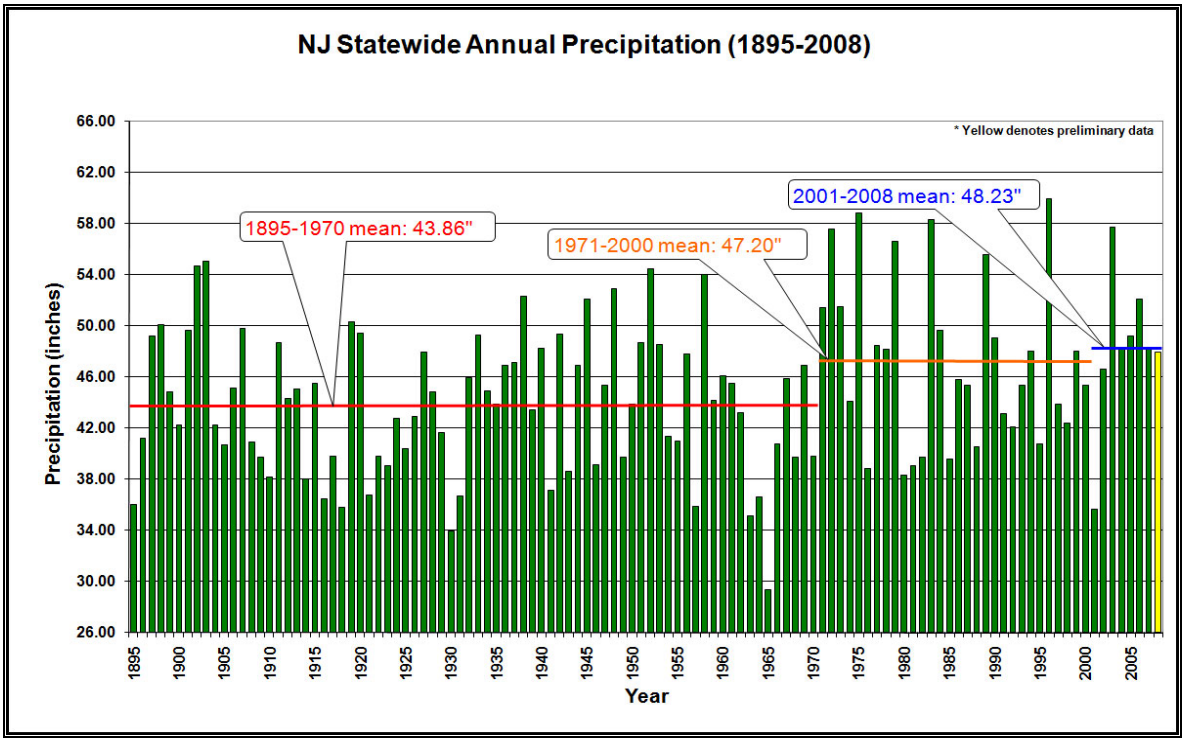


FIGURE 27: LOCATION OF NOAA RAIN STATIONS

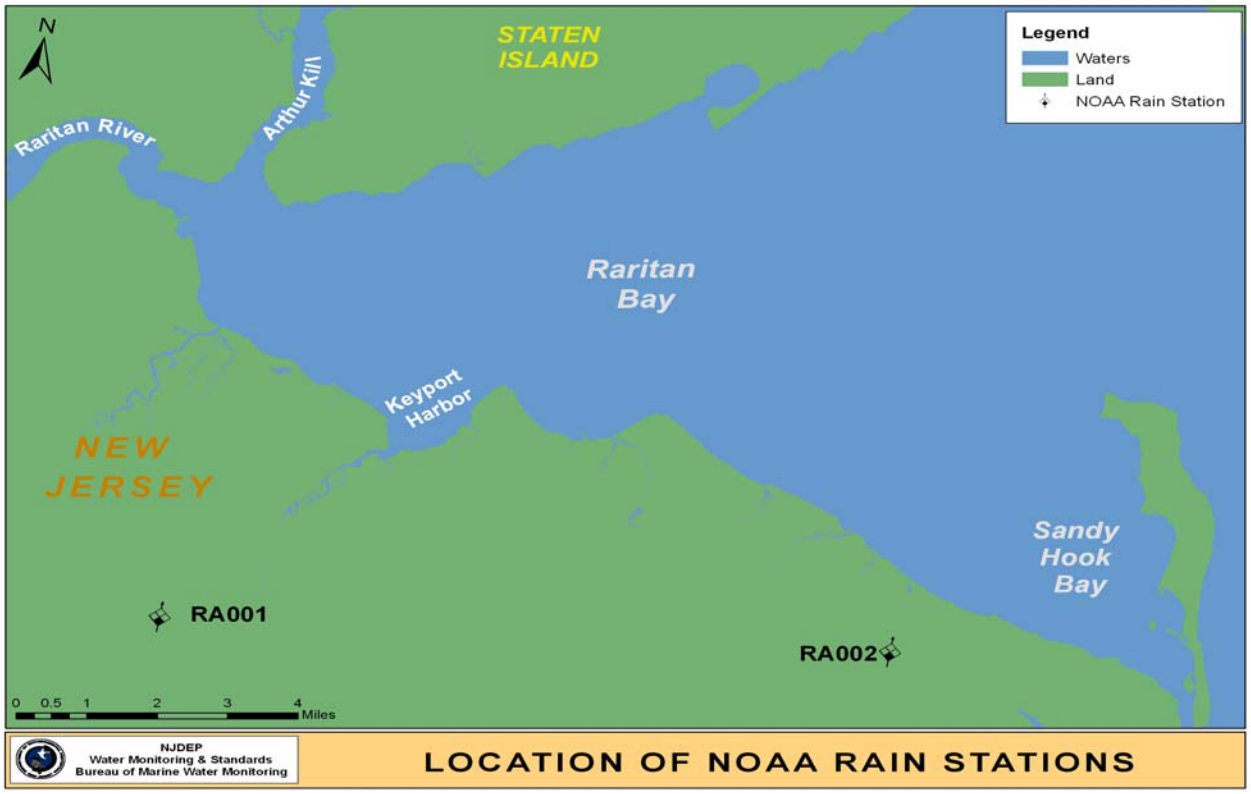
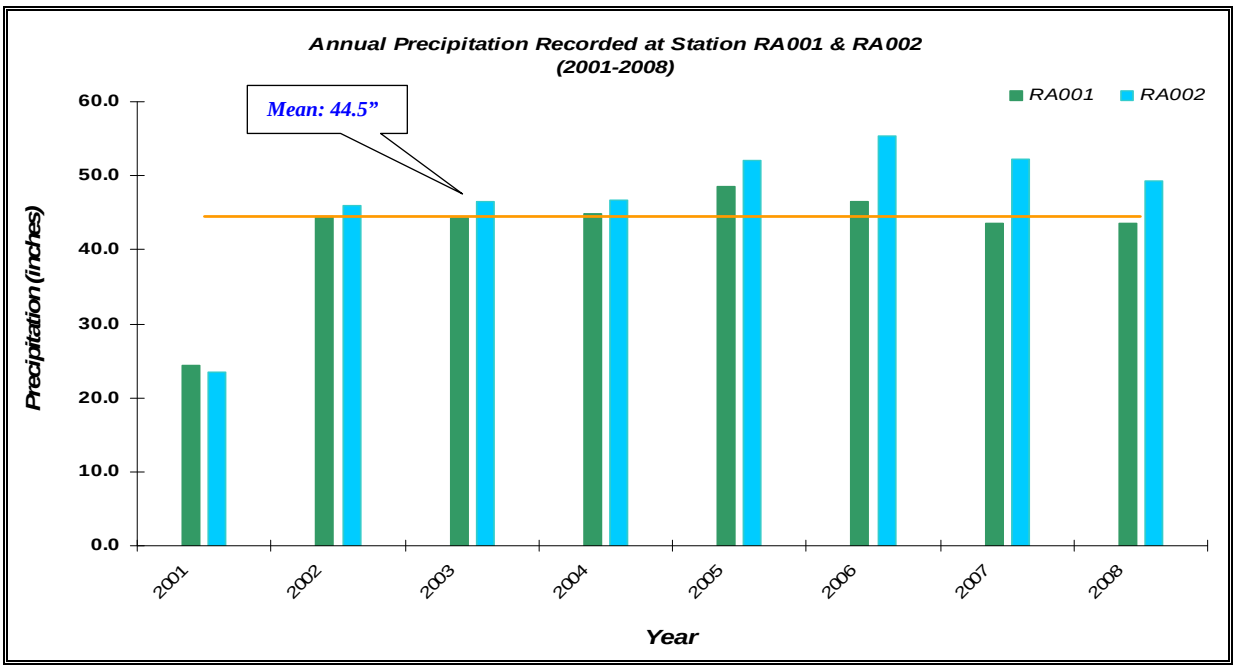


CHART 4: ANNUAL PRECIPITATION AT STATION RA001 & RA002 (2001-2008)

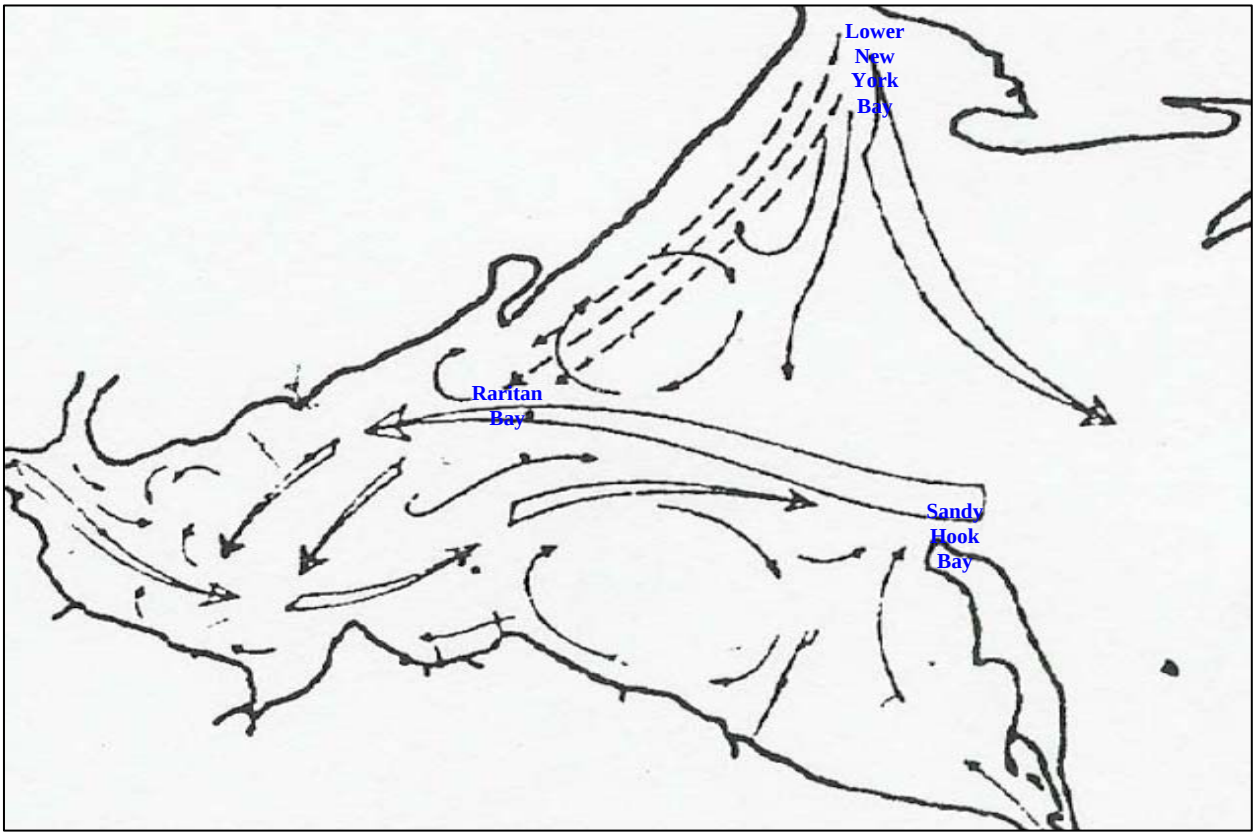


HYDROGRAPHY

The two main bodies of water in this shellfish growing area are the Raritan Bay and Sandy Hook Bay. These bays receive direct inflow from the Raritan River, the Shrewsbury and Navesink River, and numerous smaller tributaries along the shorelines of Staten Island and New Jersey. The bays also receive indirect flow from the Hudson through Lower New York Bay and the Passaic and Hackensack Rivers via Newark Bay and the Arthur Kill. The water depth in these areas ranges from 7 to 15 feet at mean low tide. The tidal range averages at 5.5 feet entering and leaving the bay in a counter-clockwise gyre (Figure 28).

Tidal currents can affect the water quality of a shellfish growing area because hydrographic and meteorological characteristics, such as tidal amplitude and type, water circulation patterns, depth, salinity, stratification characteristics, rainfall patterns and intensity, and prevailing winds may affect the distribution of pollutants in a specific area (Ingmanson and Wallace, 1989). This is why an evaluation of pollution sources and hydrographic characteristics is used to assess the water quality in a shellfish growing area.

FIGURE 28: SCHEMATIC REPRESENTATION OF NET CURRENTS IN THE RARITAN AND LOWER BAYS (SOURCE: DIAGRAM BASED ON RESEARCH CONDUCTED BY MARMER (1935) & KETCHUM (1950))



WATER QUALITY STUDIES

BACTERIOLOGICAL QUALITY

This shellfish growing area is composed of two assignments, Assignment 17 (Raritan Bay) and Assignment 27 (Sandy Hook Bay). Both assignments are sampled using the APC sampling strategy. Figure 29 shows the location of the sampling stations in this shellfish growing area. A total of 3,164 samples were collected and analyzed for Total Coliform (TC) from 53 sampling stations. This report includes data analyzed from January 2001 to December 2008. The statistical summaries for this area are listed in the tables that follow. The raw data listings for each sampling station, in accordance with the National Shellfish Sanitation Program (NSSP), are given at the end of this report in the Appendix.

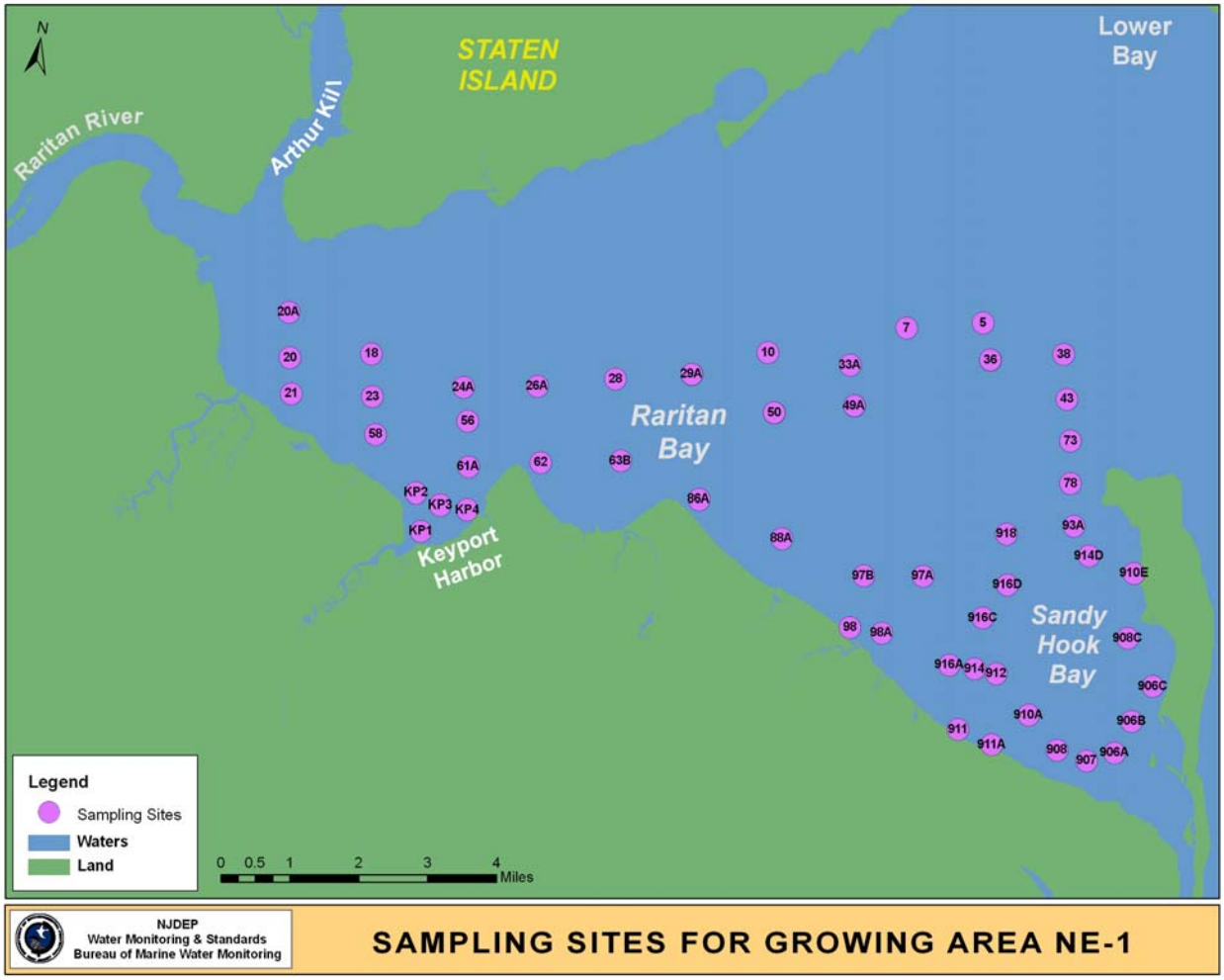
The United States Environmental Protection Agency (USEPA) and the Interstate Shellfish Sanitation Conference (ISSC) continue to provide valuable assistance in sample analysis and sample collection in this growing area. From January 2001 to December 2008, the ISC collected over 460 samples from 22 sampling stations listed in Assignment 17. These samples were analyzed by the USEPA Region 2 laboratory. The method used by the USEPA laboratory for analyzing total coliform was the MPN 5-Tube 3-Dilution Test and the criteria are listed below in Table 8.

Samples collected by WM&S/BMWM were analyzed using the standard MPN 3-Tube fermentation technique to analyze for total coliform. WM&S/BMWM normally uses the NSSP 3-tube criteria, which are listed in Table 2, as a guideline for comparison. However, due to dissimilar techniques used by WM&S/BMWM and the USEPA laboratory, all data in this report were evaluated based on NSSP MPN 5-tube criteria. This is the more conservative criteria.

TABLE 8: NSSP MPN 5-TUBE CRITERIA

	No more than 10% of the samples can exceed (MPN/100mL)
Approved Classification	**230**
Special Restricted Classification	**2300**

FIGURE 29: LOCATION OF SAMPLING STATIONS



COMPLIANCE WITH NSSP APC APPROVED & SPECIAL RESTRICTED CRITERIA

"Approved" year- round assessment

Based on the NSSP 5-tube "Approved" criteria, no more than 10% of the samples can exceed 230 MPN/100ml. Forty-seven of the 53 sampling stations in this area had exceeded the year-round *Approved* classification (Table 9). The location of these stations can be found in Figure 30. Currently, there are no *Approved* waters within this shellfish growing area. These stations are located in either *Special Restricted* or *Prohibited* waters. Stations that met the year-round *Approved* criteria were 43, 73, 97A, 908C, 910E, and 914D.

Chart 5 displays the total coliform annual geometric mean for this growing area between 2001 through 2008.

TABLE 9: TOTAL COLIFORM STATISTICAL SUMMARY (NSSP MPN 5-TUBE CRITERIA)

Station	Status	Year Round			Summer			Winter		
		Geomean	%>230MPN	N	GeoMean	%>230MPN	N	GeoMean	%>230MPN	N
10	SR	23.0	23.9%	67	7.8	8.0%	25	43.8	33.3%	42
18	P	107.0	44.8%	67	38.0	24.0%	25	198.3	57.1%	42
20	P	121.1	38.8%	67	48.5	20.0%	25	208.9	50.0%	42
20A	P	165.5	52.2%	67	93.0	40.0%	25	233.3	59.5%	42
21	P	118.3	48.4%	64	43.7	27.3%	22	199.3	59.5%	42
23	P	85.5	41.8%	67	23.0	24.0%	25	186.6	52.4%	42
24A	SR	61.2	40.3%	67	18.5	16.0%	25	124.9	54.8%	42
26A	SR	46.6	35.8%	67	17.4	12.0%	25	83.7	50.0%	42
28	SR	37.2	26.9%	67	15.2	16.0%	25	63.5	33.3%	42
29A	SR	22.1	26.9%	67	7.0	8.0%	25	43.9	38.1%	42
33A	SR	18.9	19.3%	57	12.5	13.5%	37	40.2	30.0%	20
36	SR	29.4	24.6%	57	22.5	21.6%	37	48.0	30.0%	20
38	SR	22.9	17.2%	58	16.7	15.8%	38	41.4	20.0%	20
43	SR	13.0	8.6%	58	8.7	5.3%	38	27.5	15.0%	20
49A	SR	16.1	15.8%	57	10.4	10.8%	37	36.5	25.0%	20
5	SR	29.3	17.5%	57	29.6	16.2%	37	28.7	20.0%	20
50	SR	29.1	28.8%	66	9.7	16.0%	25	56.8	36.6%	41
56	SR	77.3	39.4%	66	19.9	12.5%	24	167.7	54.8%	42
58	P	82.1	41.8%	67	31.0	20.0%	25	146.6	54.8%	42
61A	P	55.0	37.3%	67	12.9	8.0%	25	130.7	54.8%	42
62	SR	47.9	31.3%	67	13.1	8.0%	25	103.4	45.2%	42
63B	SR	33.4	29.9%	67	11.0	16.0%	25	64.7	38.1%	42
7	SR	36.4	22.8%	57	32.5	24.3%	37	44.9	20.0%	20
73	SR	10.6	8.6%	58	7.9	7.9%	38	18.6	10.0%	20
78	SR	12.6	12.1%	58	9.2	10.5%	38	22.9	15.0%	20
86A	SR	32.3	23.9%	67	11.5	8.0%	25	59.7	33.3%	42
88A	SR	19.8	19.7%	66	9.2	12.5%	24	30.8	23.8%	42
906A	SR	16.8	12.1%	58	16.2	13.2%	38	17.8	10.0%	20
906B	SR	13.0	13.8%	58	11.6	10.5%	38	16.2	20.0%	20
906C	SR	8.5	12.1%	58	7.6	7.9%	38	10.5	20.0%	20
907	SR	17.7	13.8%	58	17.4	13.2%	38	18.2	15.0%	20
908	SR	19.5	13.8%	58	17.7	15.8%	38	23.6	10.0%	20
908C	SR	7.1	5.2%	58	6.2	2.6%	38	9.1	10.0%	20
910A	SR	21.8	19.0%	58	21.6	18.4%	38	22.2	20.0%	20
910E	SR	8.7	6.9%	58	7.7	5.3%	38	11.2	10.0%	20
911	SR	24.2	22.4%	58	26.9	23.7%	38	19.7	20.0%	20
911A	SR	36.4	27.6%	58	40.3	28.9%	38	30.0	25.0%	20
912	SR	14.4	12.1%	58	12.2	10.5%	38	19.8	15.0%	20
914	SR	11.4	15.5%	58	9.3	13.2%	38	16.6	20.0%	20
914D	SR	9.0	8.6%	58	7.2	10.5%	38	13.8	5.0%	20
916A	SR	12.6	17.5%	57	10.0	13.5%	37	19.5	25.0%	20
916C	SR	10.9	10.3%	58	8.8	7.9%	38	16.2	15.0%	20
916D	SR	13.4	10.3%	58	8.8	7.9%	38	30.0	15.0%	20
918	SR	12.7	12.1%	58	9.8	13.2%	38	20.6	10.0%	20
93A	SR	11.1	13.8%	58	8.3	10.5%	38	19.0	20.0%	20
97A	SR	10.5	7.0%	57	6.8	2.7%	37	23.9	15.0%	20
97B	SR	13.3	14.0%	57	8.2	8.1%	37	32.6	25.0%	20
98	SR	27.2	24.6%	57	27.0	24.3%	37	27.5	25.0%	20
98A	SR	20.1	15.8%	57	16.3	13.5%	37	29.8	20.0%	20
KP1	P	87.7	40.9%	44	30.0	18.8%	16	162.0	53.6%	28
KP2	P	69.1	36.4%	44	17.0	13.3%	15	142.6	48.3%	29
KP3	P	74.2	36.4%	44	26.2	18.8%	16	134.4	46.4%	28
KP4	P	47.0	40.9%	44	12.1	12.5%	16	101.9	57.1%	28

FIGURE 30: STATIONS EXCEEDING NSSP MPN 5-TUBE "APPROVED" CRITERIA (YEAR-ROUND)

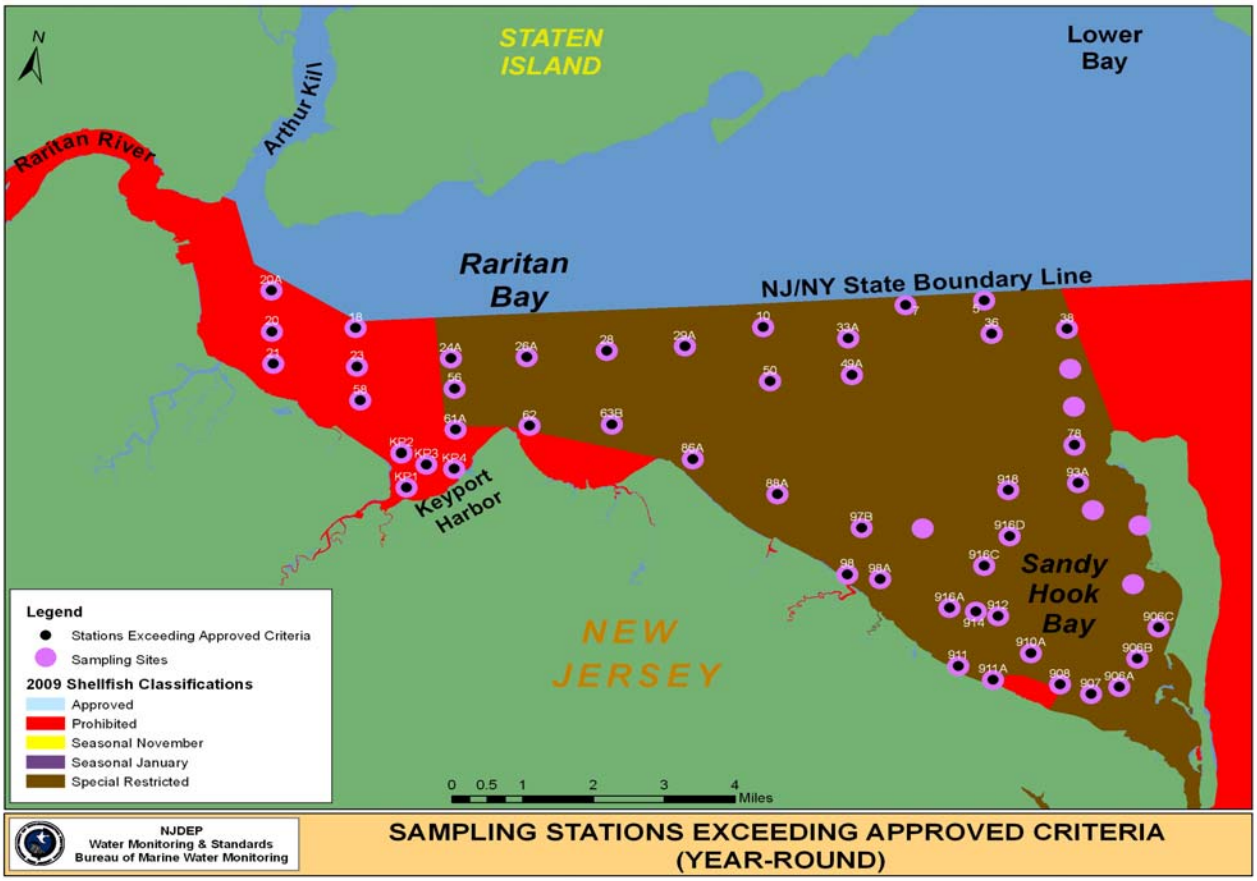
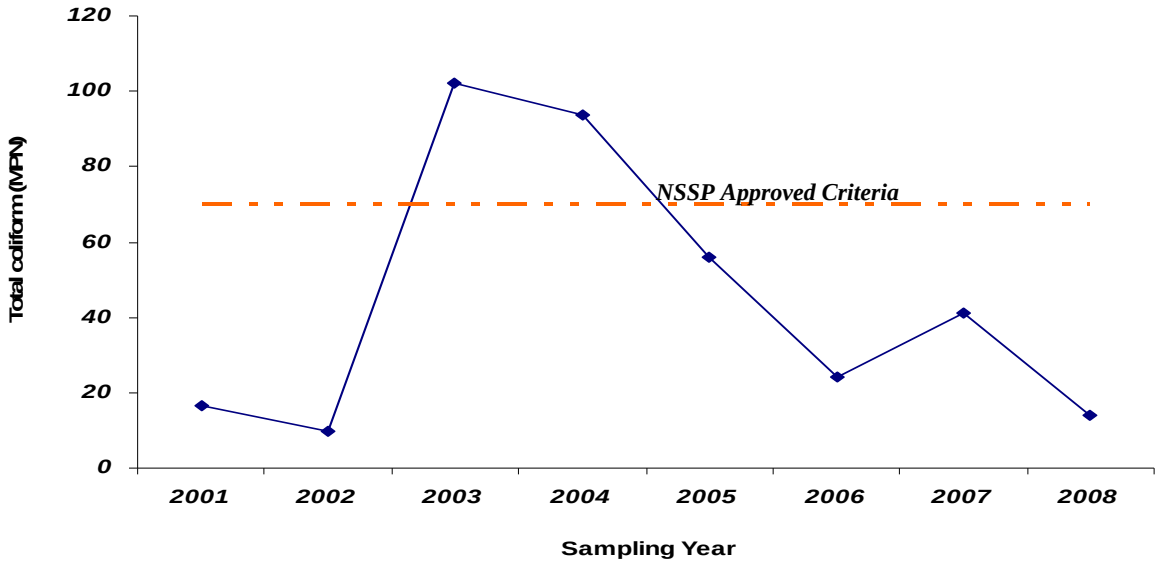


CHART 5: RARITAN-SANDY HOOK BAYS TOTAL COLIFORM ANNUAL GEOMETRIC MEAN (2001-2008)



"Approved" summer & winter assessment

Summer & winter approved criteria are the same as the year-round approved criteria. Samples collected from May 1St through October 30th are considered as summer samples. Winter samples are samples collected from November 1st through the 30th of April. Based on the data pool, 39 of the 53 sampling stations exceeded in the summer and 46 of the 53 sampling stations exceeded in the winter (Figure 31 & Figure 32). There were other sampling stations that had exceeded the 10% criteria, but were not flagged because there were insufficient samples taken in the summer or winter.

Total coliform summer and winter geometric means from 2001 through 2008 are shown in Chart 6. The summer geometric means remain consistently below NSSP "Approved" criteria. However, the winter geometric means had greatly fluctuated. The winter geometric means went from 10 MPN/100ml in 2002 to above 1,400 MPN/100ml in 2003. This result could have been attributed to the Sayreville spill that had occurred during the winter of 2003.

After the 2003 event, the winter geometric means began to decline, until 2007. It is not certain what had caused the 2007 event. According to the 2008 Annual Report released by Interstate Environmental Commission (IEC), 2006 and 2007 were considered "wet years" with rainfall total over 10 inches above the yearly average. As a result, the number of bypass events (CSOs and spills) that occurred in New York were also higher in 2007. This report is available online at http://www.iec-nynjct.org/.

FIGURE 31: STATIONS EXCEEDING NSSP MPN 5-TUBE "APPROVED" CRITERIA DURING THE SUMMER

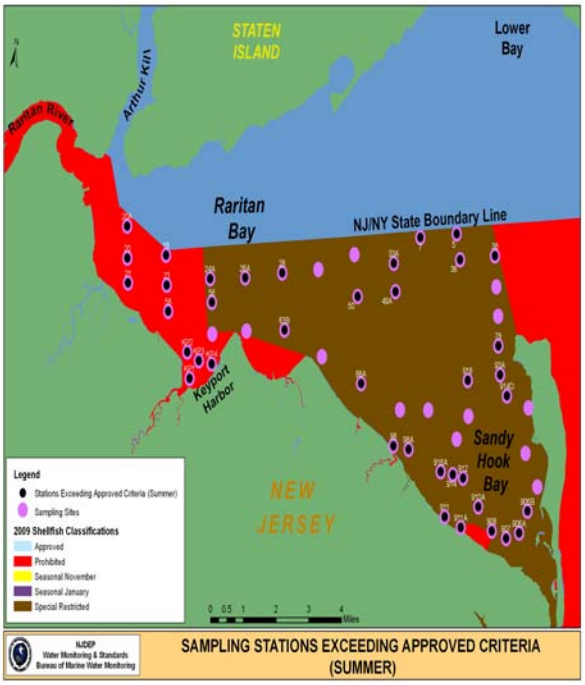


FIGURE 32: STATIONS EXCEEDING NSSP MPN 5-TUBE "APPROVED" CRITERIA DURING THE WINTER

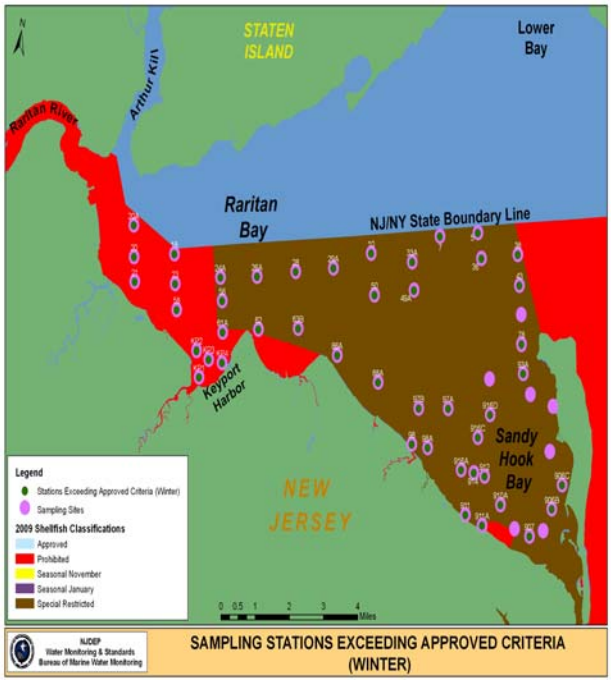
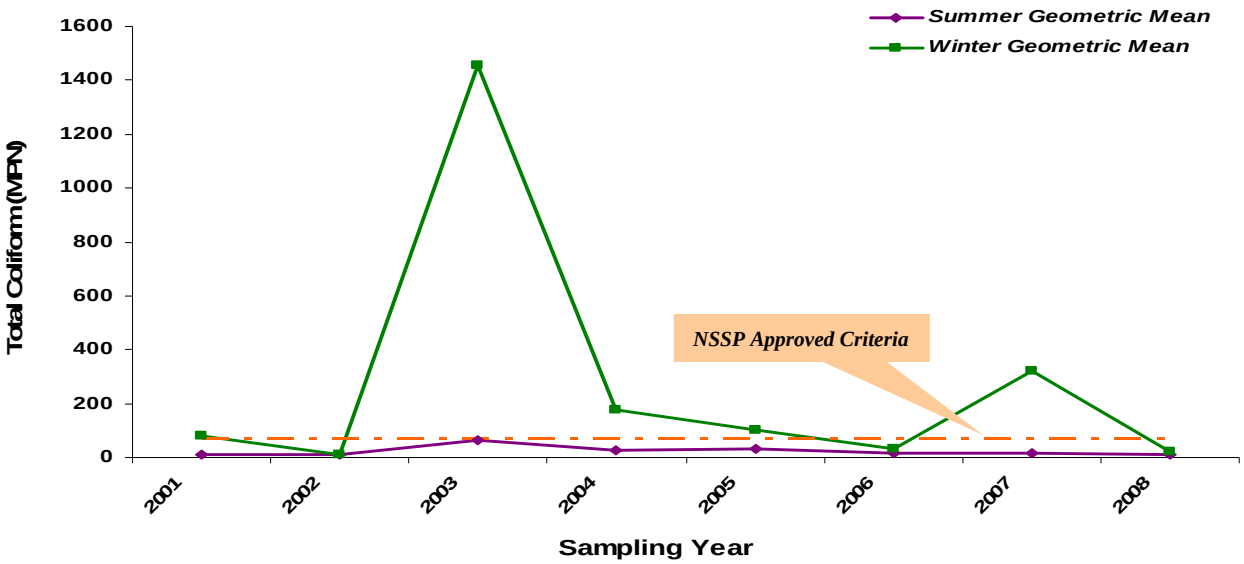


CHART 6: RARITAN-SANDY HOOK BAYS SUMMER & WINTER ANNUAL GEOMETRIC MEAN



"Special restricted" year-round, summer, & winter assessment

According to NSSP "Special Restricted" criteria, no more than 10% of the samples collected can exceed 2300 MPN/100mL. Based on the data pool gathered for this report, one station in this shellfish growing area had exceeded the NSSP "Special Restricted" winter criteria. Station 18 is situated in the *Prohibited* water of the Raritan Bay (Figure 33). Of the 67 samples collected at this site, 42 samples were collected during the winter months. Five of the 42 winter samples had a total coliform count above 2,300 MPN/100mL (Chart 7). The highest bacteria count reported was collected on April 18, 2007. Nearby stations also show a higher bacteria count on this date as well. It is certain that rainfall is one of the contributing factors. According to the rainfall data on all five sampling events, the rainfall amount reported at prior to 72 hours of sampling were between 0.5 and 5.0 inches.

FIGURE 33: STATION EXCEEDING NSSP MPN 5-TUBE "SPECIAL RESTRICTED" CRITERIA DURING THE WINTER

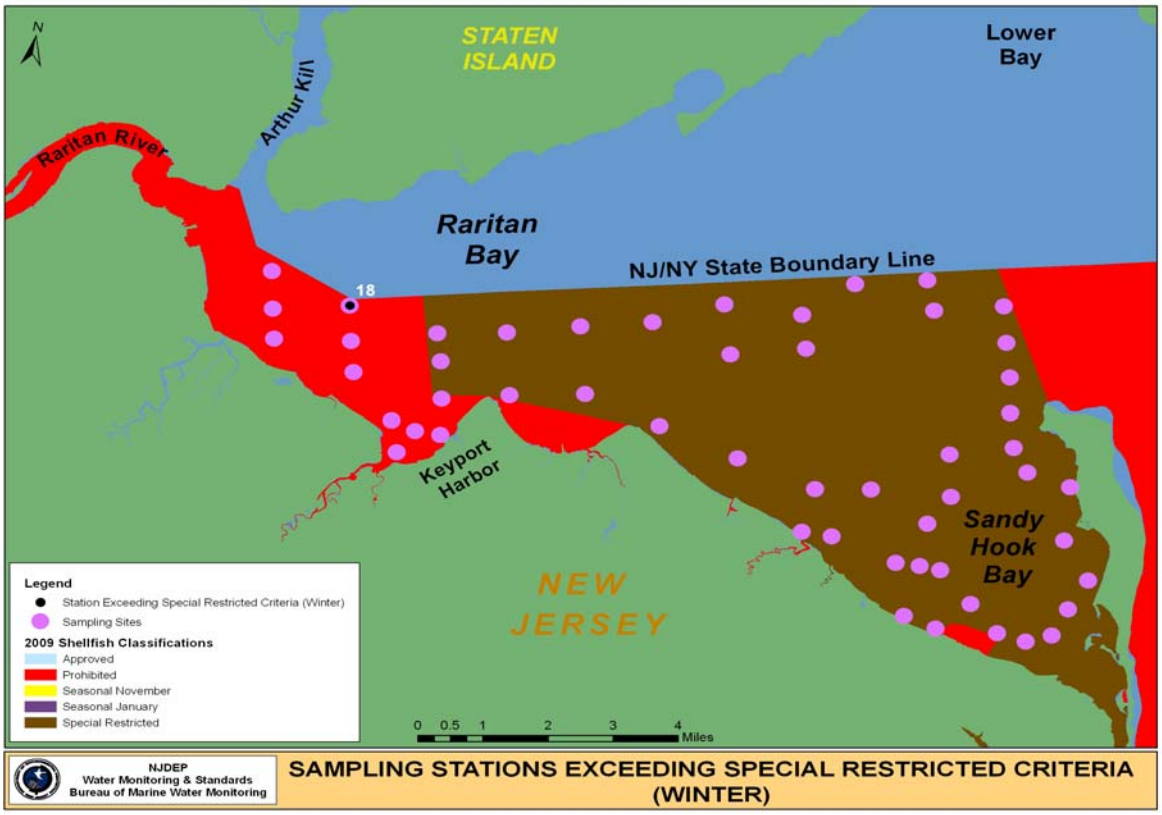
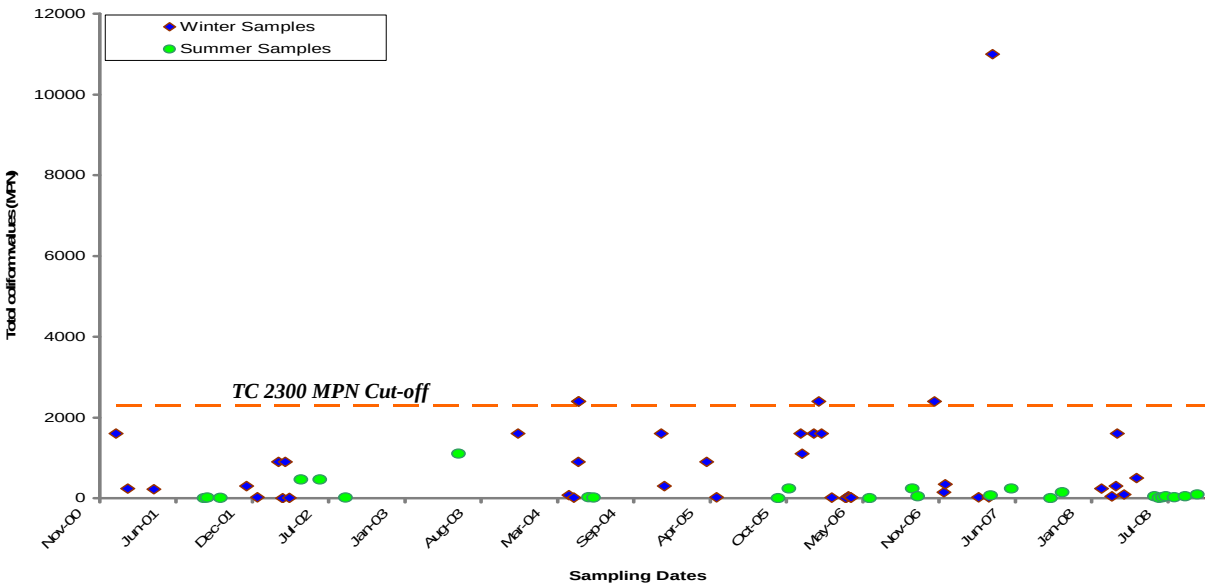


CHART 7: TOTAL COLIFORM RESULTS AT STATION 18 BETWEEN 2001-2008



SEASONAL EFFECTS

As the earth experiences variations in the tilt of its axis and its revolution around the sun, it goes through seasonal phases of summer, spring, autumn, and winter. These seasonal phases cause much variation in the atmosphere of the earth, resulting in changes in weather patterns. Temperature, precipitation, wind, and the general circulation of the atmosphere have seasonal variations that also affect the marine environment (Ingmanson and Wallace, 1989).

Seasonal effect was assessed using a t-test to compare the total coliform MPN values from samples collected during the summer season versus samples collected during the winter months. To have a seasonal component, t-probability must be less than 0.05. Twenty-seven sampling stations in this shellfish growing area exhibited a t-probability of less than 0.05. Figure 34 shows the location of these sampling stations. Table 10 lists the t-statistic probability for each of the sampling stations and the correlation between seasonal effects and water quality.

All stations were affected by the winter season. The majority of these stations are situated in the Raritan Bay and Keyport Harbor.

FIGURE 34: STATIONS AFFECTED BY SEASON

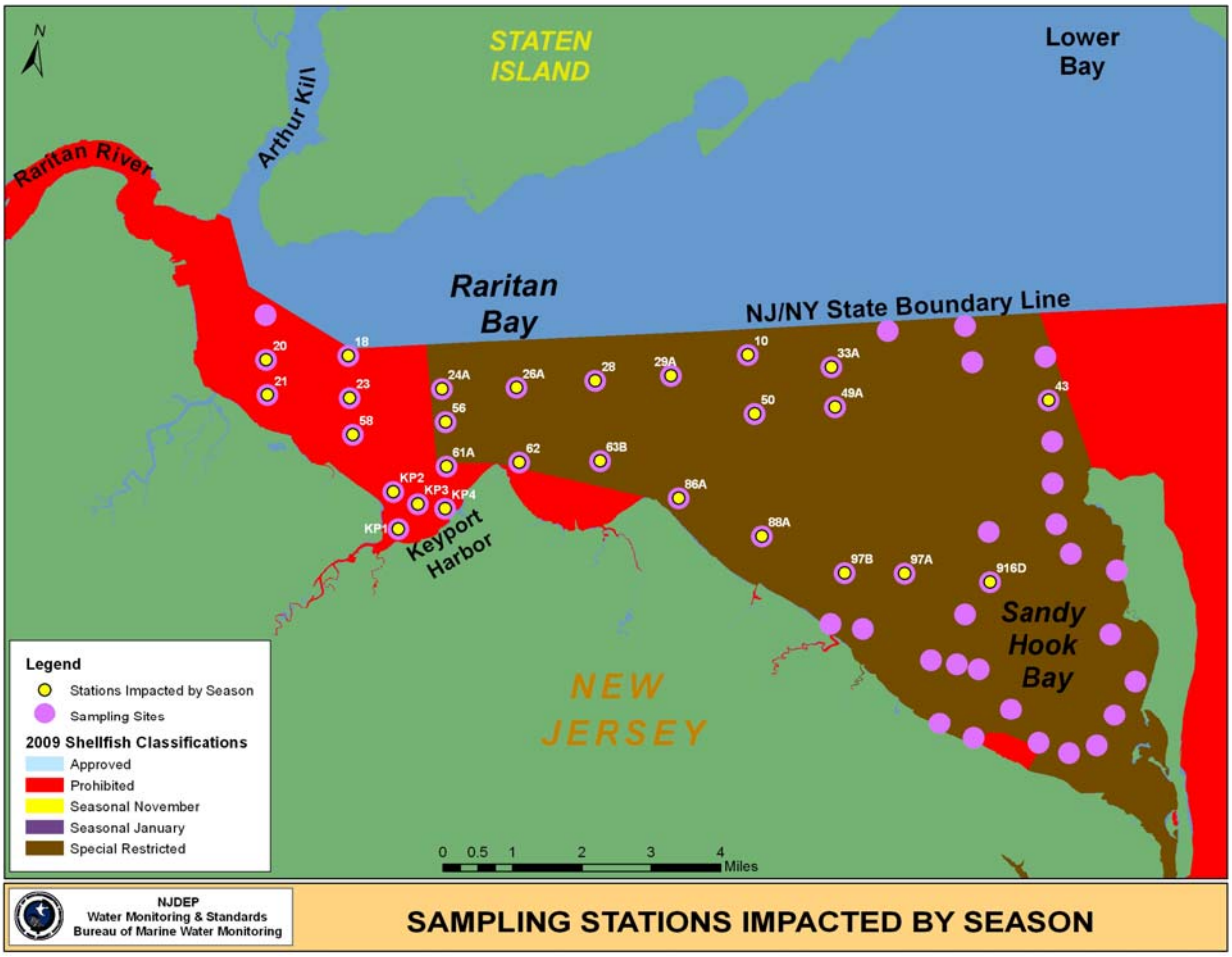


TABLE 10: SEASONAL STATISTICAL SUMMARY

Station	Status	t-Statistical Probability	Summer Geometric Mean	Winter Geometric Mean
10	SR	0.001	7.80	43.80
18	P	0.002	38.00	198.30
20	P	0.004	48.50	208.90
21	P	0.005	43.70	199.30
23	P	0.000	23.00	186.60
24A	SR	0.001	18.50	124.90
26A	SR	0.008	17.40	83.70
28	SR	0.018	15.20	63.50
29A	SR	0.001	7.00	43.90
33A	SR	0.034	12.50	40.20
43	SR	0.016	8.70	27.50
49A	SR	0.026	10.40	36.50
50	SR	0.003	9.70	56.80
56	SR	0.000	19.90	167.70
58	P	0.003	31.00	146.60
61A	P	0.000	12.90	130.70
62	SR	0.000	13.10	103.40
63B	SR	0.003	11.00	64.70
86A	SR	0.003	11.50	59.70
88A	SR	0.027	9.20	30.80
916D	SR	0.015	8.80	30.00
97A	SR	0.007	6.80	23.90
97B	SR	0.010	8.20	32.60
KP1	P	0.010	30.00	162.00
KP2	P	0.004	17.00	142.60
KP3	P	0.026	26.20	134.40
KP4	P	0.003	12.10	101.90

RAINFALL EFFECTS

Non-point source pressures on shellfish beds in New Jersey originate in materials that enter the water via stormwater. These materials include bacteria, as well as other waste, that enters the stormwater collection system. For this reason, rainfall impact was evaluated.

The t-test method is used to determine where an area is impacted by rainfall. This method compares the total coliform MPN values from samples collected during dry weather to samples collected during wet weather. Whether a sample was collected under wet or dry condition is determined by the Wet/Dry cutoff. For example, if Wet/Dry cutoff is set to 0.2 inches, this means that any rainfall amount recorded below 0.2 inches is considered as dry weather and any rainfall amount recorded above 0.2 inches is assumed to be wet weather. A sampling station with a t-statistical probability of less than 0.05 is believed to be impacted by rainfall. Rainfall assessment for this growing area was based on the t-tests, where the Wet/Dry cutoff was set to 0.2 inches.

Depending on the surroundings, some areas can either have an immediate or a delayed effect from a rainfall event. Areas that are surrounded by wetland usually have a delayed effect because wetland can act as buffers and/or filters against contaminants. Areas that are in close proximity to urban development and/or farm land could see an immediate impact. Figures 35 through 37 show the location of the sampling stations that were impacted by rainfall at different time frames.

FIGURE 35: STATIONS IMPACTED BY RAIN AT PRIOR 24 HOURS CUMULATIVE

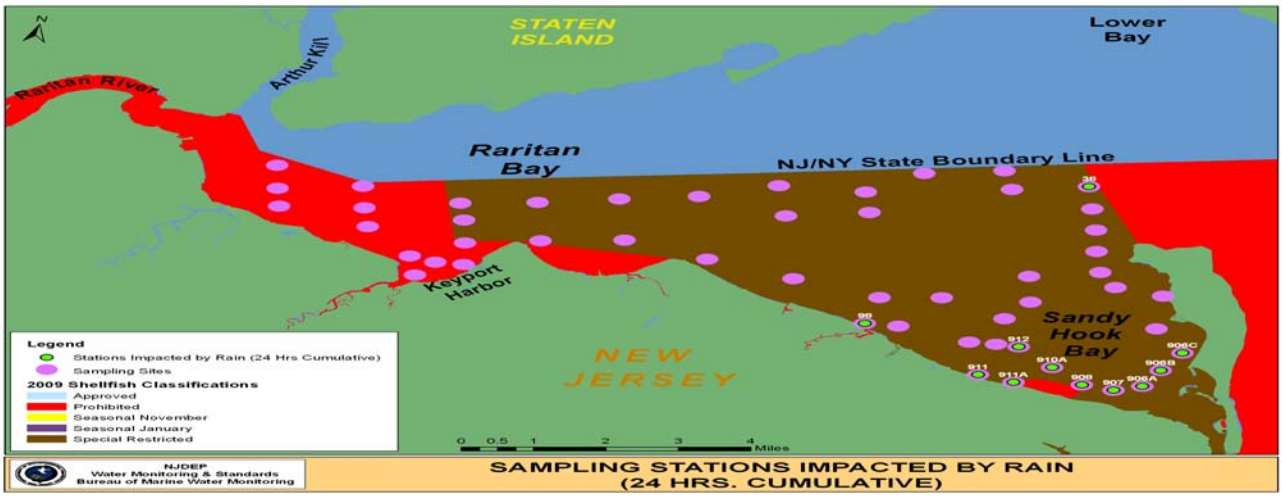


FIGURE 36: STATIONS IMPACTED BY RAIN AT PRIOR 48 HOURS CUMULATIVE

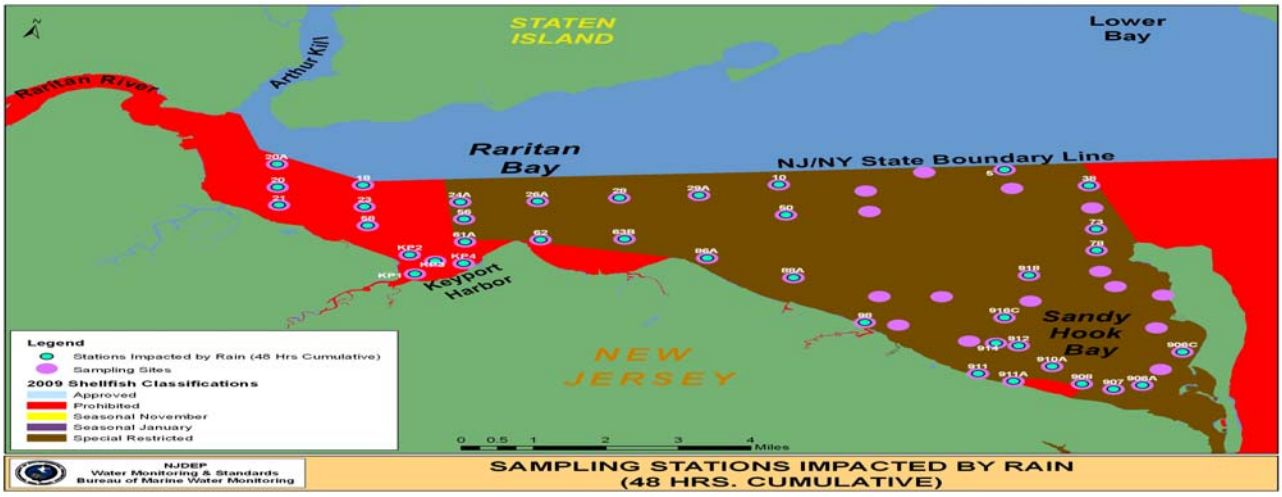
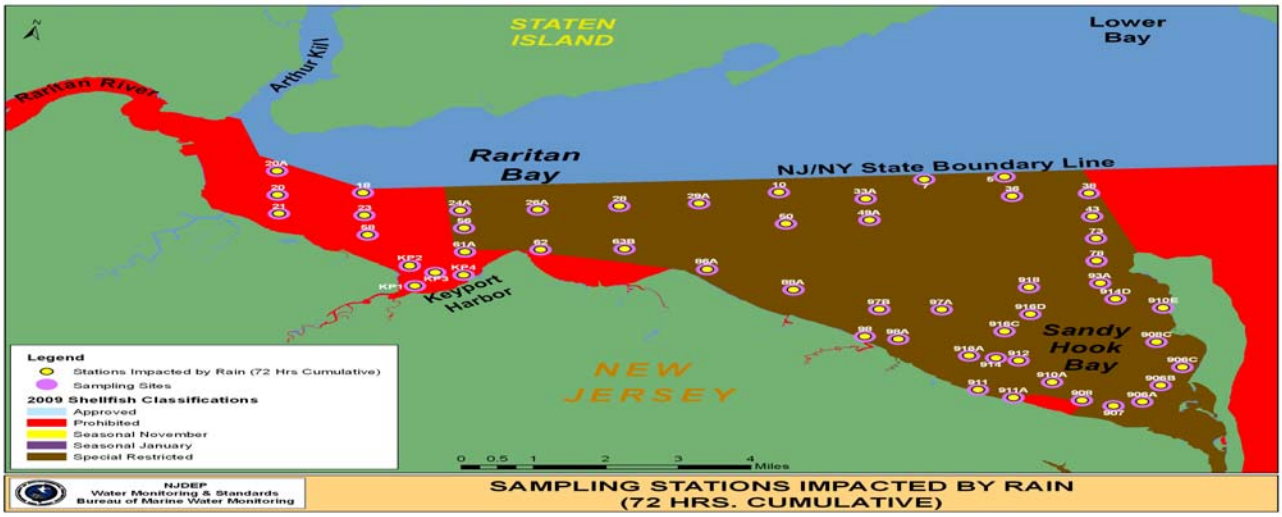


FIGURE 37: STATIONS IMPACTED BY RAIN AT PRIOR 72 HOURS CUMULATIVE



NUTRIENTS

Sixteen stations in shellfish growing area NE-1 were sampled under the estuarine monitoring program for chemical parameters, including nutrients, from 2001 to 2008. The locations of these nutrient sampling stations are shown in Figure 38.

At these nutrient stations, various parameters were measured including water temperature, salinity levels, secchi depth, total suspended solids, dissolved oxygen levels, ammonia levels, nitrate and nitrite levels, orthophosphate levels, total nitrogen levels, and the inorganic nitrogen to phosphorus ratios.

Chart 8 displays the average dissolved oxygen (DO) levels in the Raritan & Sandy Hook Bays between 2001 and 2008. The criteria are based on the New Jersey Surface Water Quality Standards (NJSWQS), listed under the New Jersey Administrative Code (NJAC7:9B-1.14). Average DO levels were well above the 4.0 mg/L criteria. At some sites, actual DO values were found to be below the criteria. Of the 3,371 DO measurements, 16 measurements were below the criteria. The results range from 2.4 mg/L to 3.9 mg/L. These measurements were reported at the following stations: R61 through R67, and 906A. At Station 906A, only one measurement was below the criteria, which was reported in June 2005. Stations R61 through R67 are located in Keyport Harbor and along the shoreline by Compton Creek.

For detailed information concerning dissolved oxygen and other nutrient levels, see the Estuarine Monitoring Reports, available electronically at: http://www.state.nj.us/dep/bmw/ .

FIGURE 38: NUTRIENTS SAMPLING SITES IN SHELLFISH GROWING AREA NE-1

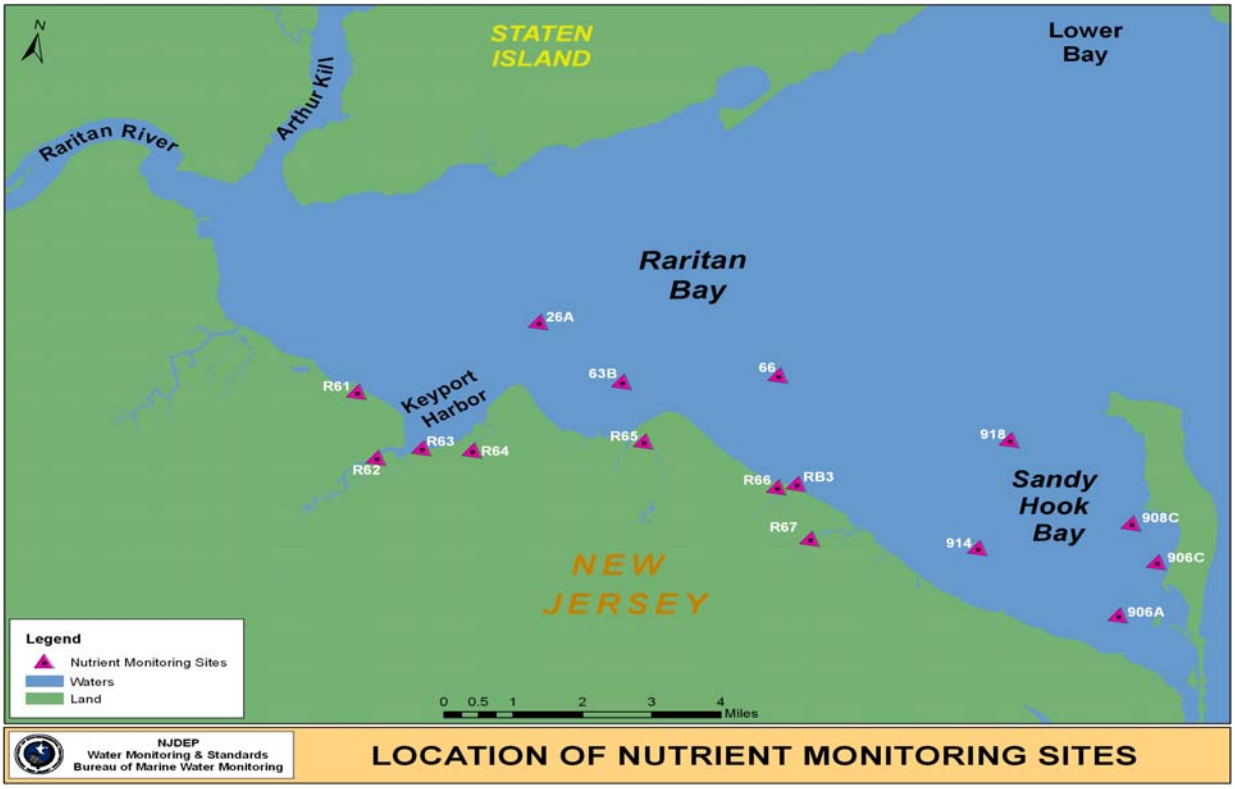
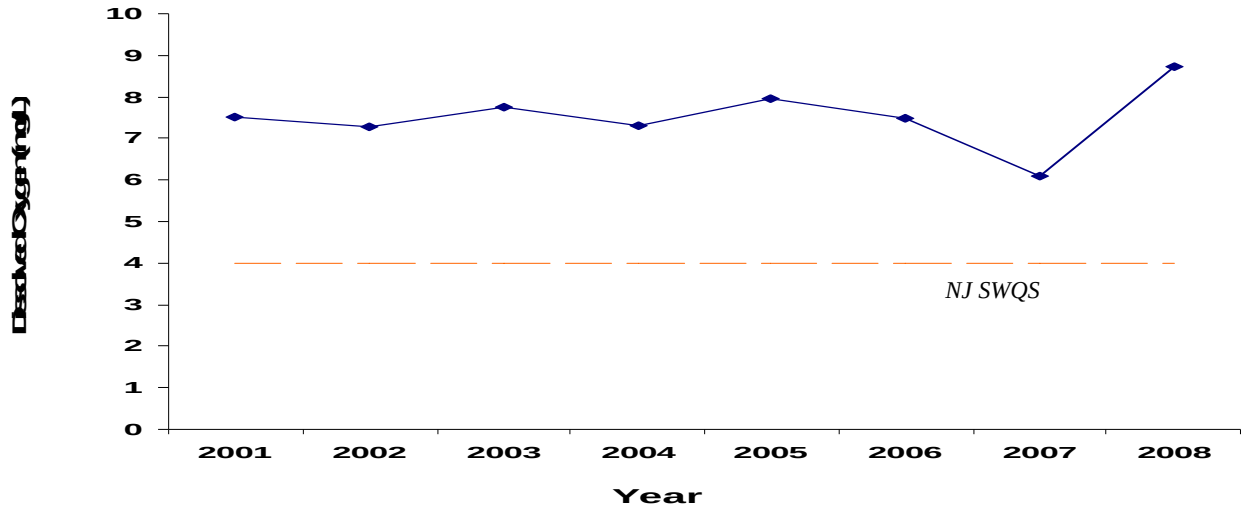


CHART 8: ANNUAL AVERAGE OF DISSOLVED OXYGEN IN THE RARITAN/SANDY HOOK BAY (2001-2008)



TOXICS MONITORING SITES

In conjunction with the total coliform assessment, WM&S/BMWM evaluates any toxicity data that are available; however, shellfish water classifications are not based on these data. The toxicity data are used as adjunct information. Applicable FDA criteria is used as a comparison. However, there are only certain parameters with FDA criteria (Table 11). When a parameter exceeds applicable FDA criteria, WM&S/BMWM investigates the area for potential risks that are associated with shellfish consumption. Closure of shellfish waters may occur if shellfish are found to be contaminated with harmful toxic chemicals.

There are several toxic monitoring sites located throughout this growing area. Figure 39 displays the location of these stations.

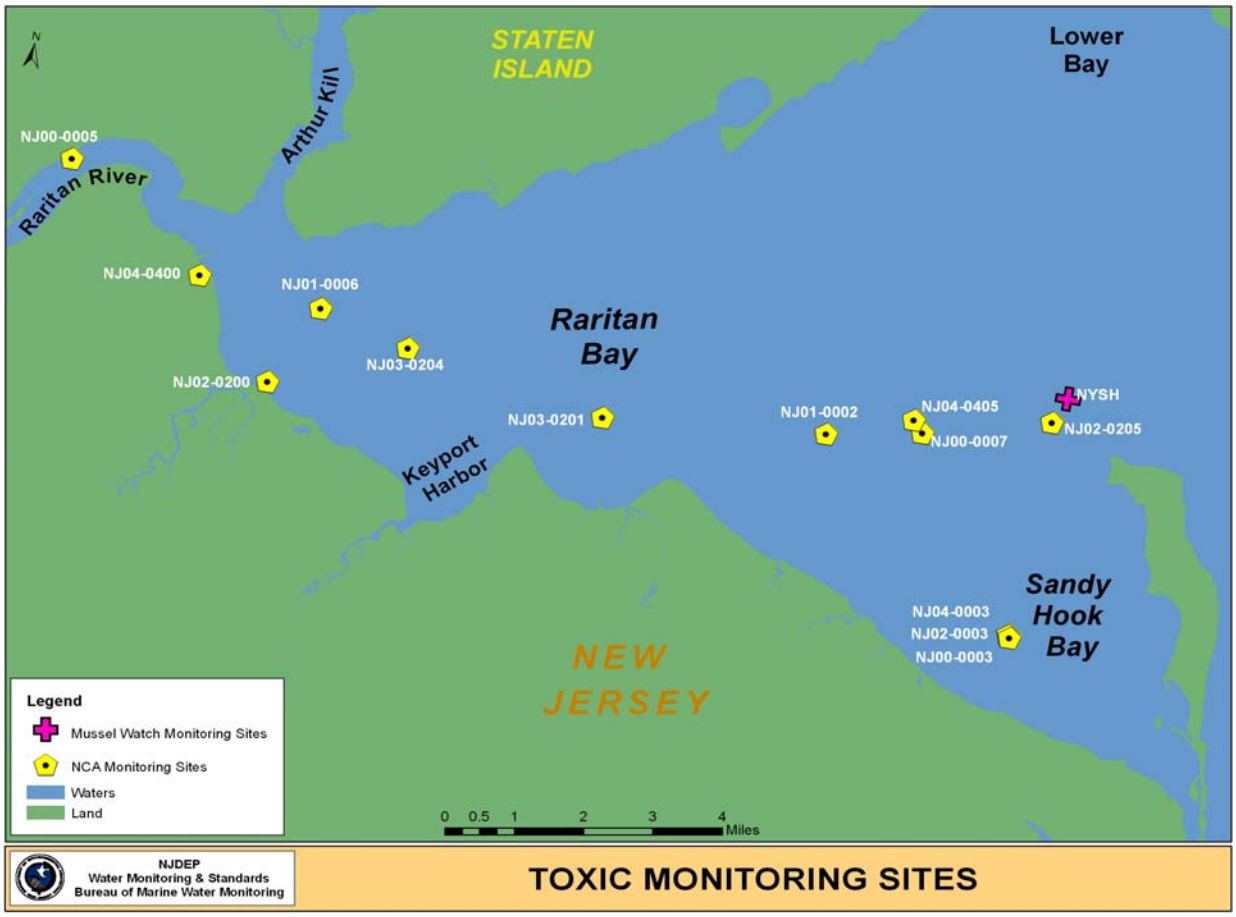
TABLE 11: FDA CRITERIA

Environmental Chemical Contaminant and Pesticide Tolerances, Action Levels, and Guidance Levels

Deleterious Substance	*Level*	*Food Commodity*	*Reference*
Aldrin/Dieldrin[a]	0.3 ppm	All fish	Compliance Policy Guide sec. 575.100
Benzene hexachloride	0.3 ppm	Frog legs	Compliance Policy Guide sec. 575.100
Chlordane	0.3 ppm	All fish	Compliance Policy Guide sec. 575.100
Chlordecone[b]	0.3 ppm	All fish Crabmeat	Compliance Policy Guide sec. 575.100
	0.4 ppm	Crabmeat	
DDT, TDE, DDE[c]	5.0 ppm	All fish	Compliance Policy Guide sec. 575.100
Diquat[d]	0.1 ppm	All fish	40 CFR 180.226
Fluridone[d]	0.5 ppm	Fin fish and crayfish	40 CFR 180.420
Glyphosate[d]	0.25 ppm	Fin fish	40 CFR 180.364
	3.0 ppm	Shellfish	
Toxic elements:			
Arsenic	76 ppm	Crustacea	FDA Guidance Document
	86 ppm	Molluscan bivalves	FDA Guidance Document
Cadmium	3 ppm	Crustacea	FDA Guidance Document
	4 ppm	Molluscan bivalves	FDA Guidance Document
Chromium	12 ppm	Crustacea	FDA Guidance Document
	13 ppm	Molluscan bivalves	FDA Guidance Document
Lead	1.5 ppm	Crustacea	FDA Guidance Document
	1.7 ppm	Molluscan bivalves	FDA Guidance Document
Nickel	70 ppm	Crustacea	FDA Guidance Document
	80 ppm	Molluscan bivalves	FDA Guidance Document
Methyl Mercury[f]	1 ppm	All fish	Compliance Policy Guide sec. 540.600
Heptachlor / Heptachlor Epoxide[e]	0.3 ppm	All fish	Compliance Policy Guide sec. 575.100
Mirex	0.1 ppm	All fish	Compliance Policy Guide sec. 575.100
Polychlorinated Biphenyls (PCB's)[d]	2.0 ppm	All fish	21 CFR 109.30
Simazine[d]	12 ppm	Fin fish	40 CFR 180.213a
2,4-D[d]	1.0 ppm	All fish	40 CFR 180.142

[a] The action level for aldrin and dieldrin are for residues of the pesticides individually or in combination. However, in adding amounts of aldrin and dieldrin, do not count aldrin or dieldrin found at below 0.1 ppm.
[b] Previously listed as Kepone, the trade name of chlordecone.
[c] The action level for DDT, TDE, and DDE are for residues of the pesticides individually or in combination. However, in adding amounts of DDT, TDE, and DDE, do not count any of the three found below 0.2 ppm.
[d] The levels published in 21 CFR & 40 CFR represent tolerances, rather than guidance levels or action levels.
[e] The action level for heptachlor and heptachlor epoxide are for the pesticides individually or in combination. However, in adding amounts of heptachlor and heptachlor epoxide, do not count heptachlor or heptachlor epoxide found below 0.1 ppm.
[f] See Chapter 10 for additional information.

FIGURE 39: TOXIC MONITORING SITES



NOAA Mussel Watch Program

The Mussel Watch Program, initiated by National Oceanic and Atmospheric Administration (NOAA) - National Status and Trends Program (NS&T) in 1986, began collecting sediment and bivalve samples from over 300 sites around the coastal and estuarine waters of the United States. Samples collected underwent heavy metal (mercury, lead, copper, chromium, arsenic, nickel, and cadmium), VOC, PAH, PCB's, and pesticides testing. For additional information regarding this program and archived data see http://ccma.nos.noaa.gov/about/coast/nsandt/welcome.html.

There is one Mussel Watch station located in this shellfish growing area. Station NYSH is located approximately two miles northwest of Sandy Hook Bay in *Special Restricted* waters (Figure 39). Data collected from 2001-2004 were evaluated and compared with available FDA criteria. Chart 9 displays the average concentration of trace metals found at this site. The only parameter that had exceeded available FDA criteria was *Lead*. From 2001-2004, three samples were collected at this site; and the highest concentration of lead was reported in 2004 (Chart 10). All other trace metals were below FDA criteria.

CHART 9: AVERAGE CONCENTRATION OF TRACE METALS AT STATION NYSH (2001-2004 TISSUE DATA)

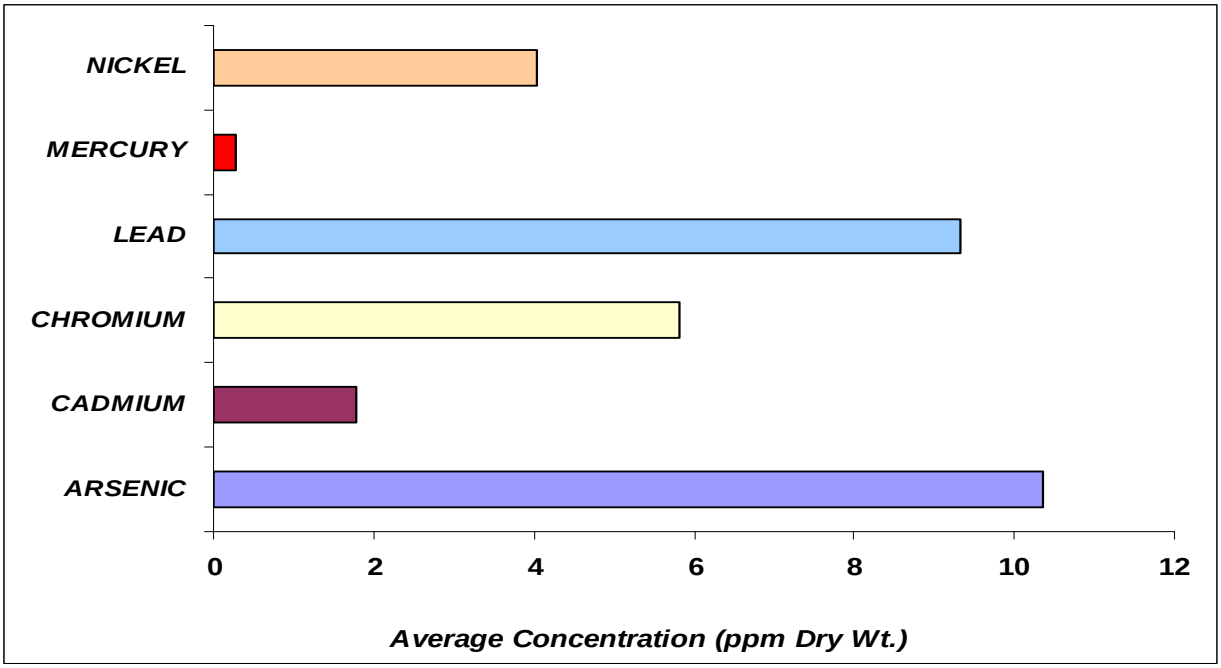
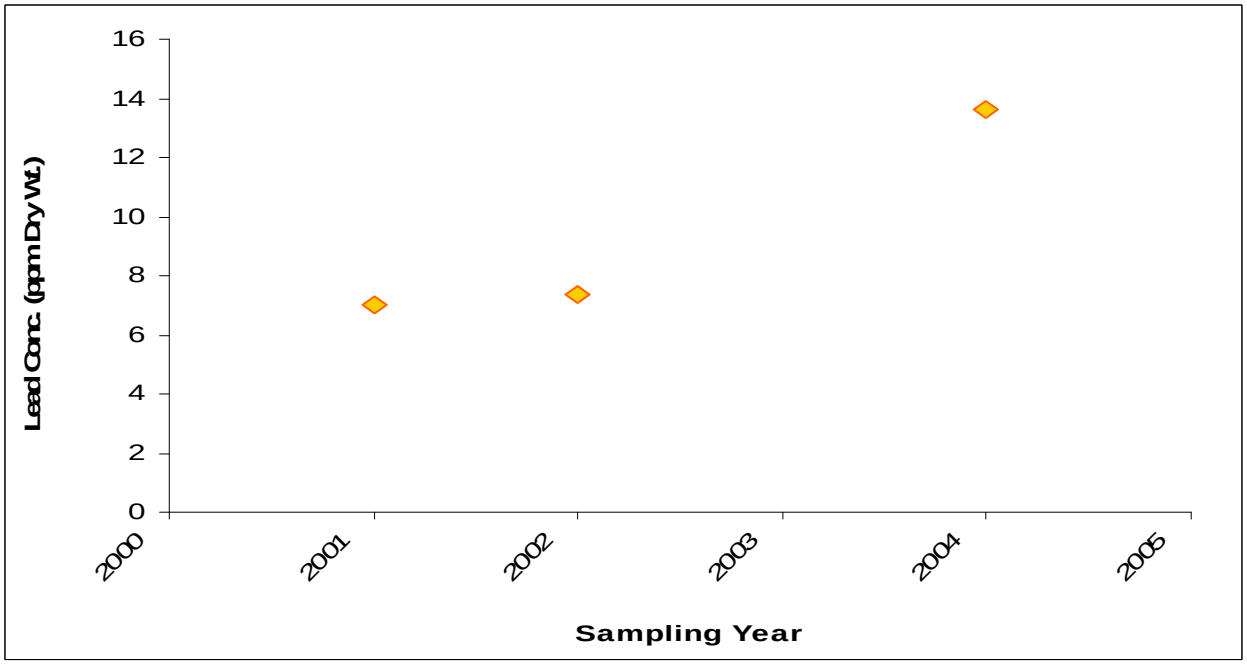


CHART 10: LEAD CONCENTRATION REPORTED AT STATION NYSH (2001-2004 TISSUE DATA)



USEPA National Coastal Assessment

USEPA National Coastal Assessment EMAP and its partners began sampling in the coastal and estuarine water of the United States in 1990. Data collected include waters column parameters, sediment chemistry & toxicity, benthic communities, and tissue contaminants. These data can be found at http://www.epa.gov/emap/nca/html/about.html.

Since there are no FDA criteria available for sediment contaminants, the ERL (Effect Range Low) and ERM (Effect Range Median) values were used as guidance. The ERL/ERM method was originated by Long and Morgan (1990) for correlating sediment chemical concentrations with biological responses. They assembled a large data set consisting mostly of AET (Apparent Effects Threshold) values, supplemented with some EqP (Equilibrium partitioning) values, results of spiked sediment bioassays, and other types of data. For each chemical, data were arranged in order of increasing concentration. The ERL was calculated as the lower 10th percentile of "effects" concentrations and the ERM as the 50th percentile of "effects" concentrations. Currently, there are guidance values for 9 trace metals, 13 individual PAHs, 3 classes of PAHs, and 3 classes of chlorinated organic hydrocarbons. The criteria for assessing sediment contaminants by site are shown in Table 12.

TABLE 12: CRITERIA FOR ASSESSING SEDIMENT CONTAMINANTS BY SITE

Rating	Criteria
Good	No ERM concentrations are exceeded, and less than five ERL concentrations are exceeded.
Fair	Five or more ERL concentrations are exceeded
Poor	An ERM concentration is exceeded for one or more contaminants.

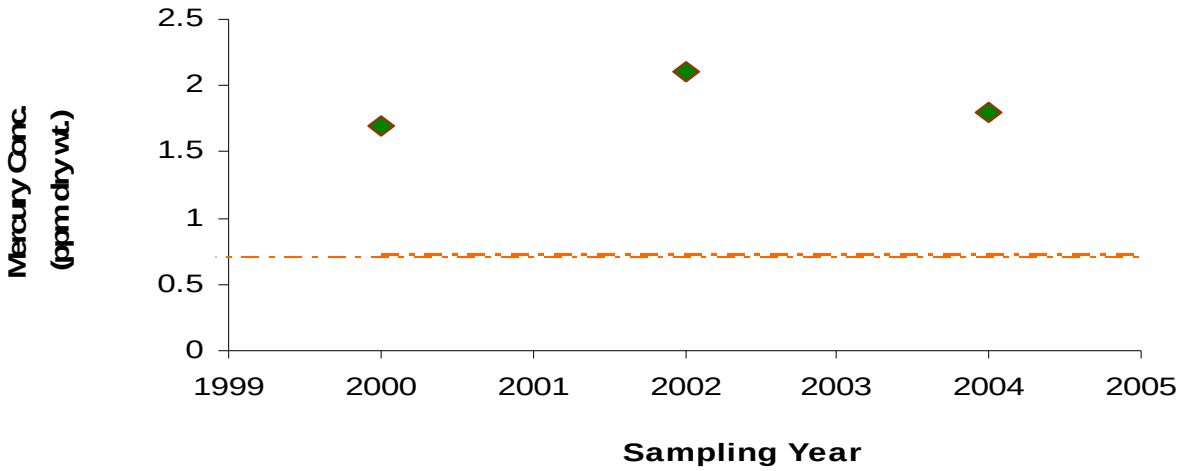
There were 11 NCA sampling stations located within this shellfish growing area (Figure 39). The most recent sediment chemistry and toxicity data were collected in 2004 at Station NJ04-0003, NJ04-0400, and NJ04-0405. The sediment data are shown in Table 13.

Based on these sediment data, only one parameter was found to exceed the ERM which was mercury. Concentrations of mercury were above the ERM value at Station NJ04-0003 and NJ04-0405. Historical mercury data at Station NJ-0003 indicated that the mercury concentration has always been higher and above the ERM value (Chart 11). There are no historical mercury data at Station NJ-0405 for comparison. However, historical data from nearby stations do show mercury levels exceeding the ERM value.

TABLE 13: 2004 SEDIMENT RESULTS VS. ERL/ERM VALUES

Parameters	*Guideline Value (ug/g dry wt.)*		*Sampling Sites*		
	ERL	*ERM*	*NJ04-0003*	*NJ04-0400*	*NJ04-0405*
Arsenic	8.2	70	20.1	5.6	17.8
Cadmium	1.2	9.6	1.9	0.6	1.3
Chromium	81	370	137.0	29.3	103.0
Copper	34	270	122.0	23.6	90.0
Lead	46.7	218	154.0	41.9	110.0
Mercury	0.15	0.71	1.8	0.04	1.5
Nickel	20.9	51.6	38.3	10.1	31.7
Silver	1	3.7	3.7	0.3	3.1
Zinc	150	410	297.0	82.3	217.0
Acenaphthene	0.016	0.5	0.0000	0.0110	0.0000
Acenaphthylene	0.044	0.64	0.0230	0.0000	0.0160
Anthracene	0.0853	1.1	0.0280	0.0340	0.0170
Fluorene	0.019	0.54	0.0120	0.0150	0.0000
2-methylnaphthalene	0.07	0.67	0.0110	0.0000	0.0000
Naphthalene	0.16	2.1	0.0160	0.0000	0.0000
Benz(a)anthracene	0.261	1.6	0.0940	0.1100	0.0530
Benzo(a)pyrene	0.43	1.6	0.1100	0.0940	0.0700
Chrysene	0.384	2.8	0.1000	0.1100	0.0540
Dibenzo(a,h)anthracene	0.0634	0.26	0.0000	0.0320	0.0220
Fluoranthene	0.6	5.1	0.1300	0.2000	0.0730
Pyrene	0.665	2.6	0.1600	0.1700	0.0870
p,p'-DDE	0.0022	0.027	0.0010	0.0014	0.0005

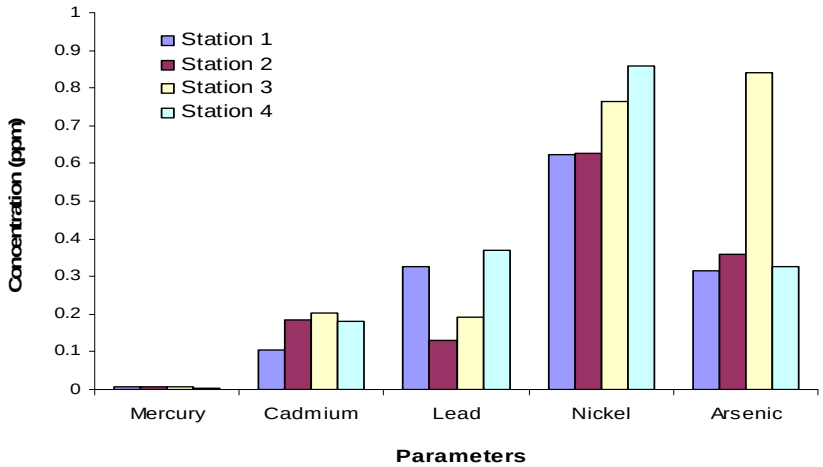
CHART 11: MERCURY CONCENTRATION REPORTED AT STATION NJ-0003 (2000, 2002, AND 2004)



From 2000 through 2004, 16 sediment samples were collected within this growing area, 9 of the 16 samples having mercury concentration above the ERM value. In response to these findings, WM&S/BMWM began analyzing shellfish tissue for heavy metals. In November 2006, with the help of NJDEP Fish & Wildlife, soft clams (*Mya arenari)* were collected from four sites in the Sandy Hook Bay (Figure 40). These samples were then brought to the WM&S/BMWM laboratory for metals analysis. The results from these tissue samples were well below FDA criteria (Chart 12).

FIGURE 40: LOCATION OF SHELLFISH SAMPLES COLLECTED BY NJDEP FISH & WILDLIFE FOR METAL ANALYSIS

CHART 12: CONCENTRATIONS OF HEAVY METALS IN SANDY HOOK



Parameters	FDA Criteria (ppm)
Mercury	1
Cadmium	4
Lead	1.7
Nickel	80
Arsenic	60

BATHING BEACH DATA

NJDEP, along with the New Jersey Department of Health and Senior Services and local health agencies, implements the Cooperative Coastal Monitoring Program, which is responsible for conducting sanitary surveys of beaches and monitors the concentration of bacteria in coastal and estuarine waters that are open to the public for recreational bathing. Samples are taken once a week, usually on Monday, for the entire summer. There are approximately 325 (ocean and bay) sampling stations throughout the state. These samples are tested for Enterococci. Local health agencies and law enforcement may close a beach at any time if the results exceed the State Sanitary Code of 104 Enterococci per 100mL. WM&S/BMWM utilizes these data as adjunct information. The closure of shellfish waters does not necessarily correspond to these results.

There were 15 bay beach monitoring stations located within this shellfish growing area (Figure 41). Table 14, lists the results generated from these sites from 2001 through 2008.

According to the Cooperative Coastal Monitoring Program Summary Report for 2006 and 2007, there were a total of 53 bay closures in 2007 as compared to 37 in 2006, for the entire New Jersey coast. The majority of these closures were due to high bacterium counts and precautionary action. None of these closures were due to floatables. The 2008 data show 14% less bay closure due to high bacteria counts (Chart 13).

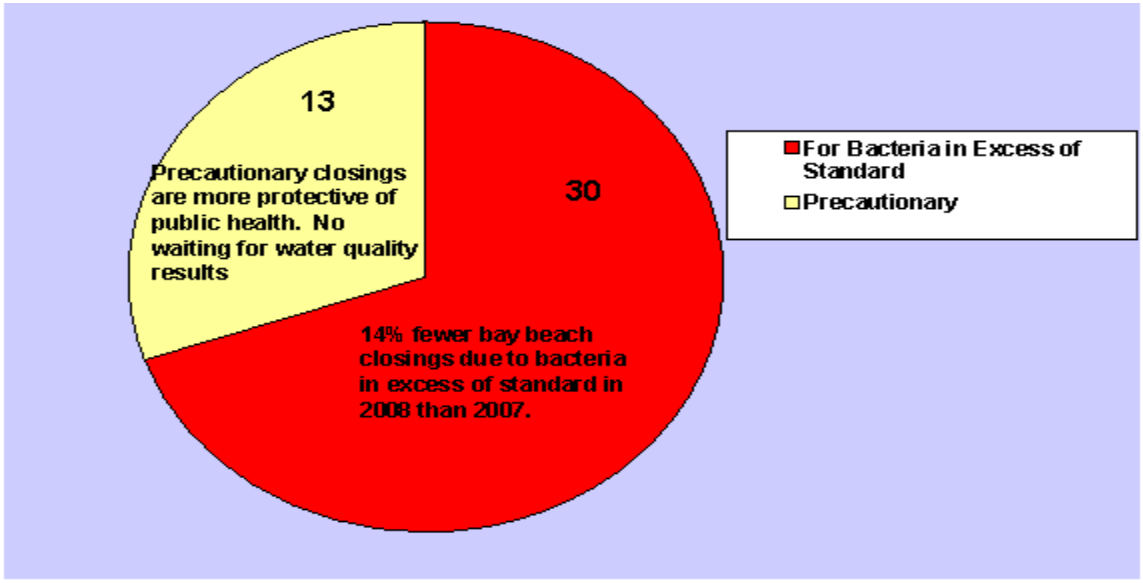
For more information regarding this program, bathing beach data, closures, and the latest report, see http://www.nj.gov/dep/wms/bmw/bathingbeach.

FIGURE 41: BATHING BEACH & ENVIRONMENTAL MONITORING SITES

TABLE 14: NE-1 BATHING BEACH MONITORING DATA FROM 2001-2008
SOURCE: COOPERATIVE COASTAL MONITORING PROGRAM

STATION ID	BATHING	ANNUAL ENTEROCOCCI GEOMETRIC MEAN (CFU/100 mL)							
		2001	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*
CCMPMC0001	NON-BATHING	43.4	18.5	32.7	51	26.5	23.3	26.5	20
CCMPMC0002	NON-BATHING	NA	NA	NA	32.6	13.7	17.4	21.5	18.2
CCMPMC0003	NON-BATHING	30.8	45.8	39.7	34	15.5	27.6	22.9	18.9
CCMPMC0005	NON-BATHING	NA	NA	NA	12.9	11.5	22.3	13.5	10.9
CCMPMC0007	NON-BATHING	NA	NA	NA	19.8	16.1	15	14.2	10.9
CCMPMC0044	BATHING	19.7	17.6	25.7	14.4	10.7	10.4	14.1	10.9
CCMPMC0045	BATHING	NA	NA	NA	22.2	16.6	15.9	17.3	14.7
CCMPMC0046	NON-BATHING	NA	NA	NA	15.3	11	13.1	20.1	22.9
CCMPMC0049	BATHING	NA	NA	NA	30	12.1	22.9	24.5	17.4
CCMPMC0050	BATHING	21.1	15.9	23.4	32.2	10	20.2	19.5	13.2
CCMPMC0052	BATHING	NA	NA	NA	15.4	10.4	11.4	15.8	10.9
CCMPMX0001	NON-BATHING	7.3	6	NA	30.5	5.3	21.7	NA	NA
CCMPMX0002	NON-BATHING	12.3	15.6	NA	34.1	4.9	10.4	NA	NA
CCMPMX0004	NON-BATHING	5.3	4.4	NA	4.8	2.7	4.1	NA	NA
CCMPMX0005	NON-BATHING	9.5	10.7	NA	19.5	2.9	23.7	NA	NA

CHART 13: 2008 NEW JERSEY BAY BEACH CLOSURES



INTERPRETATION AND DISCUSSION OF DATA

BACTERIOLOGICAL

Each state adopts either the total coliform criteria or the fecal coliform criteria for determining water quality. NJDEP has always based its water classifications on the results generated from the total coliform test. Under normal circumstances, the NSSP criteria for the standard MPN 3-tube test would be used as a guideline for the determination of shellfish growing waters classification. However, for this report, the NSSP criteria for the MPN 5-tube test were used because sample analyses were performed under both tests. Therefore, the more conservative criteria were used.

Based on the data pool assessed for this report, the majority of stations in this growing area do not meet NSSP MPN 5-tube "Approved" criteria based on year-round, summer, and winter evaluation. Currently, there are no *Approved* or *Seasonally Approved* waters in this growing area. Waters in this growing area are either classified as *Prohibited* or *Special Restricted*. When evaluating these data against the NSSP MPN 5-tube "Special Restricted" criteria, all stations were found to meet the current shellfish classifications.

When comparing summer and winter annual geometric means, summer annual geometric means remain consistently below the NSSP "Approved" geometric mean criteria; whereas, winter annual geometric means constantly fluctuate. The difference between summer and winter annual geometric means varies from year to year, with winter always exceeding summer annual geometric means. Based on this data pool, 27 stations were found to be impacted by a seasonal component; all 27 stations had total coliform levels higher during the winter. The 2007 winter annual geometric mean was 23 times higher than summer annual geometric mean. The same phenomenon was also observed in 2003 data. The 2003 occurrence was in response to the Sayreville spill. No major spill was reported in 2007 for this area. However, according to the 2006/2007 IEC Report, 2007 was listed as a "wet year" with rainfall totaling 10 inches above yearly average. Rain is a major contributing factor to this growing area. With multiple stormwater outfalls and CSOs along the New York/New Jersey shoreline, this growing area receives contaminated and polluted materials from both states during a heavy rainfall event.

Based on the rainfall evaluation, the area that showed an immediate impact to rainfall was the southern portion of Sandy Hook Bay. There are several contributing factors that could have been attributed to this finding. This area is influence by direct flow from the Shrewsbury and Navesink River. Depending on the tide, wind direction, and current, contaminated material can travel to this growing area via the Shrewsbury River. Other contributing factors include marinas, stormwater outfalls, and condos that lie along the shoreline. Beside the marinas and stormwater outfalls, the MCBOA lines and pump stations also run along the shoreline. Stations that were immediately impacted by rain were stations that were situated outside the Atlantic Highlands Municipal Marina. As previously described under the section on "Identification and Evaluation of Potential Pollution Sources, marina

activities can have a great influence on water quality.

Within 48 hours of a rainfall event, stations in the northern portion of the Raritan Bay and Keyport Harbor were impacted. This indicates that the northern portion of this growing area responds differently to a rainfall event. It has a delayed effect. It shows that that the northern portion of this growing area is not influenced by contaminated material flowing in from the Shrewsbury River or Sandy Hook Bay, but from contaminated material washing in from the Hudson River through Lower New York Bay, Raritan River, and Arthur Kill. By 72 hours, the entire growing area was impacted by rain.

Tissue and sediment data collected within this growing area from various agencies were evaluated against available FDA criteria or the sediment guidance values, ERL & ERM. Based on the sediment data, only one parameter was found to exceed the ERM, which was mercury. Concentrations of mercury were above the ERM value at two NCA monitoring sites. Historical mercury data collected at these sites indicated that the concentrations of mercury have always been higher and above the ERM value. Data collected from the Mussel Watch Program indicates that the concentration of lead was higher than FDA criteria. In response to this finding, WM&S' BMWM began analyzing shellfish tissue samples collected in the Sandy Hook Bay for heavy metals (mercury, lead, cadmium, nickel, and arsenic). Levels of heavy metals were found to be very minimal. The level of heavy metals found in these samples also coincided with the results from a study conducted back in the 1980's, which investigated heavy metals in shellfish tissue collected in this growing area.

CONCLUSIONS

Data evaluated for this report meet the current shellfish classifications of either *Prohibited* or *Special Restricted*. Several sampling stations in this area meet the NSSP 5-tube"Approved" criteria. These stations are located in Sandy Hook Bay. The area with the most potential for an upgrade would be the area surrounding the following sampling stations: 908C, 910E, and 914D. The current data support the classification of *Seasonally Approved*. However, no upgrade is recommended at this time due to the need for additional seasonal samples. It is therefore recommended that more samples be collected during the winter months, especially in the Sandy Hook area.

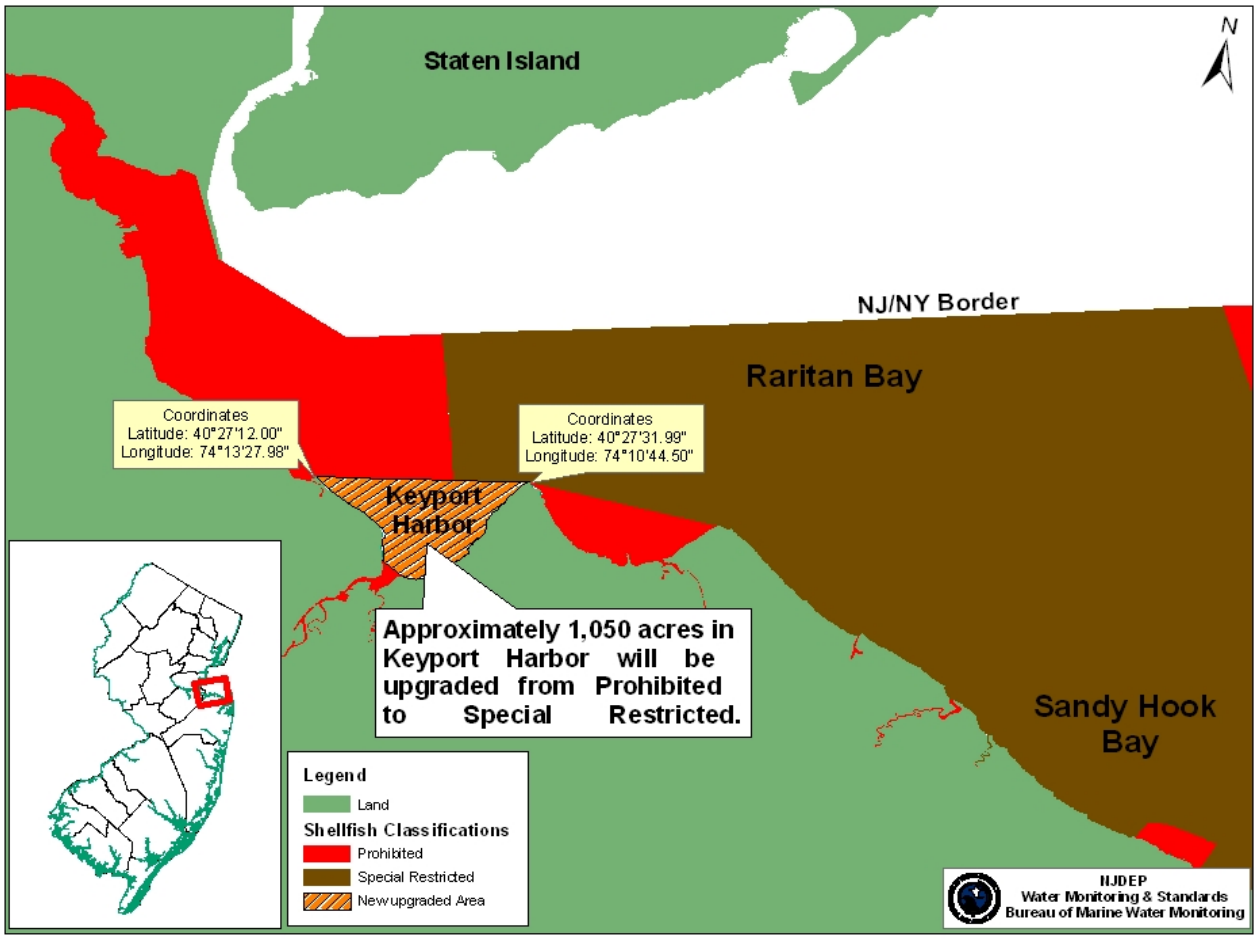
There are enough data to support an upgrade in Keyport Harbor from *Prohibited* to *Special Restricted*. Since 2004, WM&S' BMWM began sampling in this area. From 2004 through 2008, approximately 44 samples were collected from four sampling sites located in Keyport Harbor. Statistical data show that these stations do not meet the NSSP 5-tube "Approved" criteria. However, they do meet the NSSP 5-tube "Special Restricted" criteria. Therefore, it is recommended that this area be upgraded from *Prohibited* to *Special Restricted*.

RECOMMENDATIONS

SHELLFISH WATER CLASSIFICATION

It is recommended that approximately 1,050 acres of waters in Keyport Harbor be upgraded from *Prohibited* to *Special Restricted.* Figure 42 shows the location of the proposed upgraded areas.

FIGURE 42: PROPOSED 2010 SHELLFISH CLASSIFICATION FOR SHELLFISH GROWING AREA NE-1



LEGAL DESCRIPTION FOR RECOMMENDED CHANGES

N.J.A.C. 7:12-2.1 Shellfish growing water classification—Prohibited

(a) The following shellfish growing waters are classified Prohibited

3. Monmouth Middlesex County area (note that a portion is also designated as a Special Restricted area. See N.J.A.C. 7:12-3):

i. [All those waters of the Raritan Bay, Raritan River and Arthur Kill (and tributaries) lying south and west of the New Jersey/New York boundary and lying west of a line beginning on the northernmost point of land on Conaskonk Point, Union Beach, New Jersey (latitude 40 degrees 27 minutes 31.99 seconds N., longitude 74 degrees 10 minutes 44.50 seconds W.), and bearing approximately 261 degrees T to a point of land at latitude 40 degrees 27 minutes 12 seconds N., latitude 74 degrees 13 minutes 27.98 seconds W., until it intersects a line at latitude 40 degrees 27 minutes 24.78 seconds N., longitude 74 degrees 11 minutes 43.86 from the tank between Keyport and Union Beach, New Jersey at latitude 40 degrees 26 minutes 31.16 seconds N., longitude 74 degrees 11 minutes 25.18 seconds W., bearing approximately 345 degrees T to the Iso G 6 sec 80 foot tower at latitude 40 degrees 30 minutes 27.82 seconds N., longitude 74 degrees 12 minutes 47.94 seconds W., at Red Bank, Staten Island, New York, until it intersects the New York-New Jersey boundary at latitude 40 degrees 28 minutes 51.4 seconds N., longitude 74 degrees 12 minutes 13 seconds W., where this line terminates;] All those waters of the Raritan River, Arthur Kill (and tributaries), and portion of the Raritan Bay that are enclosed within a line that begins at the New Jersey/New York boundary with coordinates of latitude 40 degrees 28 minutes 51.4 seconds N., longitude 74 degrees 12 minutes 13 seconds W., then bearing approximately 165 degrees T in a southeasterly direction toward a point with latitude 40 degrees 27 minutes 24.78 seconds N., longitude 74 degrees 11 minutes 43.86 seconds W., and then proceeding in a westerly direction at approximately 261 degrees T to a point of land with latitude 40 degrees 27 minutes 12 seconds N., latitude 74 degrees 13 minutes 27.98 seconds W., and terminating;

ii. All those waters of the Matawan Creek and Luppatatong Creek and terminating at a straight line connecting a department maintained marker located on the east shore at coordinates latitude 40 degrees 26 minutes 21.68 seconds N., and longitude 74 degrees 12 minutes 7.86 seconds W., and a Department maintained marker located on the west shore at coordinates latitude 40 degrees 26minutes 29.26 seconds N., and longitude 74 degrees 12 minutes 26.21 seconds W., and terminating.

N.J.A.C. 7:12-3.2 Shellfish growing waters that are classified as Special Restricted

(a) The following shellfish growing waters are classified as Special Restricted:

1. All those waters contained within a line beginning on the northernmost point of Conaskonk Point, latitude 40 degrees 27 minutes 31.99 seconds N., longitude 74 degrees 10 minutes 44.50 seconds W., near Union Beach, New Jersey and continuing in a southwesterly direction along the coastline to a department maintained marker at latitude 40 degrees 26 minutes 21.7 seconds N., longitude 74 degrees 12 minutes 7.9 seconds W., then bearing 300 degrees T across the mouth of Matawan Creek to a department maintained marker at latitude 40 degrees 26 minutes 29.3 seconds N., longitude 74 degrees 12 minutes 26.2 seconds W., then continuing along the shoreline in a northwesterly direction to a point of land at latitude 40 degrees 27 minutes 12 seconds N., latitude 74 degrees 13 minutes 28.0 seconds W., then bearing approximately 80 degrees T ,[and bearing approximately 261 degrees T to a point of land at latitude 40 degrees 27 minutes 12 seconds N., latitude 74 degrees 13 minutes 27.98 seconds W.,] until it intersects a line at latitude 40 degrees 27 minutes 24.78 seconds N., longitude 74 degrees 11 minutes 43.86 from the tank between Keyport and Union Beach, New Jersey at latitude 40 degrees 26 minutes 31.16 seconds N., longitude 74 degrees 11 minutes 25.18 seconds W., bearing approximately 345 degrees T to the Iso G 6 sec 80 foot tower at latitude 40 degrees 30 minutes 27.82 seconds N., longitude 74 degrees 12 minutes 47.94 seconds W., at Red Bank, Staten Island, New York, until it intersects the New York-New Jersey boundary at latitude 40 degrees 28 minutes 51.4 seconds N., longitude 74 degrees 12 minutes 13 seconds W., then along that boundary in an easterly direction until it intersects the Chapel Hill South Channel at approximately latitude 40 degrees 30 minutes 30.20 seconds N., and longitude 74 degrees 2 minutes 22.03 seconds W., (just south of R "10" 18 Fl R4s Bell, located in New York State waters), thence in a southeasterly direction at a bearing of 151 T to the northernmost tip of Sandy Hook, approximately latitude 40 degrees 28 minutes 39.57 seconds N., and longitude 74 degrees 1 minute 4.02 seconds W., then proceeding in a generally southerly direction following the western shoreline of Sandy Hook to the westernmost extent of the Rt. 36 highway bridge spanning the Shrewsbury River and then following the northern edge of that bridge to where it intersects the shoreline on the mainland and then following the shoreline in a generally northwesterly direction until it intersects a line bearing approximately 201 degrees T from the navigational marker designated as Flashing light 4 second 29ft 8M (Fl 4 sec 29ft 8M) marking the easternmost extent of the Atlantic Highlands Municipal Yacht Basin's breakwater (this stone pile forms the basin's northern boundary), and then along that line in a northerly direction to the marker designated as a Flashing light 4 second 29ft 8M and following the northern side of the breakwater in a westerly direction until it reaches the structure forming the western boundary of the Yacht Basin, and then following the western edge of this structure in a southerly direction to the mainland, then following the shoreline in a generally northwesterly direction to the northernmost point of land on Point Comfort (Keansburg), then bearing approximately 272 degrees T to the northernmost point of land on Conaskonk Point (Union Beach), its point of origin.

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NJDEP, Data Miner, http://datamine2.state.nj.us/dep/DEP_OPRA/

New York-New Jersey Harbor Estuary Program, http://www.harborestuary.org/

NY/NJ Baykeeper, http://www.nynjbaykeeper.org/

US Army Corps of Engineers-New York Distinct, http://www.nan.usace.army.mil/

USEAP, National Coastal Assessment, http://www.epa.gov/emap/nca/index.html

NOAA Fisheries, Office of Science & Technology, http://www.st.nmfs.noaa.gov/st1/commercial/

Interstate Environmental Commission, http://www.iec-nynjct.org/

Middlesex County, http://co.middlesex.nj.us/

Monmouth County, http://www.visitmonmouth.com/

NJDEP Cooperative Coastal Monitoring Program, http://www.state.nj.us/dep/beaches/ccmp.html

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APPENDICES

A. Statistical Summaries

- Year-round
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- Summer Only

B. Seasonal Evaluation

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- Cumulative Rainfall
- Wet Weather Statistical Summary
- Dry Weather Statistical Summary

E. Data Listing -2001 through 2008