New Jersey Department of Environmental Protection
Water Monitoring & Standards
Land Use Management
Post Office Box 409, Trenton

Leslie J. McGeorge, Administrator

September 2006

SANITARY SURVEY

Shark River (NE 4)

January 1, 1999 – December 31, 2004

Water Monitoring Report Prepared by:

Tracy Kirwan

Bureau of Marine Water Monitoring
P.O. Box 405 Stoney Hill Road
Leeds Point, NJ 08220
www.nj.gov/dep/bmw

Robert Connell, Bureau Chief

STATE OF NEW JERSEY

Jon S. Corzine

GOVERNOR

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New Jersey Department of Environmental Protection
Lisa P. Jackson
COMMISSIONER

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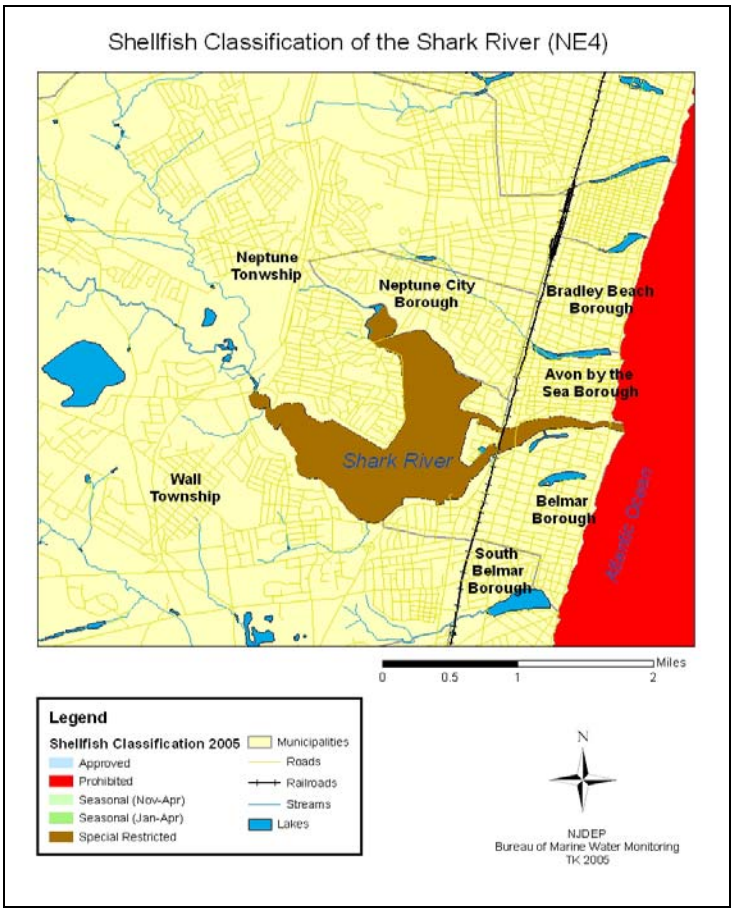
EXECUTIVE SUMMARY

The Shark River is located in southern Monmouth County and connects to the Atlantic Ocean via the Shark River Inlet (see Figure 1). Water samples from the Shark River were collected (using the Systematic Random Sampling strategy) and analyzed from 27 sampling stations for total coliform during the period of January 1, 1999 through December 31, 2004 for this Sanitary Survey Report. The Shark River has been classified as *Special Restricted* since 1987; previously it was classified as *Prohibited* due to administrative reasons. Since then, the water quality has supported the *Special Restricted* classification. All sampling stations currently comply with their criteria for the *Special Restricted* classification. The results of this data evaluation prove to be consistent with the existing shellfish growing water classification. No changes in classification are recommended for this area. The monitoring schedule will remain the same. There are no direct discharges into the Shark River, although there are numerous stormwater outfalls and other indirect discharges.

FIGURE 1: LOCATION AND SHELLFISH CLASSIFICATION OF THE SHARK RIVER



INTRODUCTION

PURPOSE

This report is part of a series of studies having a dual purpose. The first and primary purpose is to comply with the guidelines of the National Shellfish Sanitation Program (NSSP) that are established by the Interstate Shellfish Sanitation Conference (ISSC). The shellfish growing area reports establish the classifications in New Jersey waters for the purpose of harvesting shellfish for human consumption. As such, they provide a critical link in protecting human health.

The second purpose is to provide input to the Integrated Water Quality Monitoring and Assessment Report, which is prepared pursuant to Sections 305(b) and 303(d) of the Federal Clean Water Act (P.L. 95-217). The information contained in the growing area reports is used for the 305b portion of the Integrated Report, which provides an assessment to Congress every two years of current water quality conditions in the State's major rivers, lakes, estuaries, and ocean waters. The reports provide valuable information for the 305(b) portion of the Integrated Report, which describes the waters that are attaining state designated water uses and national clean water goals; the pollution problems identified in surface waters; and the actual or potential sources of pollution. Similarly, the reports utilize relevant information contained in the 305(b) portion of the Integrated Report, since the latter assessments are based on instream monitoring data (temperature, oxygen, pH, total and fecal coliform bacteria, nutrients, solids, ammonia and metals), land-use profiles, drainage basin characteristics and other pollution source information.

From the perspective of the Shellfish Classification Program, the reciprocal use of water quality information from reports represent two sides of the same coin: the growing area report focuses on the estuary itself, while the 305(b) report describes the watershed that drains to that estuary.

The Department participates in a cooperative National Environmental Performance Partnership System (NEPPS) with the USEPA, which emphasizes ongoing evaluation of issues associated with environmental regulation, including assessing impacts on water bodies and measuring improvements in various indicators of environmental health.

These shellfish growing area reports are intended to provide a brief assessment of the growing area, with particular emphasis on those factors that affect the quantity and quality of the shellfish resource. The shellfish growing area reports provide valuable information on the overall quality of the saline waters in the most downstream sections of each major watershed. In addition, the reports assess the quality of the biological resource and provide a reliable indicator of potential areas of concern and/or areas where additional information is needed to accurately assess watershed dynamics.

HISTORY OF NSSP REGULATIONS

As a brief history, the NSSP developed from public health principles and program controls formulated at the original conference on shellfish sanitation called by the Surgeon General of the United States Public Health Service in 1925. This conference was called after oysters were implicated in causing over 1,500 cases of typhoid fever and 150 deaths in 1924. The tripartite cooperative program (federal, state and shellfish industry) has updated the program procedures and guidelines through workshops held periodically until 1977. Because of concern by many states that the NSSP guidelines were not being enforced uniformly, a delegation of state shellfish officials from 22 states met in 1982 in Annapolis, Maryland, and formed the ISSC. The first annual meeting was held in 1983 and continues to meet annually at various locations throughout the United States.

The NSSP *Guide for the Control of Molluscan Shellfish* sets forth the principles and requirements for the sanitary control of shellfish produced and shipped via interstate commerce in the United States. It provides the basis used by the Federal Food and Drug Administration (FDA) in evaluating state shellfish sanitation programs. The five major points on which the FDA evaluates the state include:

1. The classification of all actual and potential shellfish growing areas as to their suitability for shellfish harvesting.
2. The control of the harvesting of shellfish from areas that are classified as restricted, prohibited, or otherwise closed.
3. The regulation and supervision of shellfish resource recovery programs.
4. The ability to restrict the harvest of shellfish from areas in a public health emergency, and
5. Prevent the sale, shipment or possession of shellfish that cannot be identified as being produced in accordance with the NSSP and have the ability to condemn, seize, or embargo such shellfish.

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 Marine Water Monitoring (BMWM), under the authority of N.J.S.A. 58:24, classifies the shellfish growing waters and administers the special resource recovery programs. Regulations delineating the growing areas are promulgated at N.J.A.C. 7:12 and are revised annually. Special Permit rules are also found at N.J.A.C. 7:12 and are revised as necessary.

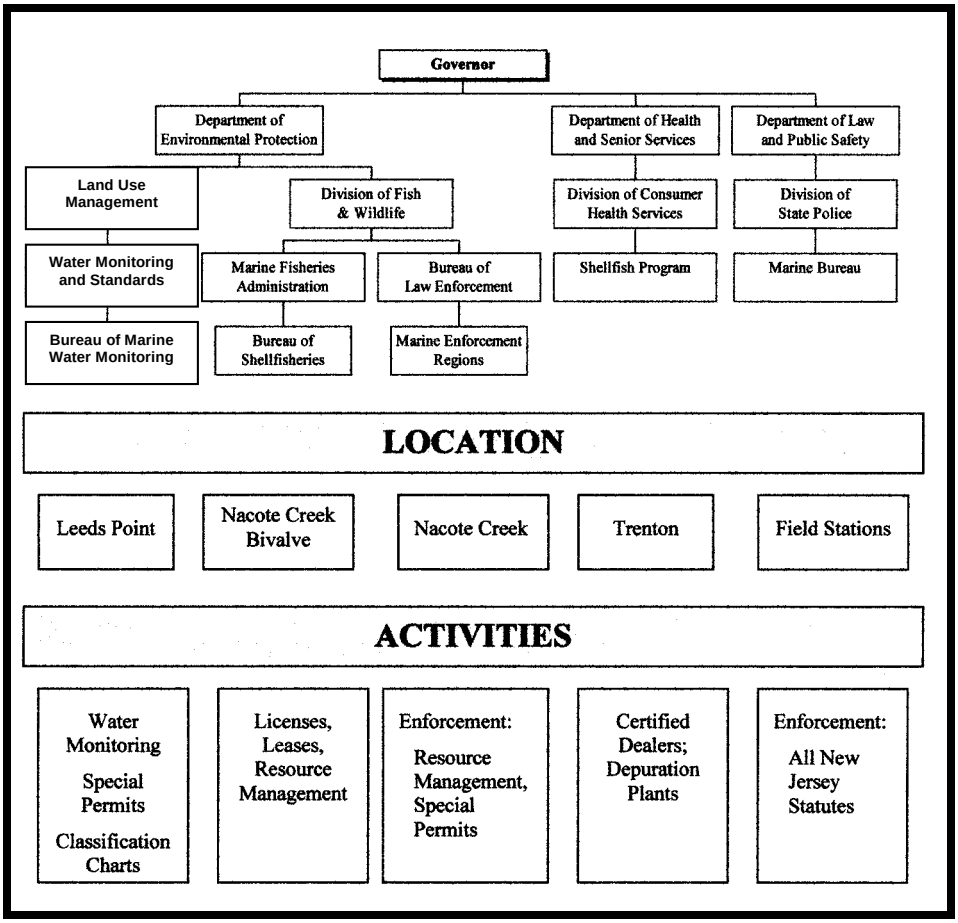
The Bureau of Shellfisheries, in the Division of Fish and Wildlife, issues harvesting licenses and leases for shellfish grounds under the Authority of N.J.S.A. 50:2 and N.J.A.C. 7:25. This bureau, in conjunction with the BMWM, administers the Hard Clam Relay Program.

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 the preceding rules.

The Department of Health and Senior Services is responsible for the certifications of wholesale shellfish establishments and, in conjunction with the BMWM, administers the depuration program.

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

FIGURE 2: ORGANIZATIONAL CHART OF SHELLFISH AGENCIES



IMPORTANCE OF SANITARY CONTROL OF SHELLFISH

Emphasis is placed on the sanitary control of these shellfish because of the direct relationship between the 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. Contamination reaches the waterways via runoff and direct discharges. Sources of such contamination are many and varied, and include urban and storm water runoffs, faulty septic systems, boat dumping, agricultural runoff, waterfowl, and animal wastes.

Filter feeding Molluscan shellfish, known as bivalves (clams, oysters, and mussels) pump large quantities of water through their bodies during the normal feeding process (see Figure 2). During this process the shellfish also collect 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, reappraisals, completed on a three-year basis. Reappraisal reports are less detailed discussions of the principle components included in the sanitary surveys. In addition, the reappraisal report does not require a full shoreline survey. If major changes to the shoreline or bacterial quality occur, then the intensive sanitary survey report is initiated prior to its l2 year schedule. If only a section of a growing area is either upgraded or downgraded from its current shellfish classification, a partial intensive report (Partial Sanitary Survey) is conducted for that shellfish growing area. Annual Reviews are written on a yearly basis for each shellfish growing area.

This report is a Sanitary Survey of the Shark River Growing Area.

After assessment, the appropriate classification is determined for that particular area. The possible classifications are *Approved, Seasonal, Special Restricted,* and *Prohibited*. *Approved* waters can be harvested for shellfish all year round. *Seasonal* waters can be harvested for all, or part, of the winter; there is a *Seasonal (Nov-Apr)* classification and a *Seasonal (Jan-Apr)* classification. *Special Restricted* waters are approved for harvest, followed by depuration or relay, which help to cleanse bacteria from the shellfish. Depuration is a process that purifies the shellfish by pumping UV treated bacteria-free water through clam 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, 2003). Relaying entails taking the market size shellfish from *Special Restricted* waters for replanting in *Approved* areas where they are left to purge for a minimum of 30 days. Harvesting clams for either depuration or relay requires issuance of a Special Permit, acquired at the Bureau of Marine Water Monitoring. No harvest is allowed in *Prohibited* waters.

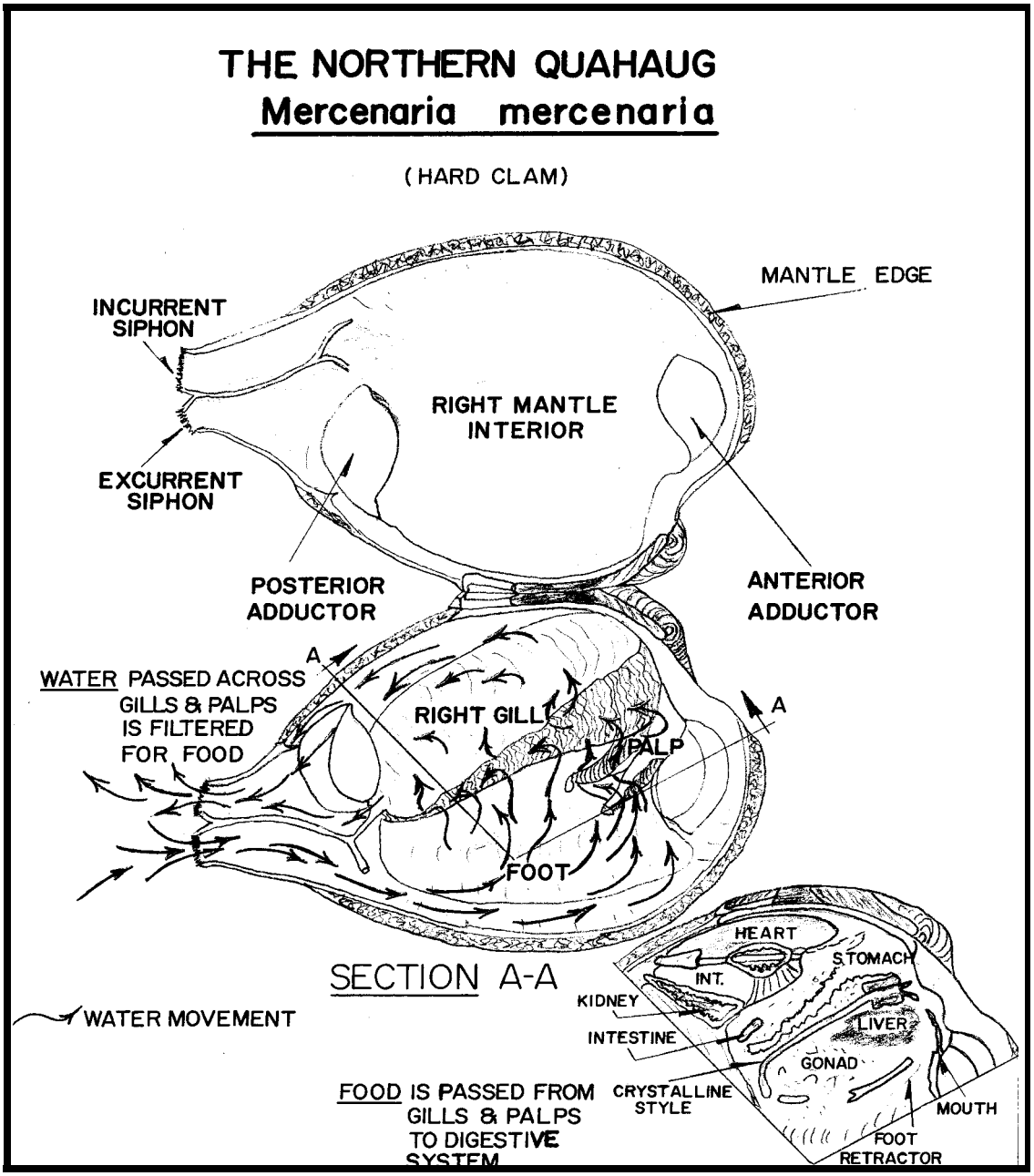
Any discrepancies in the current classification require a change, in order to correctly classify the area. If, over time, the data support improving water quality and are within the requisite criteria, then an upgrade in classification can be made. However, if the data show values exceeding criteria, then the downgrading of that particular area is required.

According to harvesting regulations, there can be no shellfish taken from waters before sunrise or after sunset or on Sundays, except as provided in N.J.S.A. 50:2-1 (N.J.A.C. Chapter 12 7:12-9.1, 2003). Only those who hold a Commercial Clam License may catch more than 150 clams a day or sell or offer the clams for sale. All hard clams

harvested must be at least 1½ inches in length.

The following narrative constitutes this Bureau's assessment of the above mentioned components to comply with the Sanitary Survey. Additionally, a shoreline survey was completed.

FIGURE 3: MERCENARIA MERCENARIA



PROFILE OF THE GROWING AREA

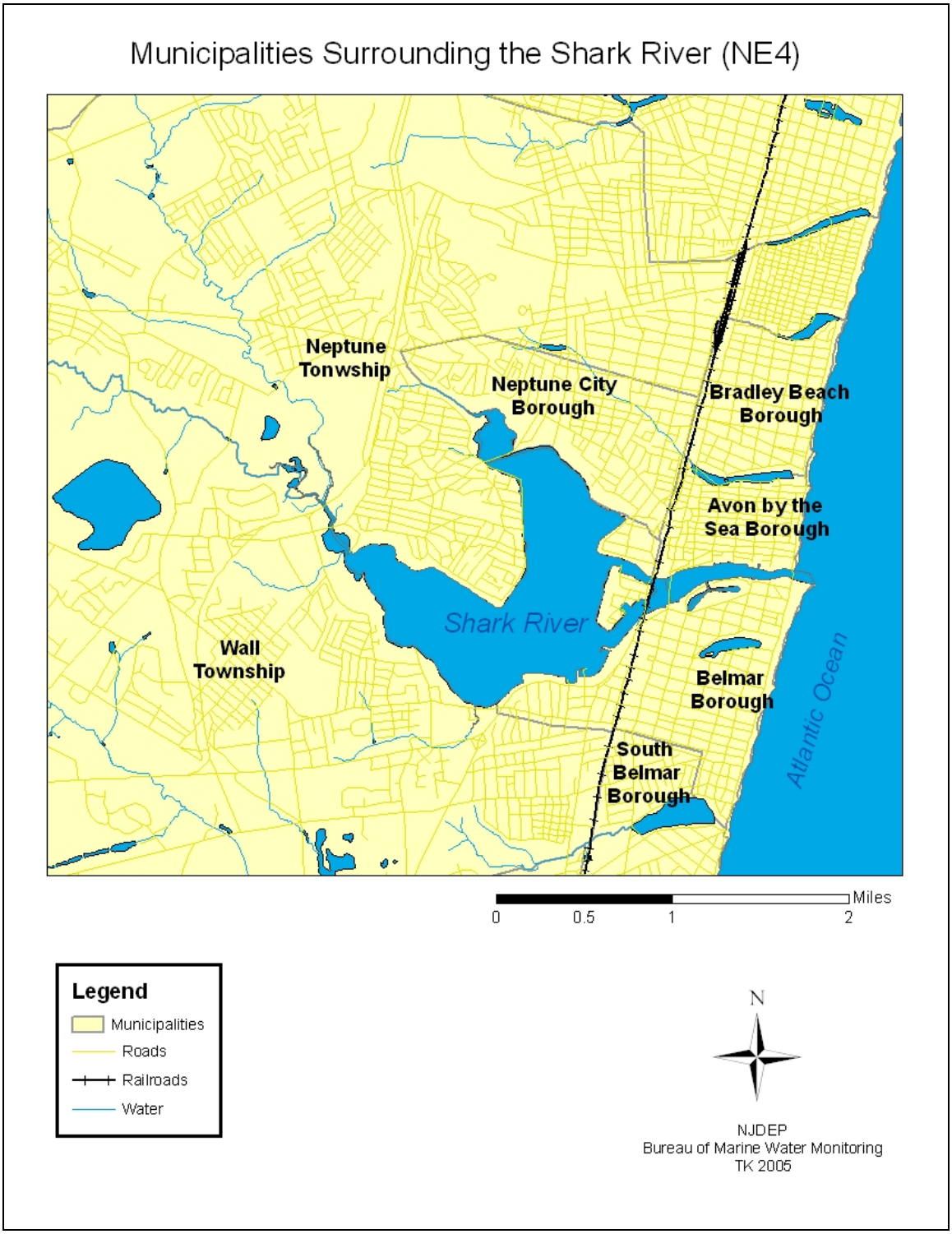
LOCATION OF THE GROWING AREA

The Shark River is located in Monmouth County. Tidal waters enter the Shark River via the inlet (see Figure 3). There are numerous small creeks and ponds that connect to the Shark River including Jumping Brook, Laurel Gully Brook, Handson Pond, Heroy's Stream, and Heroy's Pond. This river is bordered on the east by Avon-by-the-Sea, to the north by Neptune City, to the west by Neptune Township and Wall Township, and to the south by Wall Township, Belmar Borough, and Lake Como (see Figure 4). In total, the Shark River drains an approximate area of 810 acres.

This area is displayed on chart # 3 of the current State of New Jersey Shellfish Growing Water Classification Chart.

FIGURE 4: SHARK RIVER INLET (PICTURE TAKEN ON 6/22/05)

FIGURE 5: MUNICIPALITIES SURROUNDING THE SHARK RIVER



DESCRIPTION OF THE GROWING AREA

The greater part of this growing area is made up of urban lands, with areas of wetlands and forests interspersed. There are also small sections of agricultural lands, and even fewer sections of barren lands. The population statistics for the adjacent municipalities are shown in Table 1 (Census 2000). Monmouth County's population increased 11.2% from 1990 to 2000 (Census, 2000). Bradley Beach Borough is the most densely populated municipality in this growing area (see Table 1).

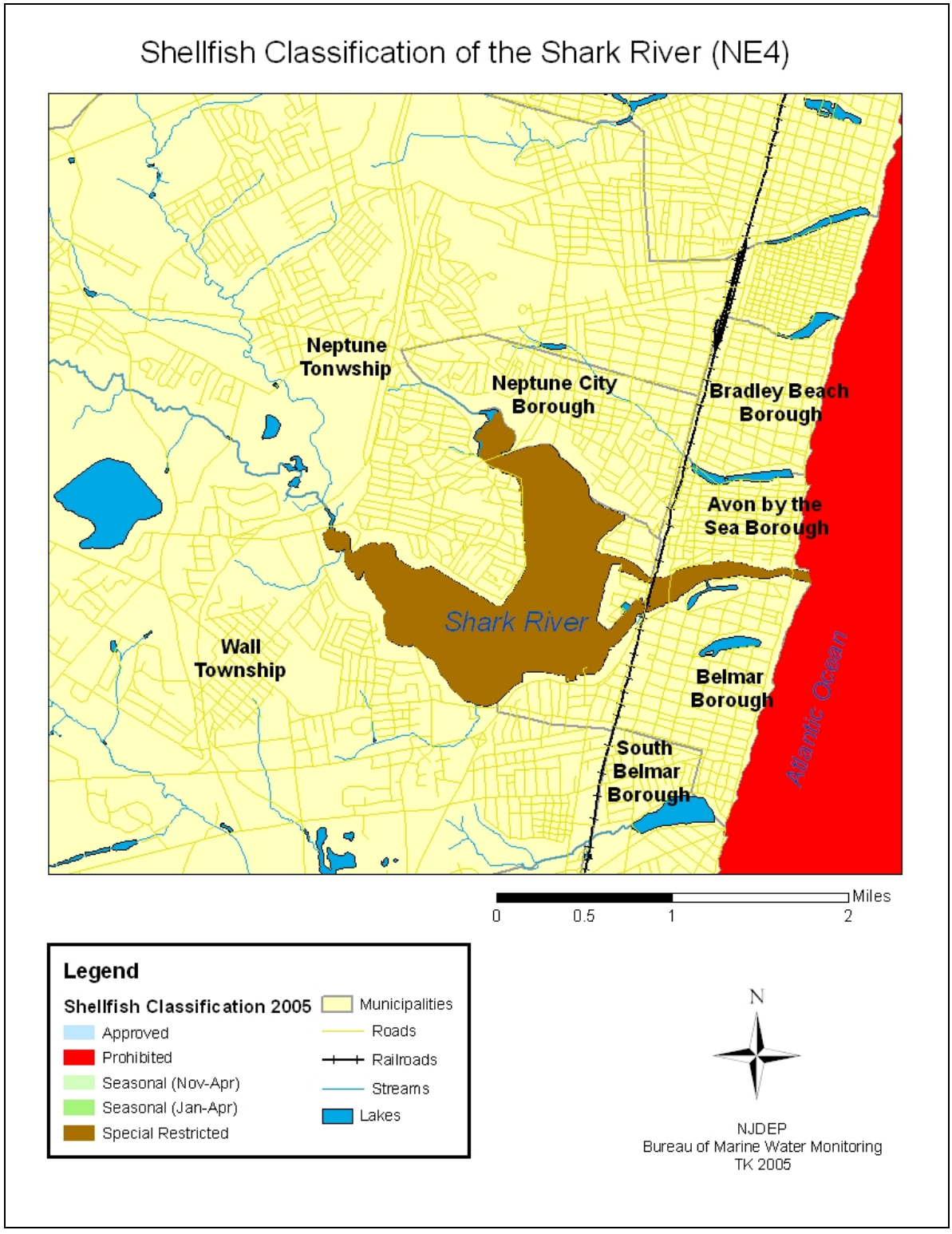
The entire Shark River is classified as *Special Restricted* (NJDEP, 2001) (see Figure 5). The *Special Restricted* classification means that it is prohibited to harvest shellfish from these waters for direct market; a special permit must be issued to be in compliance with the State of New Jersey's Relay or Depuration Programs. Recreational harvest of shellfish is not permitted from *Special Restricted* waters.

TABLE 1: POPULATION INFORMATION FOR THE SHREWSBURY RIVER GROWING AREA

Community	Area (Sq. Mi.)	Population*	Population Density (Population/Sq. Mi.)
Wall Township	30.98 sq.mi.	26,500	855.4
Neptune Township	8.81 sq.mi.	28,466	3,231.1
Neptune City Borough	0.88 sq.mi.	5,407	6,144.3
Bradley Beach Borough	0.60 sq.mi.	4,842	8,070.0
Avon-by-the-Sea Borough	0.46 sq.mi.	2,242	4,873.9
Belmar Borough	1.39 sq.mi.	6,071	4,367.6
Lake Como (South Belmar Borough)	0.25 sq.mi.	1,806	7,224.0

* 2004 Municipal Populations obtained from Monmouth County Planning Board, 2004 estimates from Census 2000.

FIGURE 6: CURRENT CLASSIFICATION OF THE SHARK RIVER



HISTORY OF THE GROWING AREA

The last Sanitary Survey for this area was written in 1994 and included data from June 1, 1988 to May 5, 1993. A reappraisal report was written in 1997, which reported data from May 5, 1993 to July 16, 1996. The 1999 reappraisal report included data from October 1, 1992 to October 1, 1998. Another reappraisal was written in 2003 and included data from November of 1994 to June of 2000. This current report satisfies the 12-year sanitary survey requirement and includes data from January 1, 1999 to December 31, 2004.

Before 1987, this entire shellfish growing area had a *Prohibited* classification. No harvest is allowed from *Prohibited* waters. In 1987, the Shark River was upgraded to the *Special Restricted* classification, based on an administrative adjustment made in compliance with the definitions in the NSSP 1986 Manual of Operations (NJDEP, Wesighan, 2001).

Until 1998, this area was sampled under the Adverse Pollution Condition (APC) of rainfall (see **Sampling Strategy** for details). It is now sampled under the Systematic Random Sampling (SRS) strategy since there are no point sources contributing to bacterial contaminants in this area. It was also in May of 1998 that the Environmental Protection Agency approved the NJ Department of Environmental Protection's plan to make the Shark River a "no discharge zone" (NJDEP Division of Fish and Wildlife, 2005). This means that no boats may dump treated or untreated sewage into the waters of the Shark River.

A special two-week long controlled harvest of shellfish in this area was allowed in February 1994 by the State of New Jersey's Depuration Program (Farnsworth, 1999). The harvest was a success and permitted Monmouth County shellfisherman to remain employed during the extremely cold period that caused the Raritan and Sandy Hook Bays to freeze over.

In 1996, the sampling of the Shark River was reduced due to a decrease in staff. Areas with no permitted legal harvest and low potential for upgrade saw a decreased sampling schedule and the minimum number of water samples (five samples, APC) was not collected.

The 1998 Annual Review of the Shark River, which included data from March 1994 through October 1997, showed that 31 out of the 45 sampling stations exceeded the *Special Restricted* criteria for fecal coliform, while sampled using Adverse Pollution Condition sampling strategy. It was recommended that no harvesting of shellfish be allowed until additional samples could be collected and analyzed for total coliform bacteria (NJDEP, 1998).

In the 1999 Reappraisal of the Shark River data were evaluated from October 1992 to September 1998 to obtain enough sets (30) of data for the water quality evaluation (Farnsworth, 1999). Five out of the 53 sampling stations met the *Approved* criteria for water quality, and all of the sampling stations met the *Special Restricted* criteria for water quality.

The 2003 Reappraisal report recommended that the 45 sampling stations in the Shark River be reduced to "about 25 to 30 sampling stations for the 2002-2003 sampling year. The 45 sampling stations were no longer deemed necessary for the proper classification of this body of water" (Wesighan, 2003). The existing stations were reduced to 25 in the 2002-2003 sampling year, however, two new stations, 1222 and 1222A were also added. These two stations were added to the southwest portion of the Shark River, where the coliform levels were the highest, to better assess the water quality. This brings the total stations currently sampled to 27, although the two newer stations have only been sampled 16 times and can not be evaluated using the Systematic Random Sampling NSSP Criteria.

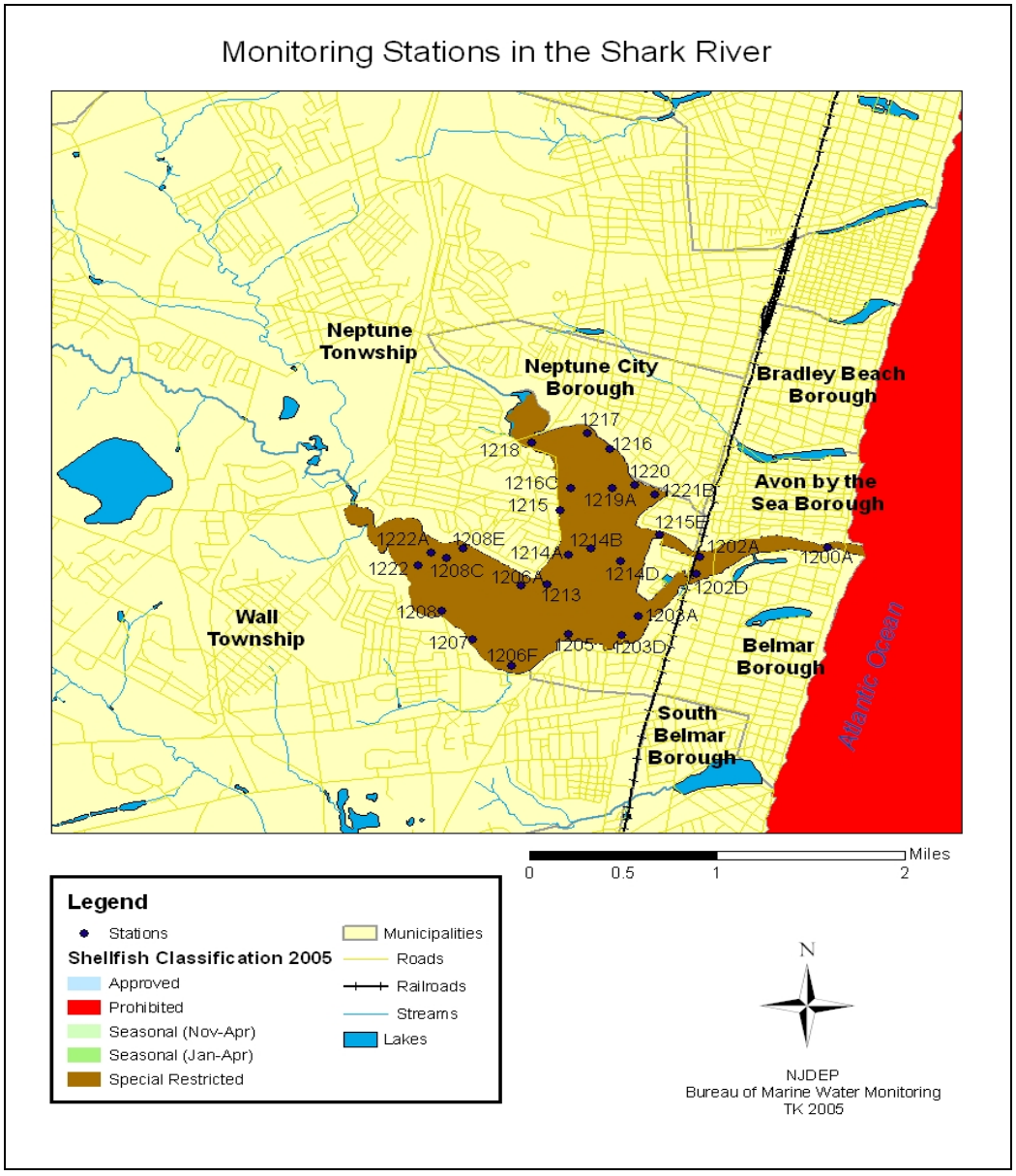
In the 2005 Annual Review of the Shark River, all of the sampling stations met the *Special Restricted* criteria for total coliform bacteria (NJDEP, 2005). No classification changes were proposed for this area.

METHODS

Approximately 1,075 water samples were collected for total coliform testing between January 1, 1999 & December 31, 2004 and analyzed by the three tube MPN method according to APHA (1970). Figure 6 shows the Shellfish Growing Water Quality monitoring stations in the Shark River. Nearly 1,640 stations are monitored for coliform levels during each year throughout the state; 27 of these stations are located in the Shark River (see Figure 6).

Water sampling was performed in accordance with the Field Procedures Manual (NJDEP, 1992). Water quality sampling, shoreline, and watershed surveys were conducted in accordance with the NSSP *Guide for the Control of Molluscan Shellfish,* 1997. Data management and analysis were accomplished using database applications developed for the Bureau of Marine Water Monitoring. Mapping of pollution data was performed with the Geographic Information System (GIS: Arcview/Arcmap).

FIGURE 7: MONITORING STATIONS IN THE SHARK RIVER



BACTERIOLOGICAL INVESTIGATION AND DATA ANALYSIS

The water quality of each growing area must be evaluated before an area can be classified as *Approved, Seasonal (Nov-Apr or Jan-Apr), Special Restricted,* or *Prohibited.* A *Seasonal* area must be sampled and meet the *Approved* criterion during the time of the year that it is open for harvest. The criteria for the bacterial acceptability of shellfish growing waters is provided in the NSSP *Guide for the Control of Molluscan Shellfish,* 2001 Revision.

SAMPLING STRATEGY

The State Shellfish Control Authority has the option of choosing one of the two water monitoring sampling strategies for each growing area.

The Adverse Pollution Condition Strategy requires that a minimum of five samples be collected each year under conditions that have historically resulted in elevated coliform levels in the particular growing area. The results must be evaluated by adding the individual station sample results to the preexisting bacteriological sampling results in order to constitute a data set of at least 15 samples for each station. The adverse pollution conditions usually are related to tide, and rainfall, but could be from a point source of pollution or variation could occur during a specific time of the year.

The Systematic Random Sampling strategy requires that a random sampling plan be in place before field sampling begins. This strategy can only be used in areas that are not affected by point sources of contamination. A minimum of six samples per station are to be collected each year and added to the database to obtain a sample size of 30 for statistical analysis.

The Shark River growing area is sampled under the Systematic Random Sampling strategy described above (see Figure 6 for the sampling stations in the Shark River).

NSSP (NATIONAL SHELLFISH SANITATION PROGRAM) 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, the laboratory does have the ability to make corresponding fecal coliform determinations for each sampling station. The fecal data are often viewed as adjunct information and are not directly used for classification.

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 of samples that exceed the variability criteria (see Table 2). For the Systematic Random Sampling Strategy, variability is expressed as the estimated 90^{th} percentile (see Table 3). These sets of criteria were developed by the NSSP to ensure that shellfish harvested from the designated waters would be safe for human consumption.

TABLE 2: CRITERIA FOR ADVERSE POLLUTION CONDITION SAMPLING STRATEGY

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

TABLE 3: CRITERIA FOR SYSTEMATIC RANDOM SAMPLING STRATEGY

	Total Coliform Criteria		Fecal Coliform Criteria	
	Geometric mean (MPN/100 mL)	**Estimated 90th percentile** (MPN/100 mL)	**Geometric mean** (MPN/100 mL)	**Estimated 90th percentile** (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 Shark River received a Category 1 classification in June of 2005. This means no new development can occur "within 300 feet of either side of about 22 miles of the Shark River and its tributaries" (Bowman, 2005). This is in part due to considerable efforts made by the Shark River Coalition, which is the group that originally proposed the river for reclassification.

In 1998, the Shark River was declared a "no discharge zone". This prevents boats from legally dumping treated or untreated sewage into the river. As a result, more marinas have pumpout stations, which is beneficial to the river.

Shoreline surveys were conducted on October 27, 2004 and June 22, 2005. The majority of the shoreline is urban land use. Most of the coastline is residential homes, condominiums, or undeveloped land. Most of the commercial sites on the Shark River are restaurants and marinas. New Jersey defines a marina as "any structure (docks, piers, bulkheads, floating docks, etc.) that supports five or more boats, built on or near the water, which is utilized for docking, storing, or otherwise mooring vessels and usually, but not necessarily, provides services to vessels such as repairing, fueling, security, or other related activities." (N.J.A.C. Chapter 12 7:12-1.2, 12-4). Some of the condominium associations along the water fit within the state definition of a marina.

During the shoreline surveys there were observations of birds, mainly sea gulls, ducks, and geese. Bird waste can add to contamination of the waters, which can contribute to high coliform values. Oftentimes, the waterfowl nest within the wetlands, where runoff washes directly over the land and into streams and bays.

Currently, plans are being developed to dredge the Shark River starting in September of 2006, and spanning the following decade. This dredging plan is in the beginning phases and still needs approvals (Sahn, 2005).

In 2005 the bridge on Route 35 finished re-construction. (see Figure 7). There may also be use of eminent domain in the area of the Route 35 bridge in Neptune to acquire private property for the township's "revitalization plan" (Bowman, 2005). Although in its preliminary stages, the township of Neptune hopes to acquire the property (70 tax lots) to make "new homes, new marine-oriented businesses and a 1,250-foot waterfront promenade" (Bowman, 2005). Currently, much of this land is occupied by established businesses, like Bry's Marina and Headliners.

FIGURE 8: ROUTE 35 BRIDGE (PICTURE TAKEN ON 6-22-05)

LAND USE

The current land use surrounding the Shark River is predominately urban, commonly residential (see Figures 8 & 9). Most properties in this area contain a single family home. However, there are also some condominium-type structures (see Figure 10). There are also scattered regions of forests and speckles of barren lands, wetlands, and agricultural lands (see Figure 11). Seven municipalities surround the Shark River; they are Wall Township, Neptune Township, Neptune City, Bradley Beach Borough, Avon-By-the-Sea, Belmar Borough, and Lake Como (formally known as South Belmar Borough). Historically, most of this region has been urban land used for residential housing. Since this region is already highly developed there has not been much residential growth in recent years.

FIGURE 9: LAND USE SURROUNDING THE SHARK RIVER

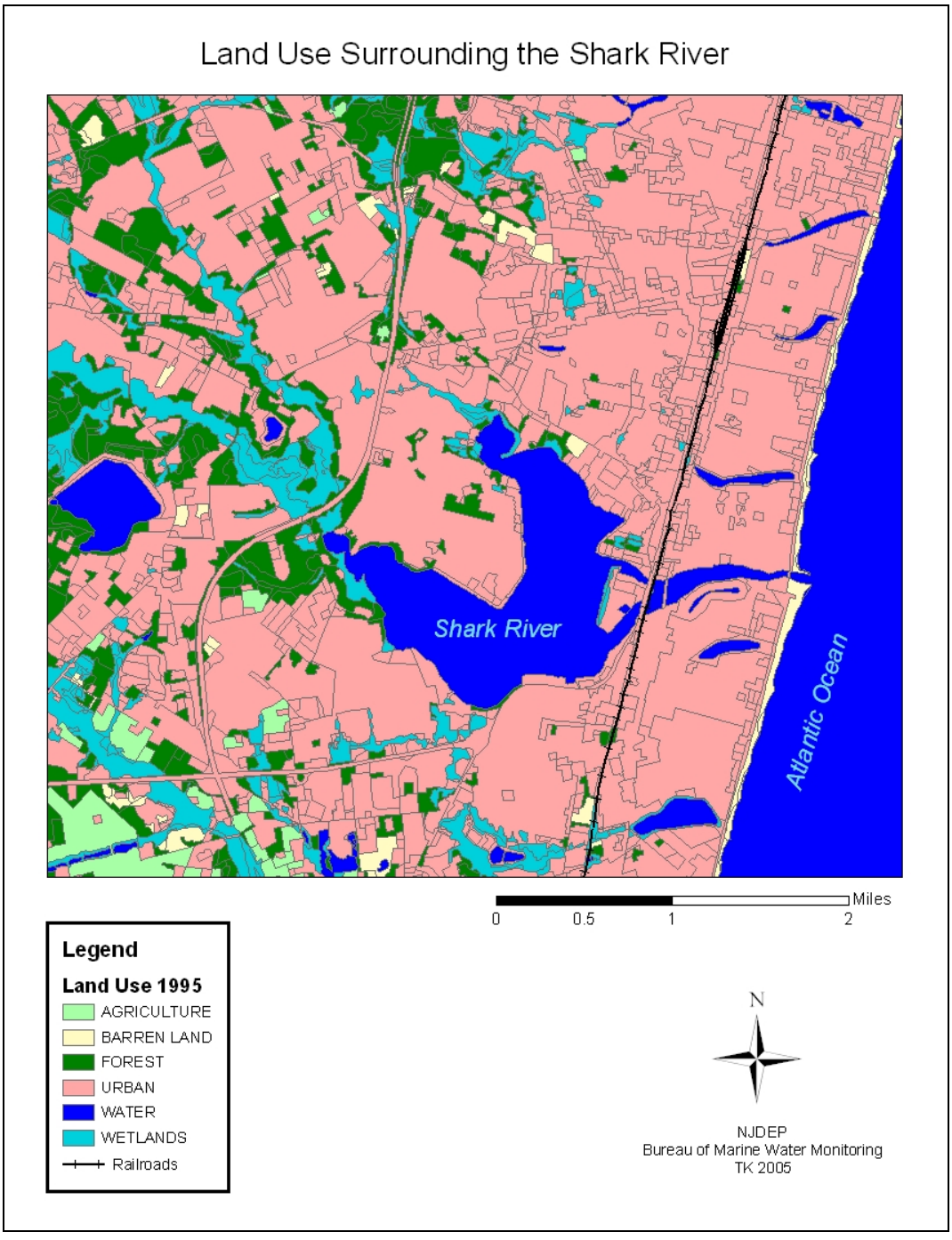


FIGURE 10: RESIDENTIAL HOUSING ON THE SHARK RIVER (PICTURE TAKEN 6-22-05)

FIGURE 11: CONDOMINIUMS ON THE SHARK RIVER (PICTURE TAKEN 6-22-05)

FIGURE 12: FOREST LAND USE ALONG THE SHARK RIVER GROWING AREA (PICTURE TAKEN 6-22-05)

EVALUATION OF BIOLOGICAL RESOURCES

The Shark River has few to abundant densities of hard clams (according to the last clam census in the 1980's done by DEP's Division of Fish & Wildlife, see Figure 12). Factors that contribute to having a viable resource include salinity, dissolved oxygen levels, bottom conditions, and predator activity.

Many activities potentially detrimental to shellfish (i.e. dredging, dumping, and filling marshes) have been stopped due to governmental regulations (CRSSA – Rutgers, 2003). However, many natural lands continue to disappear throughout the state due to development. More environmentally significant areas, such as riparian lands, small bird islands, the Pine Barrens, and shoreline buffer areas require increased protection (CRSSA _ Rutgers, 2003). These environmental changes will help to reduce the pollutants entering the waters, and consequently, improve shellfish habitat.

Waterfowl are known to inhabit this area, especially during winter months (see Figure 13). Herons, ducks, and egrets are common sights. The Shark River Inlet is often used as a diving region because of its interesting and diverse wildlife (see Figure 14).

Vegetation is an essential part of the marine ecosystem, offering habitat and nursery grounds for numerous species. In the Shark River, the submerged aquatic vegetation (SAV) is prevalent in shallow areas. Some of the most

common species of SAV in New Jersey include widgeon grass (*Ruppia maritima*), sago pondweed (*Potamogeton pectinatus*), horned pondweed (*Zannichellia palustris*) and eelgrass (*Zostera marina*) (NJDEP, 2005).

FIGURE 13: HARD CLAM DENSITIES IN THE SHARK RIVER

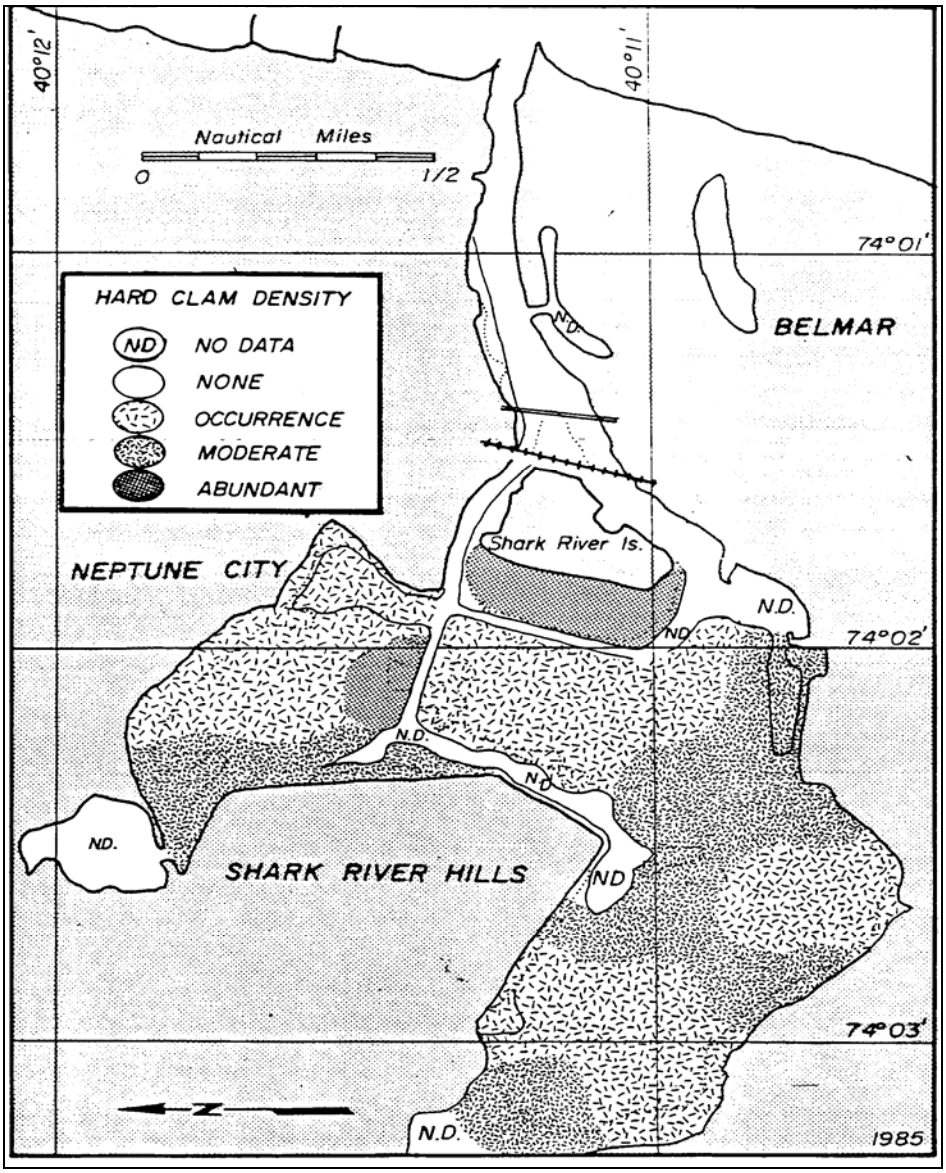


FIGURE 14: WATERFOWL ON THE SHARK RIVER (PICTURE TAKEN 6-22-05)

FIGURE 15: CRABS IN THE SHALLOWS OF THE SHARK RIVER (PICTURE TAKEN ON 6-22-05)

IDENTIFICATION AND EVALUATION OF SOURCES

EFFLUENT DISCHARGES

There are no direct discharges into the waters of the Shark River. However, there are two domestic treatment facilities in the general vicinity and some pipelines cross portions of the Shark River (see Figure 15). The Southern Monmouth Regional Sewerage Authority and the Township of Neptune Sewerage Authority both discharge treated wastewater into the Atlantic Ocean. As a precautionary measure, the NSSP requires a *Prohibited* safety zone of at least 1.5 miles around each of the ocean outfalls. Therefore, the ocean waters outside of the Shark Inlet are classified as *Prohibited*.

The Neptune Sewerage Authority did experience some minor sewage spills in 1998, but these spills were of low volume and there was no evidence that they impacted the water quality of this shellfish growing area. There were no reported spills that required a response or shellfish closure in the area of the Shark River that occurred during the January 1999 to December 2004 time period.

FIGURE 16: PIPE NEXT TO BRIDGE ON BRIGHTON AVE. (PICTURE TAKEN ON 6-22-05)

INDIRECT DISCHARGES

Known contaminated sites are scattered throughout this region, mostly within urban areas (see Figure 16). However, few of these known contaminated sites are in close proximity to the shoreline. Some common known contaminated sites include leaking underground storage tanks, septic/sewer outflows, and spills at gas stations. Since these known sites are potential sources of chemical contamination, action of the responsible party is required to eliminate these polluted sites.

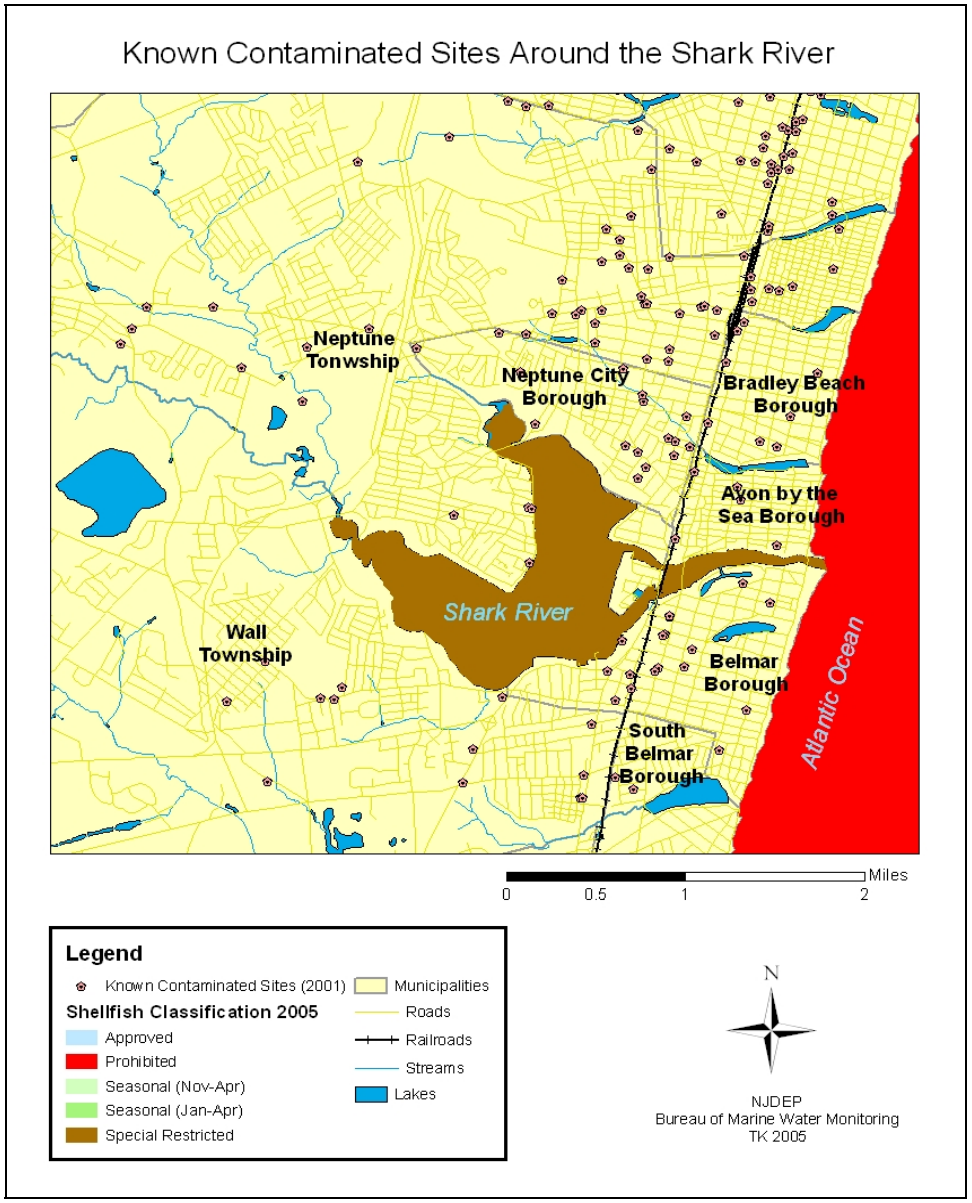
Since the Shark River is classified as *Special Restricted,* any legally harvested shellfish from this area must go through further processing before going to market. For that reason, the likelihood of humans consuming contaminated shellfish is lessened, although not prevented.

Many of the contaminated sites are underground storage tanks that contain petroleum. When petroleum is mixed with water the petroleum rises to the top, not directly affecting bottom-dwelling clams. Also, soils surrounding the underground tanks absorb the leakage, making it less likely to migrate to marine waters. These scenarios lessen the possibility of the petroleum leaks negatively affecting the shellfish, although it does not completely prevent any contamination.

The quality of a sewer system depends heavily on the municipal planning and maintenance of the sewer lines. New residential developments joining into a sewer system must be adequately planned for in order to handle the increased volume. The age of the pipes and facilities also factor in when assessing the potential for sewer problems.

Septic systems are harder to regulate since their maintenance is not the responsibility of the municipality, but that of the property owner. Faulty septic systems can add bacteria into runoff, which can then enter into water bodies, causing high bacteria counts. In 1998, the Monmouth County Department of Health approved over 650 septic and well applications for its municipalities (MCDH).

FIGURE 17: KNOWN CONTAMINATED SITES NEAR THE SHARK RIVER



STORM WATER INPUTS

Runoff is a term for the surface water that moves from land to the ocean. During this transition the water picks up both nutrients (helpful and harmful) and pollutants. While some of this runoff provides nutrients for plants and animals, it also carries pollutants that can potentially contaminate the waters. Some pollutants include bird waste, agricultural pesticides, animal waste, and bacteria from faulty septic systems and failing municipal infrastructure. Storm drains along roads collect the runoff and transmit it to stormwater outfalls (see Figure 17). The outfalls deposit the runoff into streams, bays, oceans, and other bodies of water. Stormwater

outfalls are one of the most significant non-point sources of pollution. They are often found in urban areas, and are especially common within lagoon communities. The first flush after a rain event often carries the most pollutants.

There are many stormwater inputs into the Shark River and its tributaries (see Figure 19). These numerous storm water inputs have the potential to negatively impact the water quality within this growing area.

Historically, the Shark River was impacted by rain events; it was sampled under the Adverse Pollution Condition of rainfall prior to 1998. It is now sampled under the Systematic Random sampling regime.

The impact of animal waste on water contamination is of significant concern. (see Figure 18). Fecal waste carries a great deal of bacteria, and runoff can easily bring the bacteria to swimming beaches and various water bodies. This can cause the contamination of shellfish and sickness in humans and animals. As previously mentioned, faulty septic systems create the same problem, bringing bacteria-laden runoff back to streams, lakes, bays, and eventually the Atlantic Ocean.

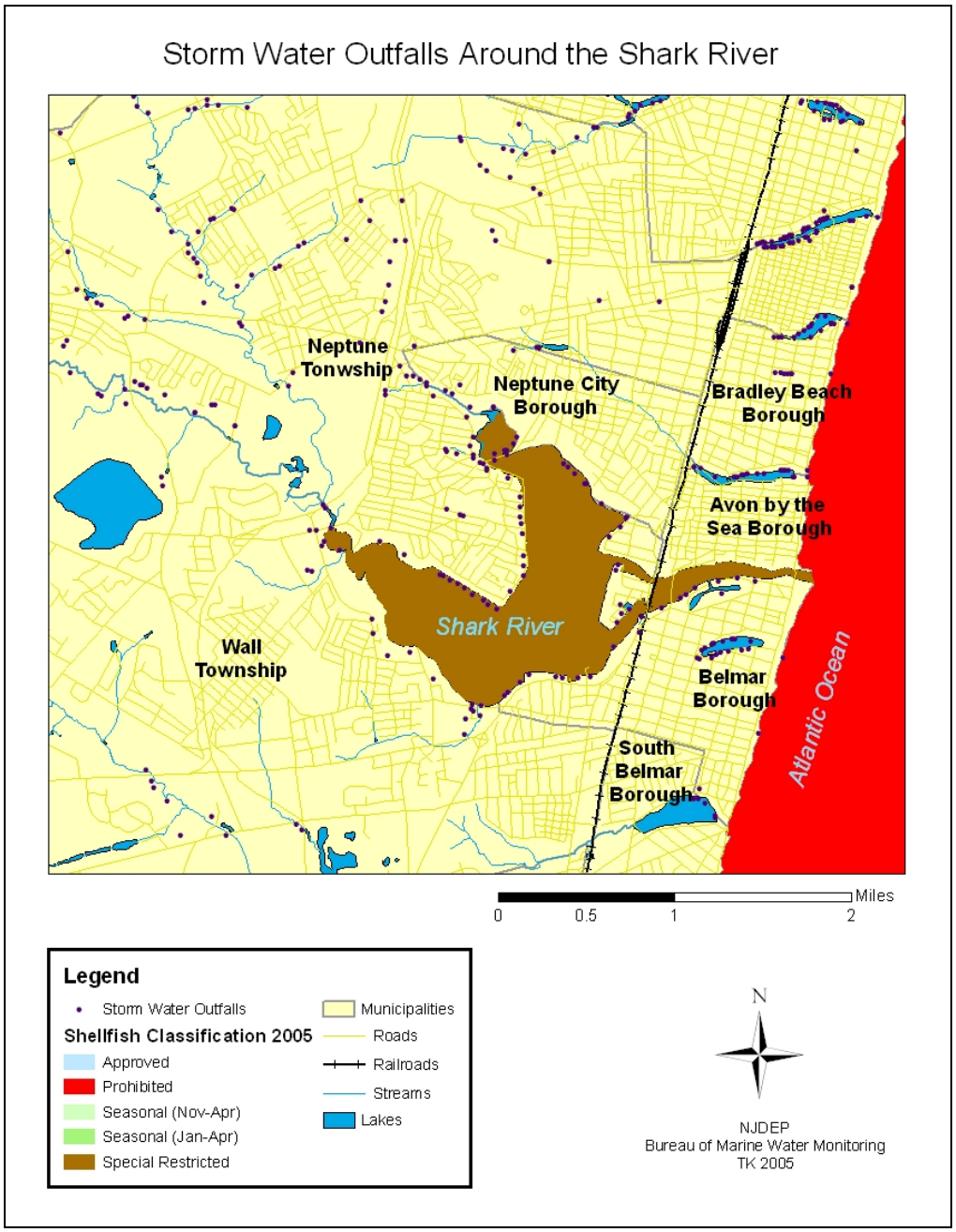
Contaminated runoff reaching storm water outfalls is a major contributor to the pollution of water bodies. Pesticides, carrion, animal wastes, and petroleum products are among the harmful contributors. Considering the substantial amount of outfalls in this area, it is crucial to understand the importance of their regulation, in order to prevent pollution.

The Bureau of Marine Water Monitoring conducts stormwater projects to help lessen the effect of stormwater runoff. Water samples are taken during a storm event and the preceding days in order to determine the effect of runoff. Once a possible source of the problem is identified, the appropriate people (usually the municipality/county) are notified to remedy the situation. Currently, there is no stormwater project planned for the Shark River.

FIGURE 18: STORMWATER OUTFALL ON THE SHARK RIVER (PICTURE TAKEN 6-22-05)

FIGURE 19: STORMWATER OUTFALL IN THE SHARK RIVER (PICTURE TAKEN 6-22-05)

FIGURE 20: STORMWATER OUTFALLS AROUND THE SHARK RIVER



MARINAS

Boating is a popular summertime activity within the Shark River. In this growing area there are a total of 15 marinas (see Figure 20 and Table 4).

Although good for tourism, the marinas, and the accompanying boats, can discharge many harmful pollutants into the water. Gas fumes, oil, and grease from boats and marinas can contribute to the contamination of the waters. There are also irresponsible boat owners who do not use available pump out stations, instead dumping human wastes directly into the local water bodies. Therefore, 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.

New Jersey defines a marina as "any structure (docks, piers, bulkheads, floating docks, etc.) that supports five or more boats, built on or near the water, which is utilized for docking, storing, or otherwise mooring vessels and usually, but not necessarily, provides services to vessels such as repairing, fueling, security, or other related activities." (N.J.A.C. Chapter 12 7:12-1.2, 12-4). New Jersey designates the confines of the marina as *Prohibited* for the harvest of shellfish. A buffer of the adjacent waters is calculated using a dilution analysis formula (Equation 1) and then the area is classified fittingly.

It is recognized by the NSSP *Guide for the Control of Molluscan Shellfish*, 2003, that there are significant regional differences in all factors that affect marina pollutant loading. The manual, therefore, allows each state the latitude in applying specified occupancy and discharge rates. The NSSP guidelines assume the worst case scenario for each factor.

EQUATION 1: MARINA BUFFER EQUATION. (ADAPTED FROM FDA. 1989):

$$BufferRadius(ft) = \sqrt{\frac{2x10^{9}(FC/person/day)x2(person/boat)x[(.25slips \geq 24') + (0.065 \times slips < 24')]x2}{140000(FC/M^{3})xdepth(ft)x0.3048(M/ft)x\pi x2(tides/day)}} x3.28(ft/M)$$

Explanation of terms in equation:

Fecal coliform per person per day:	2×10^{9}
Number of people per boat:	2
For slips able to accommodate boats > 24 feet (combination of factors yields multiplier of 0.25):	
Number of slips occupied:	50%
Number of boats occupied:	50%
For boats < 24':	6.5% discharge waste
Angle of shoreline:	180^{o}, which results in factor of 2
Number of tides per day:	2
Depth in meters:	depth in feet x conversion factor
Water quality to be achieved:	140000 FC/meter ^{3}
Convert meters to feet:	3.28

Marina buffer zones can be calculated using the above formula, Equation 1. The State of Virginia and the USFDA also developed an alternative to this formula, which determines buffer zones using a dilution analysis computer program (the Virginia Model). The formula above considers only dilution and occupancy rates. The computer program is used for complex configurations and considers factors like tidal exchange and bacterial die-off.

There are 15 marinas in the Shark River, as shown in Table 4. Most of these marinas are located near the inlet (see Figure 20). Many of the marinas in this area run charter and party boat trips, although there are also many private boats within the marinas (see Figure 21). The waters enclosed within the marina footprint are classified as *Prohibited*; depending on the size of the marina and the water quality, water immediately adjacent to each marina may be classified as *Prohibited*, *Special Restricted*, or *Seasonal* (no harvest May through October or May through December). Marina buffer zones were calculated using the Virginia Model or the marina buffer equation, depending on the location. The size of each buffer zone is shown in Table 4.

TABLE 4: MARINA FACILITIES LOCATED IN THE SHARK RIVER

	Marina Name	# of Slips	Size of Buffer Area (radius; feet)
1	Southport Condo Marina	12	310
2	Townhouse Marina	30	250
3	Total Marine at Seaview	100	1267
4	Shark River Yacht Club	166	976
5	Private Owner Marina	8	358
6	Riverview Ave. Boat Yard	10	204
7	Bry's Marina	20	339
8	Belmar Municipal Marina	250	1693
9	Captain Bill's Sunset On The Waterfront	45	508
10	AP's Inlet Marina	18	401
11	Avon Fishing Basin	15	302
12	Main One Marina	50	896
13	Shark River Hill Beach & Yacht Club	74	1169

	Marina Name	# of Slips	Size of Buffer Area (radius; feet)
14	Shark River Hills Marina	180	2055
15	Oliver Com Pier	8	358

FIGURE 21 : MARINA FACILITIES LOCATED IN THE SHARK RIVER

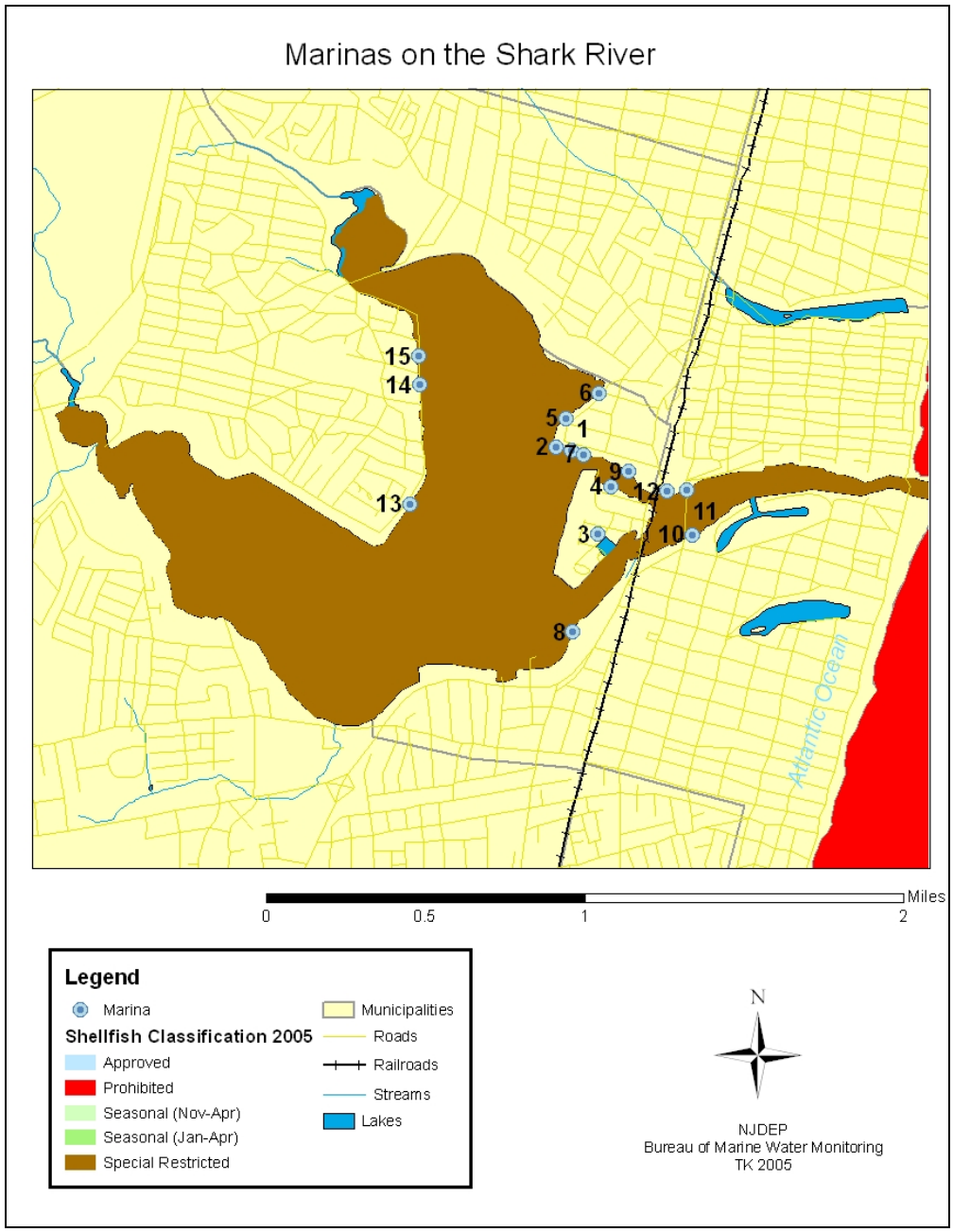


FIGURE 22: MARINA (PICTURE TAKEN ON 10-27-04)

SPILLS OR OTHER UNPERMITTED DISCHARGES

Spills reported to the DEP hotline are passed on to the Bureau of Marine Water Monitoring. Since there is a direct relationship between the pollution of shellfish growing areas and the transmission of diseases to humans, the Bureau must carefully assess each spill occurrence. If the spill is determined to be detrimental to the shellfish beds then a closure is made in the impacted area to protect public health. The closure is not lifted until the source of the problem is fixed/eliminated and all samples in that area fit within the appropriate classification criteria.

There were no significant spills or unpermitted discharges concerning the Shark River reported via the DEP Hotline during the January 1, 1999 through December 31, 2004 time period.

HYDROGRAPHY AND METEOROLOGY

PATTERNS OF PRECIPITATION

Precipitation patterns in the coastal areas of New Jersey are characteristic of the Mid-Atlantic coastal region. Typical summer storm events are localized and usually associated with thunderstorms. Winter storms are frequently associated with northeasters. Hurricanes sometimes occur during the summer and early fall.

Tropical Storm Floyd hit the Jersey shore in mid-September of 1999. In September of 2000, another tropical storm, Gordon, also reached the Jersey shore (NOAA, 2005). The data from these months show no obvious impact on the water quality of the Shark River. There were no other major tropical storms or hurricanes in this area between January of 1999 and December of 2004.

The major inputs of water into the Shark River are from a combination of precipitation, groundwater inflow, runoff, streams, and tidal exchange. The Shark River drains an area of 23 square miles. There is an average range of 6 feet for the tides in this area. The tidal cycle is semidiurnal, with two high tides and two low tides in a 24-hour period. The tides around the Atlantic Ocean occur twice a day (two high and two low) and have essentially the same range, or vertical distance from high to low water (Ingmanson and Wallace, 1989). Tidal flushing is through the Shark River Inlet. (USDI-GS).

The Shark River precipitation inputs for the period January 1, 1999 through December 31, 2004 are shown in Table 5. There have been no significant changes in hydrography since the last sanitary survey in 1994. The primary weather station for this area is Toms River. The secondary weather station for this area is Newark. The secondary station data are used when data from the primary station are incomplete.

TABLE 5: CLIMATOLOGICAL DATA

Rainfall Recorded at NOAA's Toms River (8816) Station
Temperature Recorded at NOAA's Toms River (8816) Station
* Temperature Recorded at NOAA's Newark (6026) Station

Sampling Date	Precipitation in Inches			NOAA WSO Number	Average Daily Temperature (Fahrenheit)
	Day of Sampling	Day of Sampling & Previous Day	Day of Sampling & Two Previous Days		
1/6/99	0	0	3.36	8816	20
2/3/99	0.58	0.73	0.73	8816	49
3/3/99	0	0.04	0.56	8816	39
4/6/99	0	0	0.01	8816	42
5/5/99	0.005	0.265	0.275	8816	66*
6/3/99	0	0	0	8816	79
7/7/99	0	0	0	8816	88
8/4/99	0	0	0	8816	73
9/27/99	0	0	0	8816	60
10/6/99	0	0.92	0.925	8816	47
6/20/00	0.005	0.545	1.165	8816	66
10/19/00	0	0.1	0.1	8816	53
11/8/00	0	0	0	8816	49
1/8/01	0.6	0.6	0.6	8816	37
2/20/01	0	0	0	8816	31
4/3/01	0	0	0.05	8816	45*
5/23/01	0.1	0.2	0.8	8816	62
7/17/01	0	0	0	8816	76
8/1/01	0	0	0	8816	67
10/17/01	0	0	0.3	8816	53
11/5/01	0	0	0.02	8816	51
12/14/01	0.1	0.105	0.11	8816	56
1/10/02	0.005	0.01	0.01	8816	38
3/1/02	0	0	0	8816	33
4/1/02	0.005	0.805	0.81	8816	46
5/31/02	0.4	0.4	0.4	8816	76
11/20/02	0	0.09	0.09	8816	45
5/5/03	0.12	0.12	0.19	8816	48
5/13/03	0	0	0.005	8816	61
5/29/03	0	0.7	0.8	8816	59
7/28/03	0.06	0.06	0.06	8816	76
8/11/03	0.005	1.145	1.145	8816	76
9/8/03	0	0	0	8816	67
10/27/03	0.37	0.61	0.61	8816	63
11/12/03	0.4	0.4	0.4	8816	54
12/10/03	0	0	0	8816	31
1/7/04	0	0.36	0.48	8816	29
2/9/04	0	0.005	1.505	8816	26
3/24/04	0.1	0.105	0.105	8816	37
4/19/04	0	0.04	0.04	8816	59
7/15/04	0.23	0.235	4.485	8816	70

WATER QUALITY STUDIES

BACTERIOLOGICAL QUALITY

The data for this report were collected from 27 stations in the Shark River. A total of 1,075 surface water samples were analyzed from this growing area for total coliform (TC). The waters of the Shark River are classified as *Special Restricted*. This report drew data from January 1, 1999 to December 31, 2004; during this time period all stations were sampled using the Systematic Random Sampling (SRS) strategy. Systematic Random Sampling is used since there are no point sources contributing to bacterial contaminants in this area.

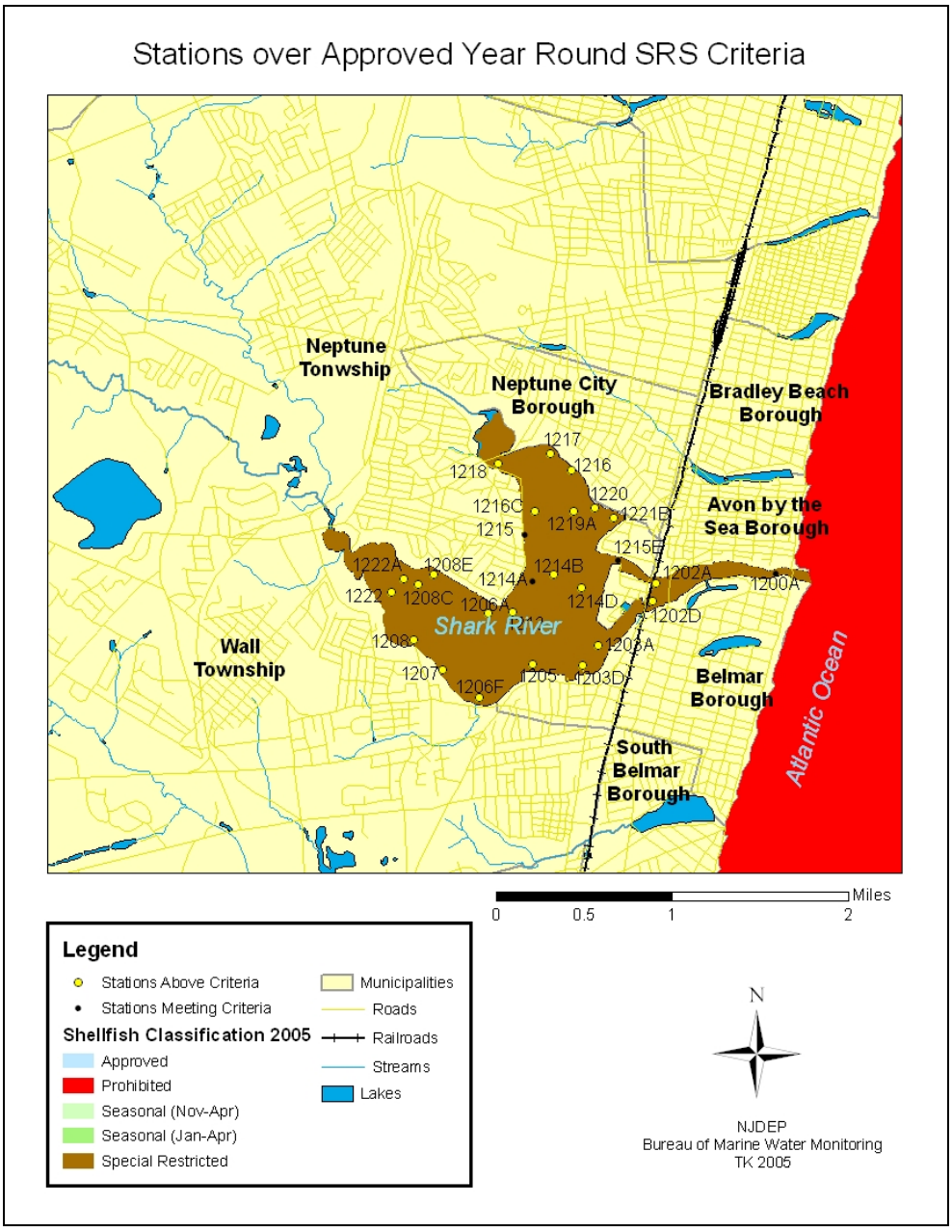
An assignment run is a set grouping of sampling stations that are retrieved by an allocated boat captain in a day's time. This run is sampled 8 times a year. These assignment runs provided sufficient samples for evaluation, bearing in mind the sample size must be at least 30 for each station according to the Systematic Random Sampling strategy.

COMPLIANCE WITH NSSP *APPROVED* CRITERIA

Each sampling station must comply with its respective criteria according to the National Shellfish Sanitation Program (NSSP) Model Ordinance (1997 Revision) for *Approved, Seasonal,* or *Special Restricted* waters, based on a minimum of 30 data sets. In order for waters to be classified as *Approved,* the total coliform geometric mean must be below 70 MPN/100ml and the total coliform Est. 90^{th} Percentile must be below 330 MPN/100ml.

Twenty-three stations within the Shark River did not meet the year-round SRS *Approved* criteria (see Figure 22). Overall, no waters in the Shark River need downgrading based on the *Approved* criteria, since all waters of the Shark River are classified as *Special Restricted*.

FIGURE 23: STATIONS EXCEEDING SRS YEARROUND APPROVED CRITERIA



COMPLIANCE WITH NSSP *SPECIAL RESTRICTED* CRITERIA

All stations sampled also complied with the NSSP total coliform criteria for *Special Restricted* waters. For waters to be classified as *Special Restricted*, the Geometric Mean must be below 700 MPN/100ml and the Est. 90th Percentile must be below 3300 MPN/100ml. No stations need downgrading based on the *Special Restricted* criteria.

COMPLIANCE WITH NSSP CRITERIA DURING SEASONS

All Data (Summer and Winter)

The year round data are divided between the summer and winter sampling seasons. The summer season runs from May through October, and the winter season runs from November through April. Twenty-four stations in the Shark River growing area did not meet the total coliform *Approved* criteria during the summer months, although all met the *Special Restricted* criteria. Nineteen of the stations in the Shark River growing area did not meet the total coliform *Approved* criteria during the winter months, although all met the *Special Restricted* criteria.

TIDAL EFFECTS

Tidal exchange usually produces a mixing of impaired water with higher quality water. This mixing often helps to improve the water quality of sections adjacent to the urban shorelines, which are frequently contaminated by runoff. The major inputs of water into this estuary are from a combination of precipitation, groundwater inflow, and tidal exchange.

Three stations have a statistically significant tidal component (a T-statistic probability is less than 0.050, see Table 6 and Figure 23). The geometric means were higher during ebb than during flood for stations 1208C and 1218 (the 90^{th} percentile is not available for the ebb and flood designations). Station 1202D had a higher geometric mean on the flood tide. The high geometric means on the ebb tide show that the respective tributaries are probably affecting stations 1208C and 1218. Station 1218 is located in the northern section of the Shark River, by Musquash Cove and station 1208C is located in the western section, near the mouth of the Shark River and Jumping Brook tributaries (see Figure 24). This shows that these tributaries are potential sources of contamination. Station 1202D has a higher geometric mean on the flood tide, which might have been influenced by the Route 35 bridge construction over the last couple of years. All of these stations are located in *Special Restricted* waters and do not exceed the criteria.

Presently, no changes in classification are needed as a result of the tidal impacts at these stations.

TABLE 6: TIDAL EFFECTS

Station	Geometric Mean Total Coliform MPN		Probability>[T]
	Ebb	Flood	
1202D	44.6	55.6	**0.024**
1208C	236.7	76.1	**0.028**
1218	196.3	64.7	**0.021**

FIGURE 24: SAMPLING STATIONS AFFECTED BY TIDE

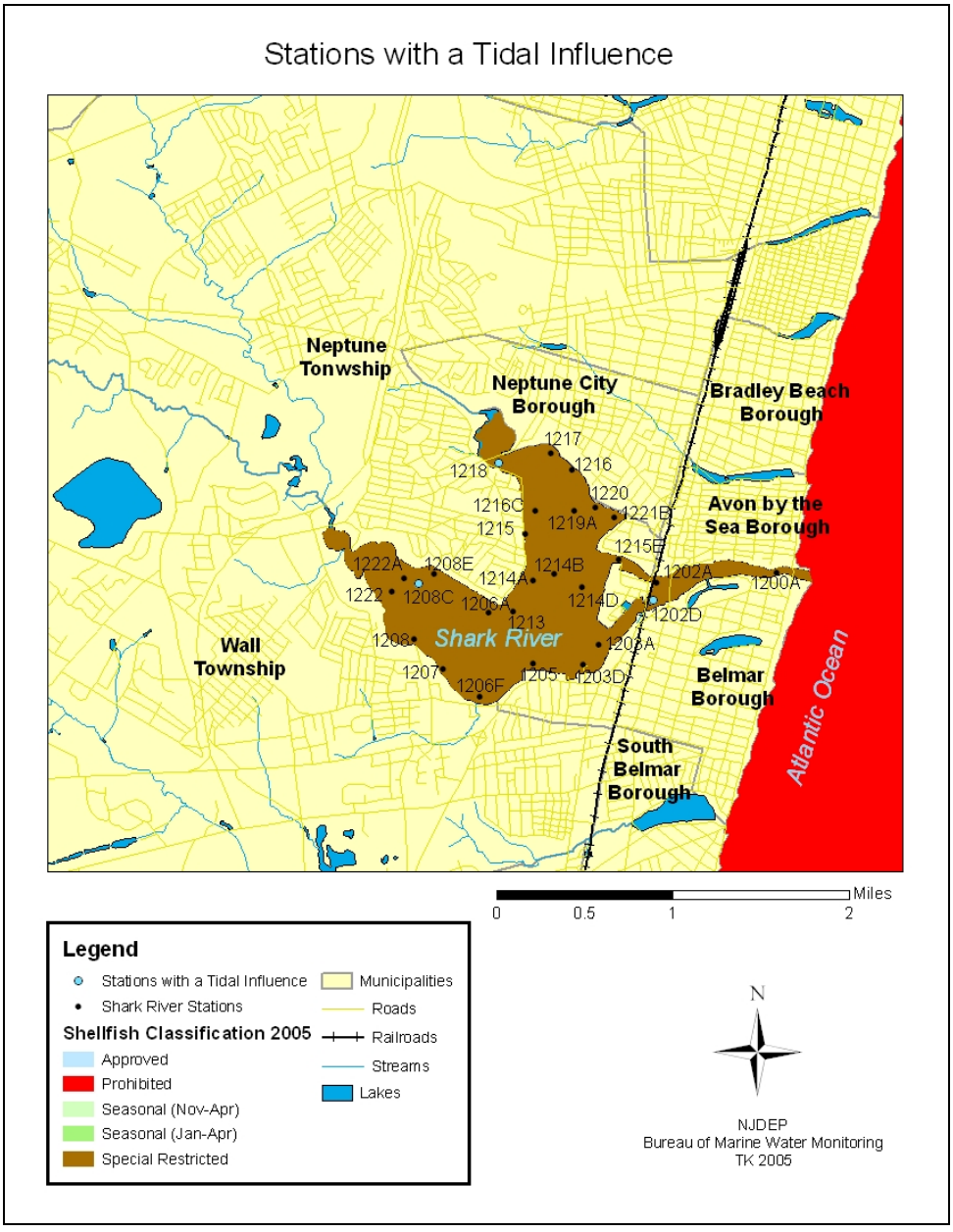


FIGURE 25: SOUTHWEST PORTION OF THE SHARK RIVER ON EBB TIDE

SEASONAL EFFECTS

Statistically significant seasonal impacts were not observed at any of the stations. The T-statistic probability must be less than 0.050 for a seasonal difference at that station to be considered significant. This means there are no significant differences between the winter data and the summer data in the Shark River. Summer includes the months of May through October and winter includes November through April.

Summertime pressures are usually more likely to impact these waters, although they are not significant enough to trigger a seasonal impact in the Shark River. Summer usually affects the water quality more because of such things as heavy boat travel, higher summer temperatures, and other seasonal recreational uses. The water quality also has the potential to be affected by other non-point sources from increased summer population and/or increased use of recreational water activities. No changes in classification are needed as a result of seasonal influences.

RAINFALL EFFECTS

Nonpoint source pressures on shellfish beds in New Jersey can originate in materials that enter via storm water. These materials, including bacteria, often enter the storm water collection system after rain events.

It should be noted that a particular short-term data set might not indicate significant rainfall effects even if the historical data indicate that a significant effect occurs in a particular area. This is due to one or more of the following factors:

- Data during the short term may consist of primarily rainfall data or dry weather data. In this case, if there are insufficient data points in each category, the test for significance cannot be done.
- Data collected after rainfall in the normal sampling regime may miss the effects of the 'first flush'.
- Rainfall data are based on the closest established NOAA station. Since rainfall patterns along the coastline, particularly during the summer months, tends to include locally heavy rainfall, the rainfall amounts recorded at the NOAA station may not accurately reflect the rainfall at the sampling station(s).

The rainfall amounts were relatively low prior to 2003, with several dry summers. During the winter of 2002 there were a few big snowstorms and there was heavy precipitation in the spring of 2003.

Currently, there are no stations with a rainfall correlation greater than 0.600 in the Shark River. A relationship between rainfall amounts and total coliform levels is suggested if the rainfall correlation coefficient is greater than 0.600.

However, further analysis was used in order to determine the wet/dry relationship within the Shark River. Once it was determined that 0.2 inches of rain triggers the most t-statistic probabilities (below 0.050); then the data was analyzed at 0 hours, 24 hours, and 48 hours. The Shark River seems to be most impacted by the 0.2 inches of rain between the 24 and 48 hour period.

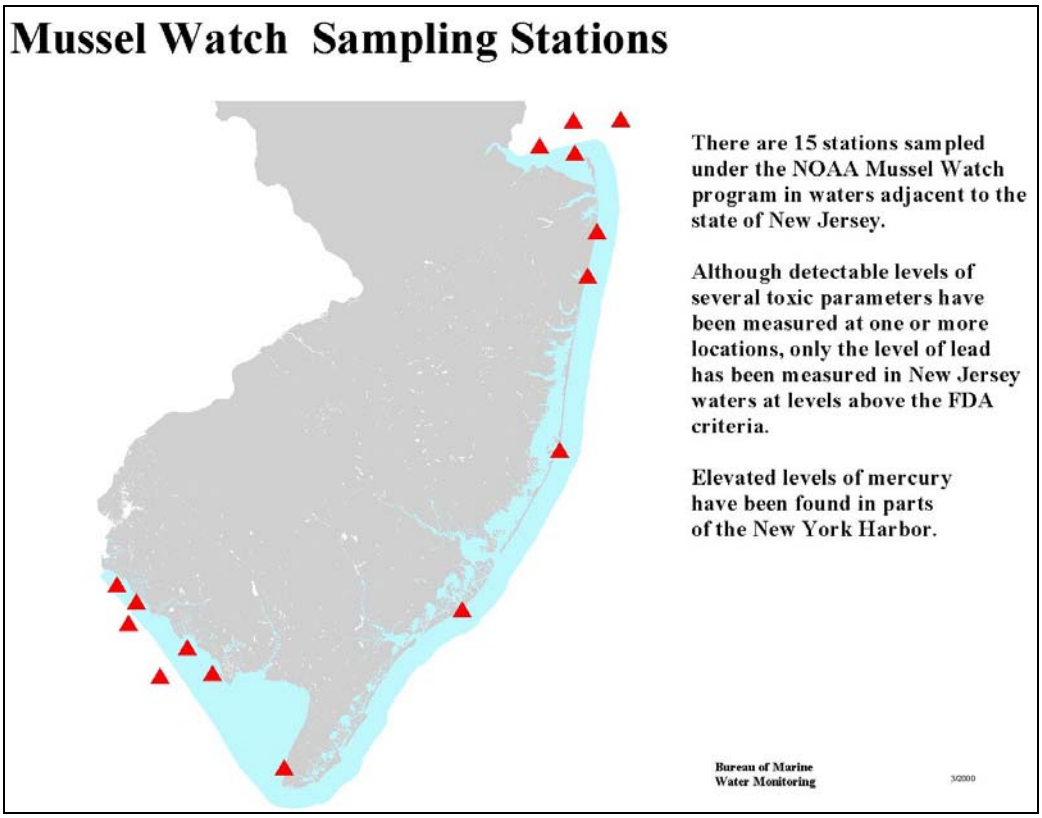
RELATED STUDIES

Although the Bureau of Marine Water Monitoring assesses classification based on total coliform bacteria, the laboratory is capable of running many other tests on the water samples. In addition to testing for total coliform, all samples retrieved prior to June of 2003 were also tested for fecal coliform (some areas that were not being tested for total coliform are still tested for fecal coliform, but fecal coliform testing was cut back due to high laboratory volume in June of 2003). Other capabilities include testing New Jersey waters for levels of phytoplankton, toxins (in Atlantic and Cape May Counties), and nutrients.

NOAA Mussel Watch Program

The NOAA Mussel Watch Program monitors the levels of toxins and metals in coastal waters. The blue mussel, *Mytilus edulis*, occurs worldwide and effectively takes up toxins and metals from seawater and sediments. The toxins and metals then become concentrated in the mussel's living tissues. Assays from the living tissues of this shellfish can be made easily and cheaply. The Mussel Watch Program monitors metals such as mercury, lead, zinc, nickel, cadmium, copper, chromium, aluminum, silicon, manganese, iron, arsenic, selenium, tin, antimony, thallium, and silver. The program also monitors toxins such as the synthetic organic compounds that are widely used in pesticides, solvents, flame-retardants, and other products. There is a mussel watch station in the Atlantic Ocean outside of the Shark River Inlet, but none are located in the river (see Figure 29). There were no exceedances in criteria at the mussel watch station outside of the Shark River Inlet between 1999 and 2004.

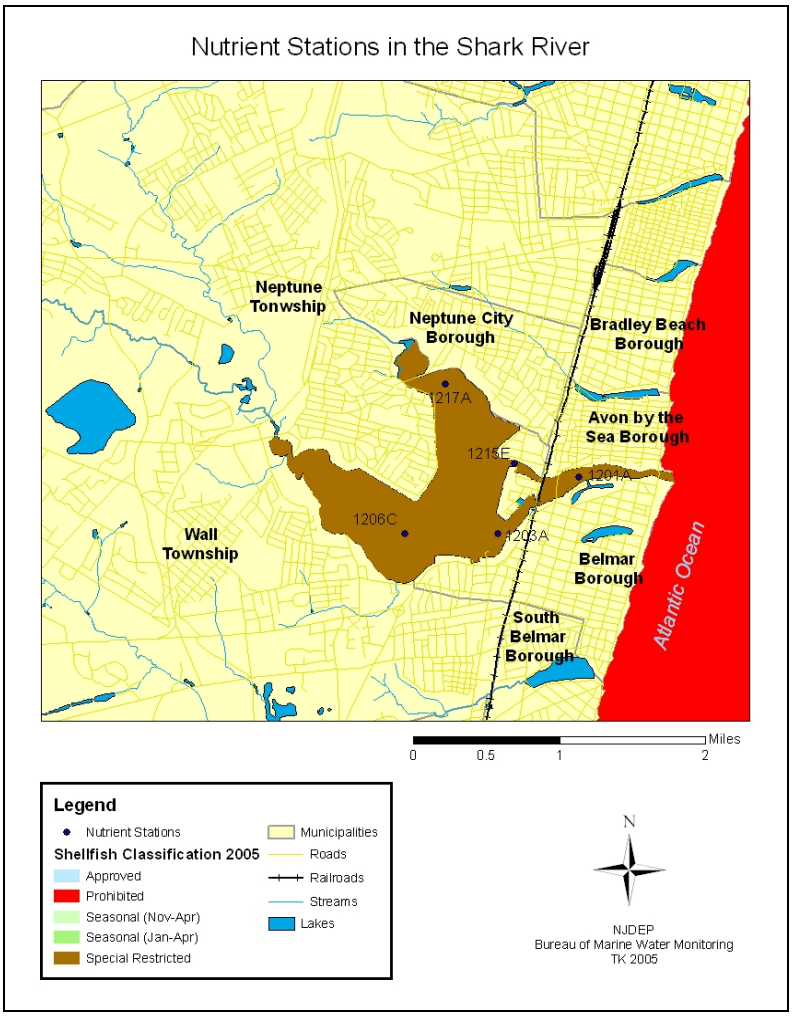
FIGURE 26: SAMPLING SITES WHERE NOAA MUSSEL WATCH DATA HAS BEEN COLLECTED



Nutrients

Nutrient and dissolved oxygen samples are collected at 5 stations, 1201A, 1203A, 1206C, 1215E, & 1217A, within the Shark River (see Figure 30). The parameters are evaluated, analyzed, and presented in a separate report by the Bureau of Marine Water Monitoring, available on the web at: www.nj.gov/dep/bmw. The waters of the Shark River experience low surface dissolved oxygen in the fall season (data from 1998-2002); all other nutrients are within recommended ranges (NJDEP, 2004). Water quality at the nutrient stations in the Shark River and the Shark River Inlet is consistent with the water results found throughout the state. More detailed information concerning dissolved oxygen and nutrient levels can be found in *New Jersey Ambient Monitoring Program: Report on Marine and Coastal Water Quality 1998-2002* (NJDEP, 2004).

FIGURE 27: SAMPLING SITES WHERE ADDITIONAL DATA HAS BEEN COLLECTED FOR NUTRIENTS



INTERPETATION AND DISCUSSION OF DATA

BACTERIOLOGICAL

Total Coliform Evaluation

Appendix 1 lists the water quality data obtained from the sampling period of January 1, 1999 to December 31, 2004. Systematic Random Sampling strategy was used to collect the samples, laboratory tests were run for total coliform, and a thorough analysis of the data was assembled for this report.

The bacteriological data for each station supports the respective criteria for the *Special Restricted* classification under the total coliform standard. Based on the data, this growing area is adequately classified.

There were 3 stations with a tidal component, zero with a seasonal component, and no stations had a rainfall correlation, although it was found that the Shark River shows the most impact 24 to 48 hours after 0.2 inches of rainfall. On analysis it was found that none of these impacted stations require a change in classification.

CONCLUSIONS

BACTERIOLOGICAL EVALUATION

Analysis of the Shark River shellfish growing area samples indicate that the geometric mean and 90^{th} percentile total coliform levels meet the standards of the National Shellfish Sanitation Program (NSSP).

The Shark River is acceptably classified, as supported by the current coliform levels.

RECOMMENDATIONS

BACTERIOLOGICAL EVALUATION

Presently, there are no recommended classification changes. However, the continuing improvement to the water quality of the Shark River is a promising trend. Efforts such as those to make the Shark River a ‘no discharge zone’ and a C1 designation should be helping to improve the water quality of the Shark River.

RECOMMENDED CLASSIFICATION CHANGES

There are currently no changes in classification for the Shark River. All stations fit within their respective classification criteria.

RECOMMENDED CHANGES IN MONITORING SCHEDULE

The recommendation for the 2006 sampling season is to continue the current sampling regimen. This area is currently sampled by one assignment run under the Systematic Random Sampling strategy. There are currently twenty-seven stations and eight runs are done per year.

RECOMMENDATIONS FOR FURTHER STUDY

There are currently no special studies planned for the Shark River. High priority projects are currently in the works, but a stormwater study in the western portion of the Shark River might be carried out in the next three years depending on time and resources.

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ACKNOWLEDGMENTS

This report was written under the direction of Robert Connell, Bureau Chief and Leslie J. McGeorge, Administrator. Alena Baldwin-Brown provided editorial review and Mike Kusmiesz assisted in statistical and GIS data analysis. Special acknowledgment is given to Captain Donald Owens and supervisor Bob Schuster for their efforts in collecting shellfish water quality samples in the NE4 area (Shark River). This study would not have been completed without the analytical capabilities of our microbiology laboratory staff, including Eric Feerst, supervisor, Lisa DiElmo, Elena Heller, Bruce Hovendon, and Bob Seabrook; and our chemistry laboratory staff, including Dawn Feldman, Bill Heddendorf, and Eric Ernst. Deborah Watkins, Julie Nguyen, Paul Weisghan, and Mike Curtis provided guidance with the written report. Additional thanks are also given to Marion Petruzzi. Tracy Kirwan took the cover picture on June, 22 2005.

APPENDICES

A. Statistical Summary

B. Tidal Evaluation

C. Seasonal Evaluation

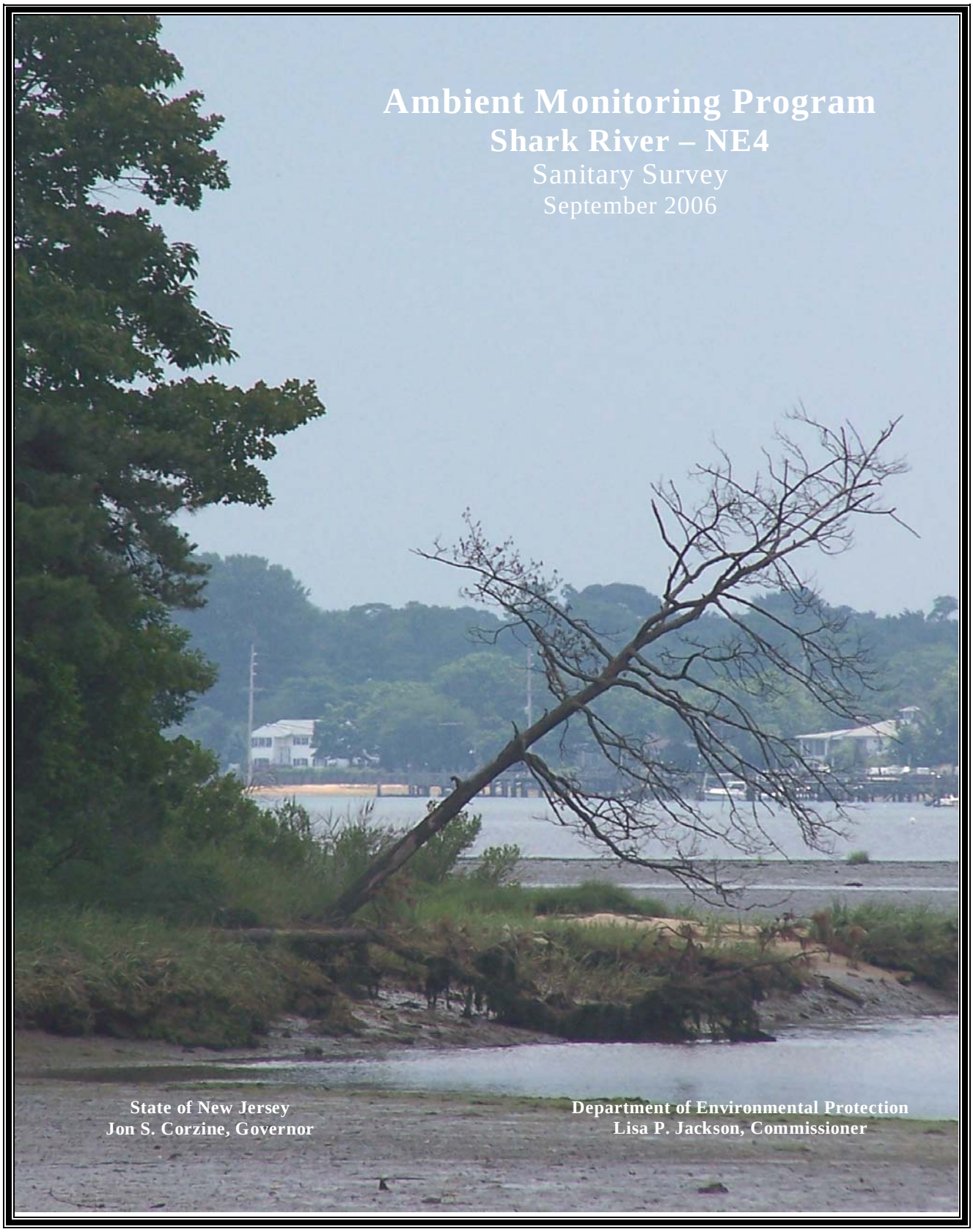
D. Precipitation

Rainfall Correlation

Cumulative Rainfall

Wet/Dry Statistics

E. Data Listing – January 1, 1999 through December 31, 2004


Ambient Monitoring Program
Shark River – NE4
Sanitary Survey
September 2006
State of New Jersey
Jon S. Corzine, Governor
Department of Environmental Protection
Lisa P. Jackson, Commissioner