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

Leslie J. McGeorge, Administrator

SANITARY SURVEY

MANASQUAN RIVER

October 1, 1994 – September 30, 2005

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Water Monitoring Report Prepared by:

Tracy Kirwan

Bureau of Marine Water Monitoring
PO 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

SANITARY SURVEY

MANASQUAN RIVER

October 1, 1994 – September 2005

New Jersey Department of Environmental Protection
LISA P. JACKSON
COMMISSIONER

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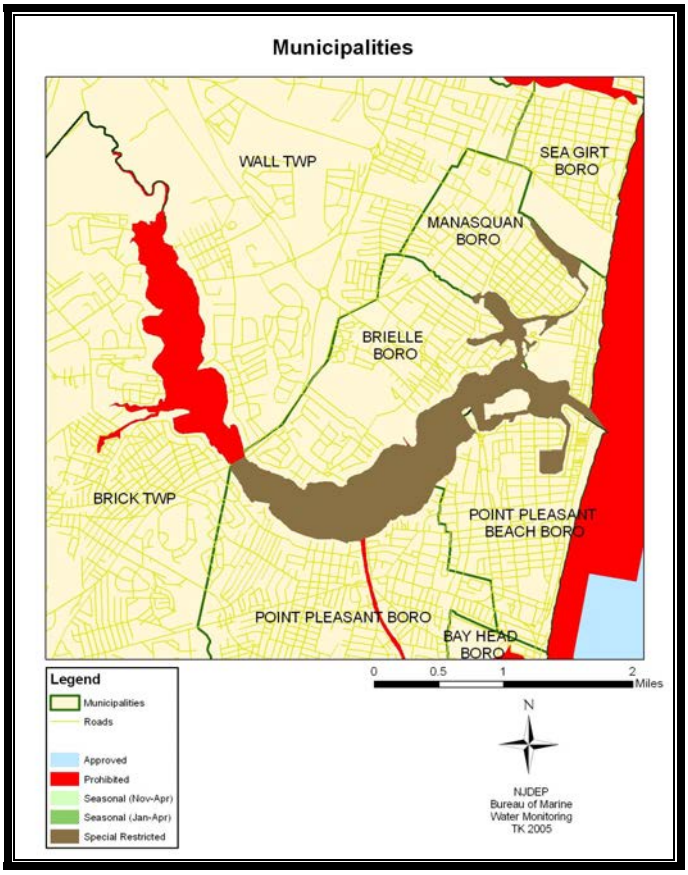
EXECUTIVE SUMMARY

The Manasquan River is approximately 23 miles long and drains an area of 81 square miles (Monmouth Management Area 12, 2003). The Manasquan River divides Ocean County and Monmouth County and connects to the Atlantic Ocean via the Manasquan Inlet. It also connects to the Barnegat Bay through the Point Pleasant canal. The Manasquan River is classified as *Prohibited* upstream of the Route 70 Bridge and *Special Restricted* downstream of the Route 70 Bridge. The Point Pleasant Canal is classified as *Prohibited* (see Figure 1). Water samples from the Manasquan River were collected (using the Systematic Random Sampling strategy) and analyzed from 44 sampling stations for total coliform during the period of October 1, 1994 through September 30, 2005 for this Sanitary Survey report. All sampling stations comply with their criteria for *Special Restricted* and *Prohibited* classifications, respectively. No stations in *Special Restricted* waters exceed *Special Restricted* criteria; however, many still exceed the *Approved* criteria, so no upgrades or downgrades in classification are recommended in this report. The results of this data evaluation prove to be consistent with the existing shellfish growing water classifications. The monitoring schedule will remain the same. There are no direct discharges into the Manasquan River, although there are numerous stormwater outfalls and other indirect discharges.

FIGURE 1: CURRENT CLASSIFICATION OF THE MANASQUAN 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.

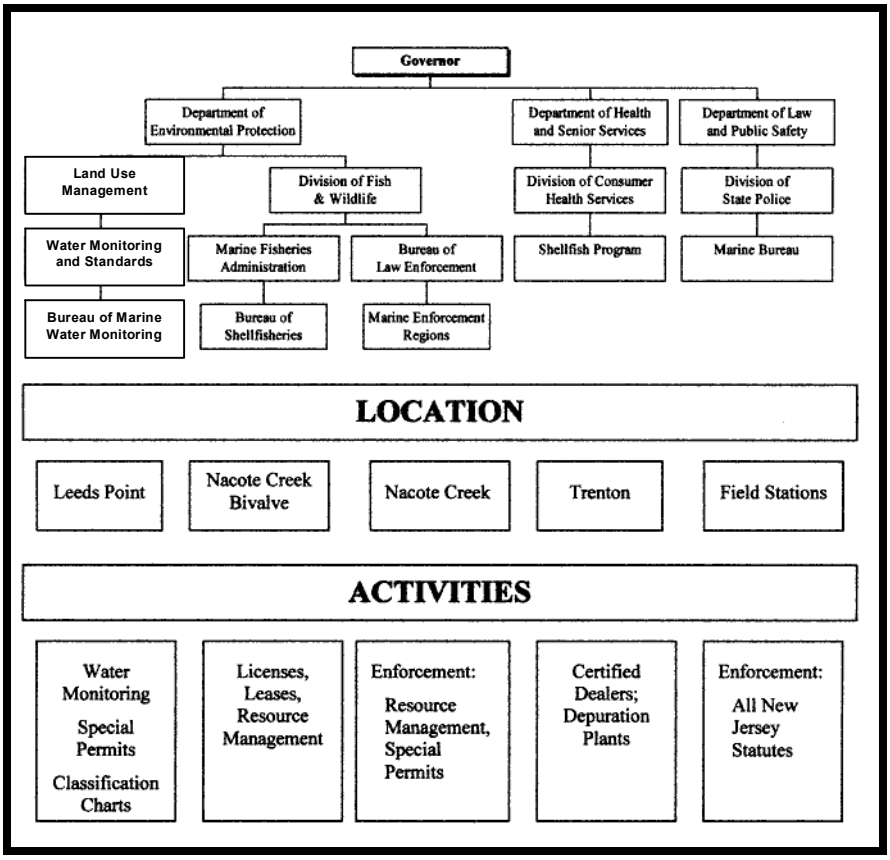
The Bureau of Shellfisheries, in the Division of Fish and Wildlife, issues harvesting licenses and leases for shellfish grounds under the Authority of N.J.S.A. 50:2 and N.J.A.C. 7:25. This bureau, in conjunction with the BMWM, administers the Hard Clam Relay Program.

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 2.

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 3). 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 Manasquan River Growing Area.

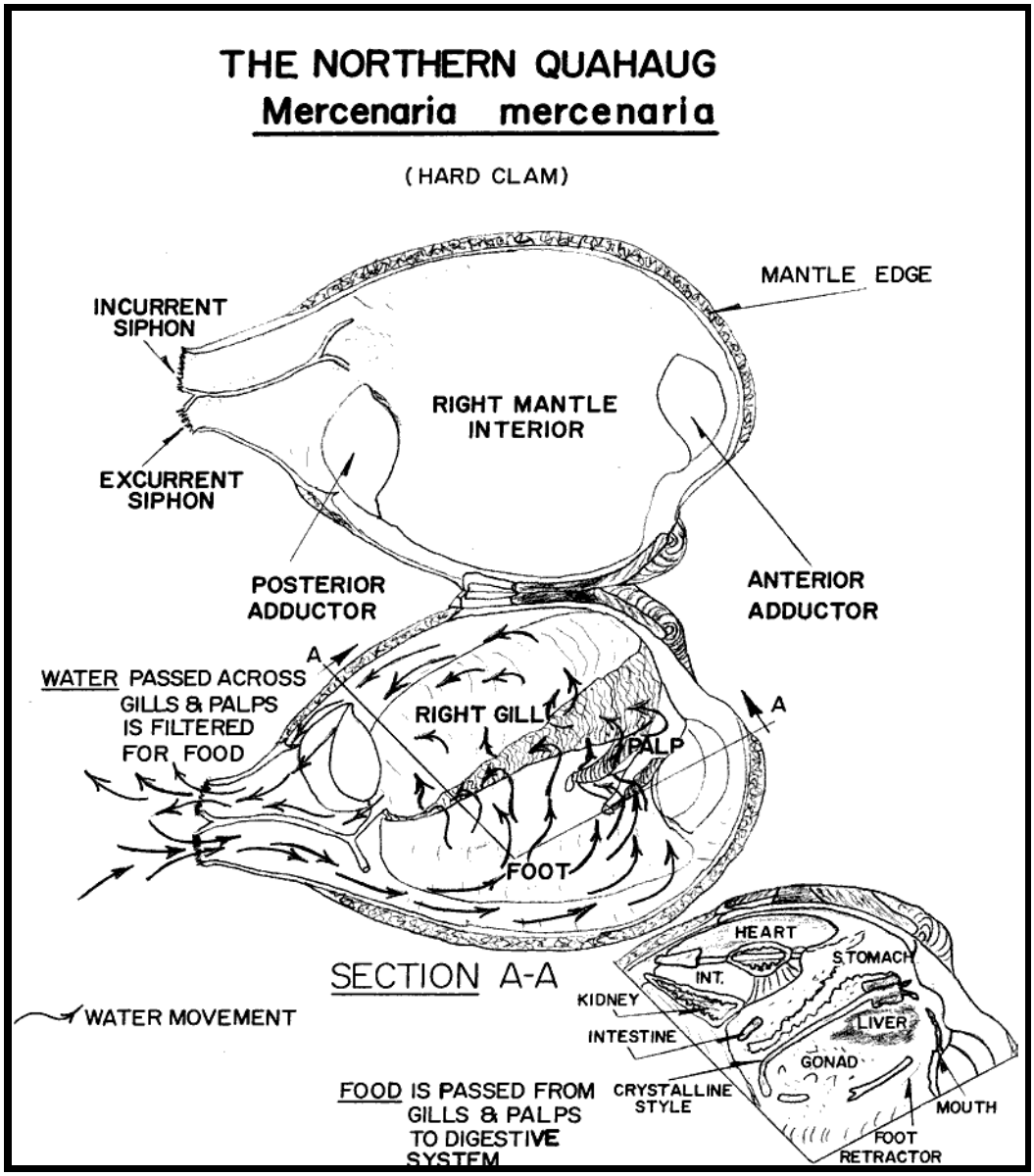
After assessment, the appropriate classification is determined for that particular area. The possible classifications are *Approved, Seasonal, Special Restricted*, and *Prohibited*. *Approved* waters can be harvested for shellfish all year round. *Seasonal* waters can be harvested for all, or part, of 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, 1994-2005). 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, 1994-2005). 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: CROSS-SECTION OF MERCENARIA MERCENARIA



PROFILE OF GROWING AREA

LOCATION OF GROWING AREA

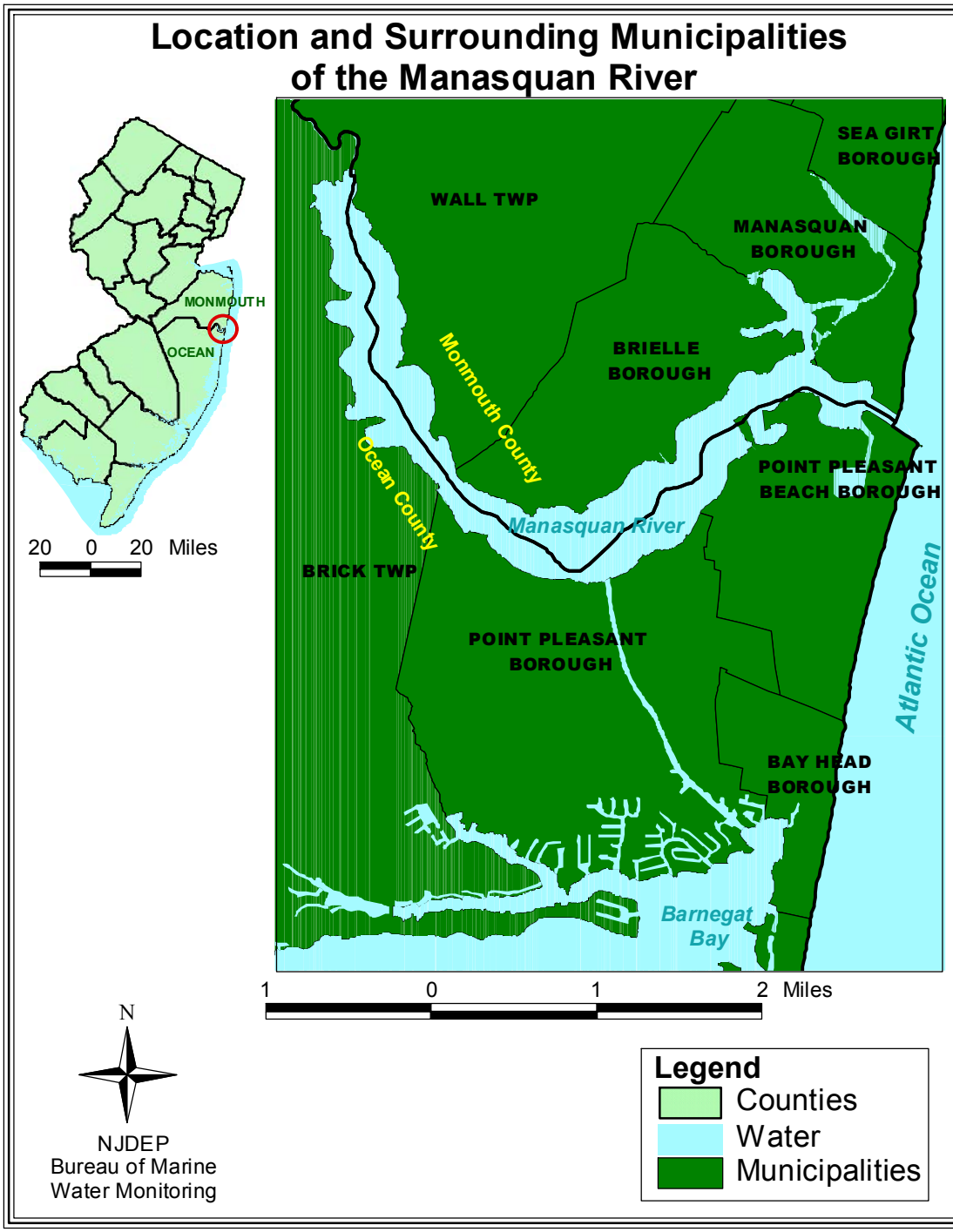
The Manasquan River is approximately 23 miles long and drains an area of 81 square miles (Monmouth Management Area 12, 2003). The Manasquan River also serves as a boundary, separating Ocean County from Monmouth County, as seen in Figure 4. This river connects to the Atlantic Ocean via the Manasquan Inlet. It also connects to the Barnegat Bay through the Point Pleasant canal. The Manasquan River is the northernmost entry point to the Intracoastal Waterway. The major tributaries of the Manasquan River are Squankum Brook, Debois Creek, Mingamahone Creek, and Marsh Bay Brook. There are six municipalities surrounding the Manasquan River, three in Monmouth County and three in Ocean County. Brielle Borough, Manasquan Borough, and Wall Township are located in Monmouth County, while Point Pleasant Beach Borough, Point Pleasant Borough, and Brick Township are located in Ocean County (see Figure 4).

This area is also displayed on chart # 3 of the current State of New Jersey Shellfish Growing Water Classification Chart. The population statistics for the adjacent municipalities are shown in Table 1 (US Census, 2000).

TABLE 1: POPULATION INFORMATION

Community	Area (Square Mile)	Population (2000 Census)	Population Density (Population / Square Mile)
Wall Township	30.4	25,261	830.9
Brielle Borough	1.8	4,893	2,718.3
Manasquan Borough	1.5	6,310	4,206.6
Brick Township	26.3	76,119	2,894.2
Point Pleasant Borough	3.7	19,306	5,217.8
Point Pleasant Beach Borough	1.6	5,314	3,321.2

FIGURE 4: LOCATION AND MUNICIPALITIES OF THE MANASQUAN RIVER



DESCRIPTION OF GROWING AREA

This report concentrates on the main portion of the Manasquan River, where the shellfish beds reside. The lower 6.5 miles of the 23-mile long river is deemed part of the Manasquan River estuary (USEPA, 1998). The estuary includes the shellfish waters, but also the narrows, (the section where the width of the river decreases and there is little tidal influence), various tributaries, and some lakes. The harvestable waters are the main focus of this report. The whole estuary, however, will be considered when evaluating such things as runoff.

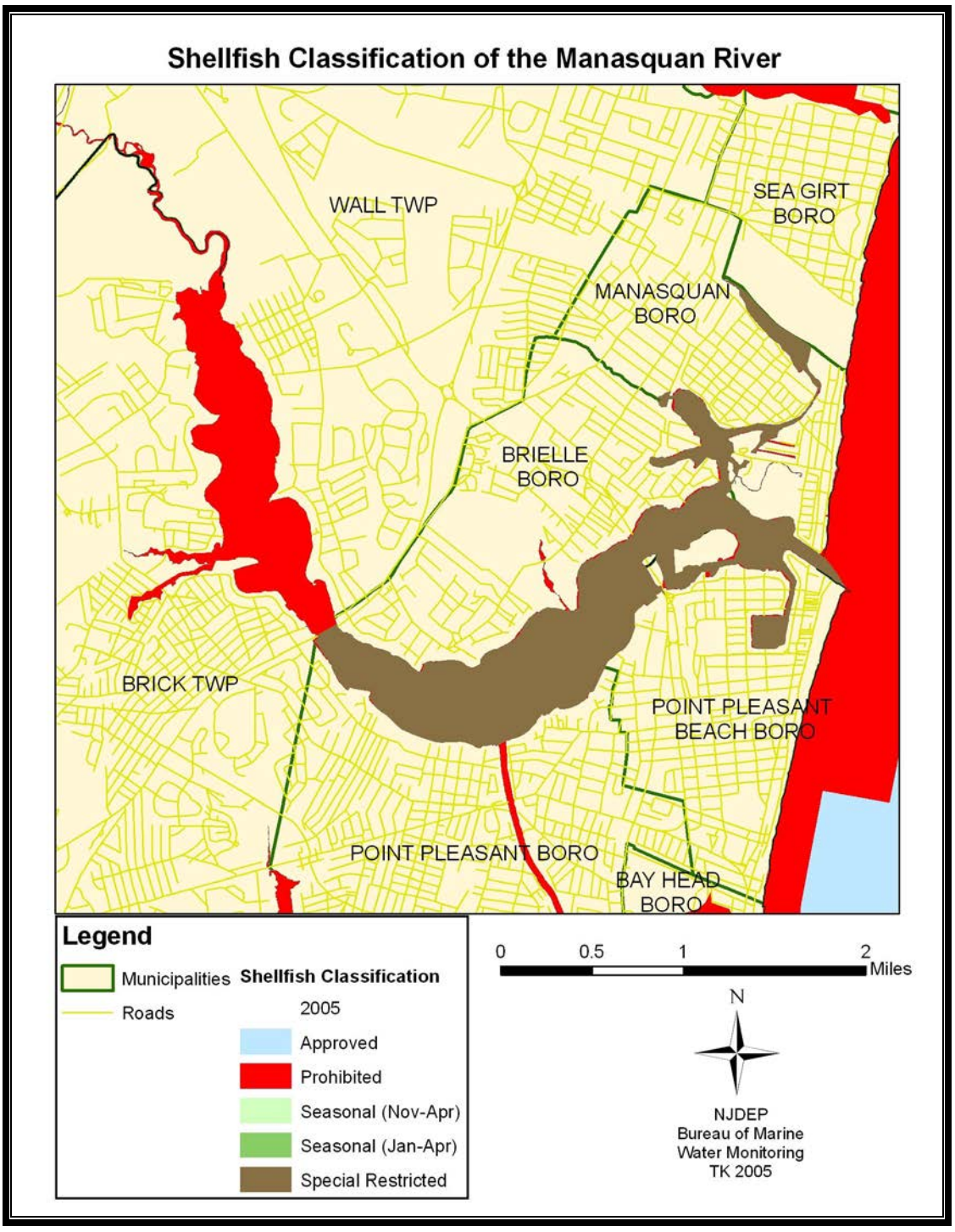
The Manasquan River is heavily used for recreational purposes. The recreational use is substantially increased in the summer months due to a seasonal growth in population. Portions of this growing area are resort spots on the Jersey shore; therefore, summer populations tend to be higher than the other seasonal populations.

Popular ocean bathing beaches are located both north and south of the Manasquan Inlet. The Manasquan Inlet provides direct access to the Atlantic Ocean, which attracts fishermen, both commercial and recreational. As a result, there are many marinas within the Manasquan. There are also many waterfront restaurants that provide boat access. Consequently, much of the river shoreline is bulkheaded.

There is agricultural land use near the headwaters of the Manasquan, but as the river runs southeast toward the ocean, the land use becomes mostly urban. Within these urban areas there are some conservation lands; Gull Island, in the eastern portion of the river, and the Manasquan River Wildlife Refuge are such examples.

The area upstream of the Route 70 bridge is classified as *Prohibited*, as is the Point Pleasant canal. The remaining portion of the river, downstream of the Route 70 bridge, is classified as *Special Restricted* (see Figure 5).

FIGURE 5: CURRENT CLASSIFICATION OF THE MANASQUAN RIVER



HISTORY OF GROWING AREA

The Lenape Native Americans gave this river its name, Manasquan, which means "mouth of this river." (MWMG, 1999). By the 1880's, the area was becoming a tourist attraction due to its connection with the New York railroads. Over the following decades this area supported many different businesses including brick making, bog-iron, marl, farming, and munitions (MWMG, 1999).

Historically, the Manasquan River has dealt with heavy silting, especially after the completion of the Point Pleasant Canal in 1925. The Point Pleasant Canal allowed for a safer passageway into the river than the Manasquan Inlet. Historically, many boats wrecked in the treacherous Manasquan Inlet and, for a couple of years, the inlet was even closed because sand clogged the waterway.

In 1961, the entire Manasquan River, NE-5 (previously known as Area 6), was classified as *Prohibited* for harvesting shellfish. It was not until 1987 that the classification of the entire river was upgraded to *Special Restricted*. The last alteration to the classification of the Manasquan was made in 1990, when 424 acres northwest of the Route 70 bridge were downgraded from *Special Restricted* to *Prohibited*. The downgrading of these waters was a result of high coliform levels associated with nonpoint source runoff from development.

The Manasquan River was analyzed for both total and fecal coliform from 1985-1995. In order to reduce analytical lab costs, total coliform testing was very sporadic from 1995-2004. Fecal coliform was regularly tested from 1997-2003; therefore fecal coliform was used to classify the waters for many years. In fact, it was not until 2004 that the Manasquan River resumed consistent total coliform testing.

The New Jersey Water Supply Authority controls the Manasquan Reservoir, located upstream of the Manasquan River. The reservoir, which was opened in 1990, normally diverts 15-20 MGD (million gallons per day) from the Manasquan River (by way of Timber Swamp Brook) and has a capacity of 4.7 billion gallons of water (Chronology of NJ Water Supply Development and MWMG, 2001). Since the Manasquan Reservoir and the Manasquan River are within the same watershed, the condition of one can directly influence the condition of the other.

There are a few sections in this growing area still utilizing septic systems, although most homes and businesses are linked to sewer systems.

Boating, commercial and recreational, has historically been very popular in this area. Even today, most marinas are filled to capacity during the summer season.

The last sanitary survey, which included data from May 1986 through February 1990, was completed in June 1992. In October 1996, a reappraisal of the Manasquan River was completed, which drew data from January 1, 1990 to December 31, 1995. The last reappraisal report included data from January 1992 through September 1999 and was completed in March 2000.

METHODS

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

Approximately 1,369 water samples were collected for total coliform testing between October 1, 1994 and September 30, 2005 and analyzed by the three-tube MPN method according to APHA (1970). Figure 6 shows the shellfish growing water quality monitoring stations in the Manasquan River. Nearly 1,640 stations are monitored in New Jersey each year, 44 are within the Manasquan River.

Water quality sampling, shoreline, and watershed surveys were conducted in accordance with the NSSP *Guide for the Control of Molluscan Shellfish,* 2001 Revision.

Data management and analysis was accomplished using database applications developed for the Bureau. Mapping of data was performed with the Geographic Information System (GIS:ArcView®/ArcGIS®).

BACTERIOLOGICAL INVESTIGATION AND DATA ANALYSIS

The water quality of each growing area is constantly evaluated so the area can be correctly classified as *Approved, Seasonal (Nov-Apr or Jan-Apr), Special Restricted,* or *Prohibited*. *Seasonal* areas must be sampled and meet the criterion for the portion of the year it is open for shellfish harvesting. Criteria for bacterial acceptability of shellfish growing waters are provided in NSSP *Guide for the Control of Molluscan Shellfish,* 2001 Revision.

SAMPLING STRATEGY

The State Shellfish Control Authority has the option of choosing one of 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 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 also be from a point source of pollution or a variation 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.

Until 1996, the Manasquan River was sampled under the Adverse Pollution sampling strategy, with the adverse condition of rainfall. The Bureau made the decision to change the sampling strategy to Systematic Random Sampling for several reasons. The conditions that existed in the Manasquan River at that time met the criteria for the Systematic Sampling protocol. Also, there was no direct discharge into the estuary. At that time there were several areas that had to be sampled after rainfall which made scheduling difficult. Since the Manasquan Estuary was one area that met the criteria for Systematic Random Sampling, it was decided that this change would allow for the most efficient use of the captains sampling schedule while still maintaining an accurate representation of the area.

The Manasquan River is currently sampled under the Systematic Random Sampling strategy described above.

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, 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 that exceeds the variability criteria (see Table 2). For the Systematic Random Sampling Strategy, variability is expressed as the 90th percentile (see Table 3).

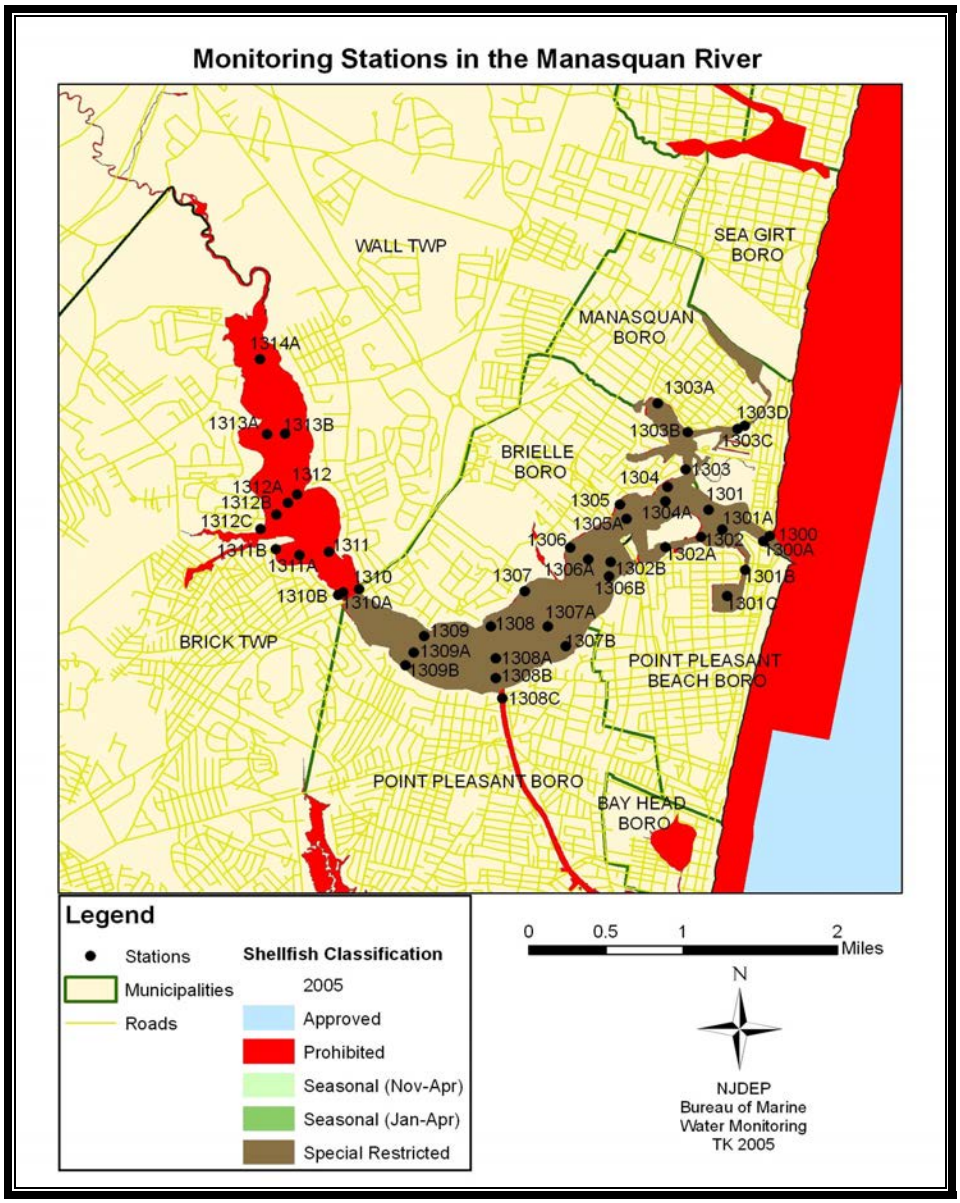
TABLE 2: CRITERIA FOR ADVERSE POLLUTION CONDITION SAMPLING STRATEGY

	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

FIGURE 6: SAMPLING STATIONS



SHORELINE SURVEY

CHANGES SINCE LAST SURVEY

Provisions are now being made to eradicate previous damage done to the Manasquan River. New developments have continued to change stormwater patterns and the river is now seeing the negative effects. The increasing amount of rainwater being directed to the Manasquan and its tributaries creates erosion and sedimentation. This sedimentation also affects the shellfish because it can cover over the bottom dwelling species, which can lead to their suffocation. Pollutants like various bacteria, nutrients, and metals also bond to sediments, creating further problems for shellfish. For the aforementioned reasons, the NJDEP has listed the Manasquan and several of its tributaries as either impaired or severely impaired.

Since the Manasquan tributaries are impaired, flushing depends on the tidal exchange with the Atlantic Ocean via the Manasquan Inlet. However, this tidal exchange is not enough to offset the negative influences, which are constantly being fed into the river. Therefore, the Manasquan is left with impaired water. The low tidal flow also increases the amount of silting.

In order to help remedy these problems, the DEP adopted a Storm Water Management and Discharge Control Ordinance for the Manasquan River in 2001 (SMDCO, 2001). This ordinance aims to reduce pollutants in stormwater discharges, lessen the volume of water discharged, decrease possible reasons for stream flooding and erosion, remove illegal connections and discharges, and regulate the non-stormwater discharges to the storm drain system (SMDCO, 2001).

The shoreline survey shows some new/repaired sections of bulkheading along the Manasquan River (see Figure 7). Beach and shallow water habitats are taken away from birds and other creatures when bulkheads are constructed. Additionally, bulkheading is often made of pressure-treated wood, which harbors many harmful chemicals, like arsenic, chromium, and copper. However, there are new bulkheads, which are not made of pressure treated wood, but plastic. Not all of the long-term effects of the plastic bulkheading have been determined (i.e. ability for mussel attachment) (Lampo, 1999).

In February 2004, the DEP Green Acres Program acquired 113 acres adjacent to Allaire State Park in Wall Township. This land will help preserve, “one of the last remaining undeveloped land parcels in a Monmouth County Industrial zone” (NJDEP Postmaster, 2004).

FIGURE 7: NEW BULKHEADING, THE WOODEN POLES ARE REMNANTS OF THE OLD BULKHEAD

LAND USE

The majority of land use surrounding the Manasquan River is urban (see Figure 8). Much of the Manasquan coastline is residential housing, with commercial sections near the inlet. The residential homes often have one or more boats on a private dock; some residences even fit within the definition of a marina, having the ability to support 5 or more boats (see Figure 9). Commercial land use is common around the inlet where there is a cluster of marinas (see Figure 10).

There is a continuing trend of residential housing growth throughout New Jersey, and this area is a prime example. More and more forested and agricultural land is being developed to provide for residential housing. These houses and parking lots now stand where forests once acted as a filter for runoff. Most of the waterfront areas along the Manasquan are already developed. Nonetheless, development along the tributaries can also influence the water quality of the Manasquan. Since there is substantial development along the tributaries at this time, issues like the aforementioned sedimentation problem worsen.

There are also agricultural regions within the Manasquan estuary. Agricultural areas are known to contaminate waters with such things as pesticides, fertilizers, and fecal matter. There were once quite a number of farms in this region, but residential housing has replaced many of them. However, some still exist and they are possible sources of contamination.

The crowds of tourists in the summertime also cause both a substantial increase in residential use as well as boat use. While the influx of people strains the various utilities, it also boosts the commercial industries.

FIGURE 8: LAND USE PATTERNS ALONG THE MANASQUAN RIVER

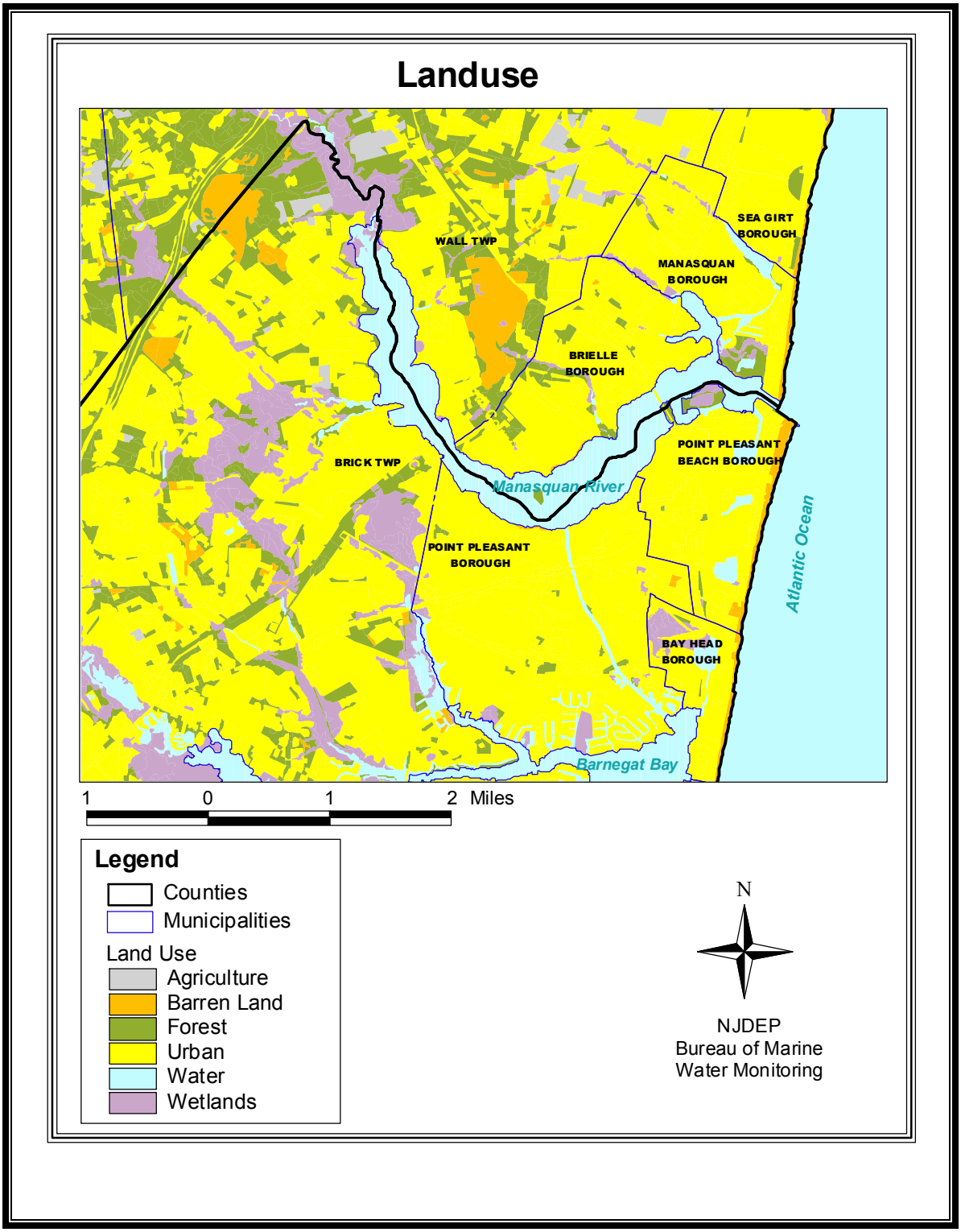


FIGURE 9: RESIDENTIAL HOUSING ON THE MANASQUAN RIVER

FIGURE 10: COMMERCIAL LANDUSE ON THE MANASQUAN RIVER

EVALUATION OF BIOLOGICAL RESOURCES

There are approximately 1,500 acres of shellfish growing waters within the Manasquan estuary. Factors that contribute to having a viable shellfish resource include salinity, dissolved oxygen levels, bottom conditions, and predator activity. In 1995, hard clam harvesting within the Manasquan River brought in more than 1.2 million dollars. According to the most recent survey in the 1980's, there are also some soft-shelled clams within the river, and blue mussels reside around the Point Pleasant Canal and Gull Island (see Figures 11 & 12).

There is no harvesting allowed in the *Prohibited* region of the Manasquan River. Any clams harvested from the *Special Restricted* portion of the Manasquan River require additional processing, either by depuration or relay.

Depuration requires clams to be filtered by UV treated water for 48 hours in a depuration plant. The depuration plants in New Jersey are located near Sandy Hook.

Relay requires clams from *Special Restricted* waters to be transplanted to *Approved* waters to purge themselves for at least 30 days. There is a strict quota for relay clams set by the New Jersey Shellfish Council. Both depuration and relay require a special permit issued by the Bureau of Marine Water Monitoring.

Overall, the Manasquan is moderately harvested. The Manasquan River is also home to commercial clam boats which harvest shellfish from ocean waters (see Figures 13 & 14).

Submerged aquatic vegetation (SAV) is located in shallow sections of the Manasquan River. Vegetation is an essential part of the bay ecosystem, offering habitats and nursery grounds for numerous species. The SAV of a region is a good indicator of its overall health.

There are also numerous wildlife species in the vicinity of the Manasquan River. These include plants and animals, both aquatic and terrestrial. On the shoreline survey, various waterfowl species were spotted including a kingfisher, egrets, swans, ducks, and loons.

FIGURE 11: OCCURRENCE OF HARD CLAMS IN THE MANASQUAN RIVER (1980'S)

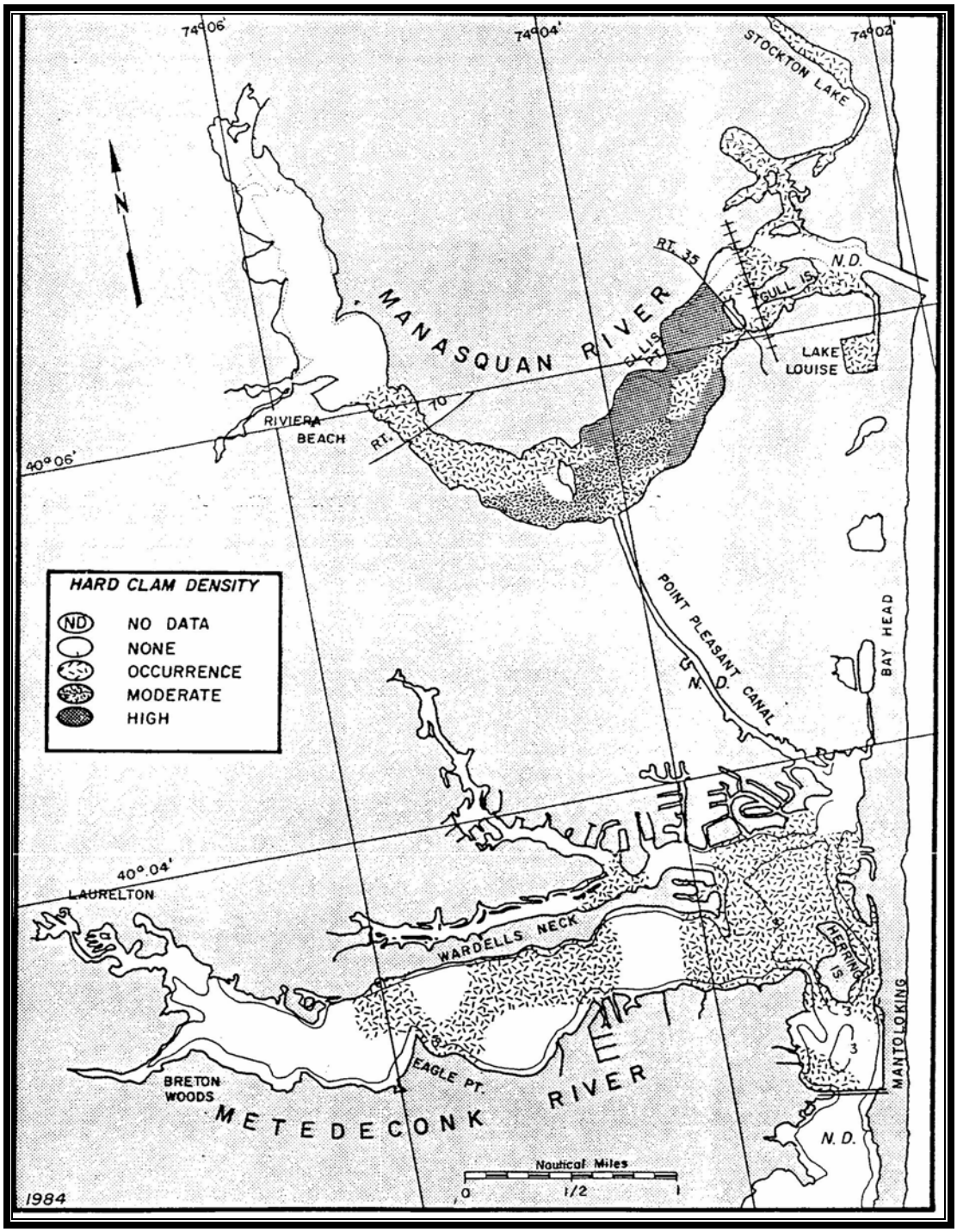


FIGURE 12: LOCATION OF SOFT CLAMS AND BLUE MUSSELS RECORDED IN THE MANASQUAN RIVER (1980'S)

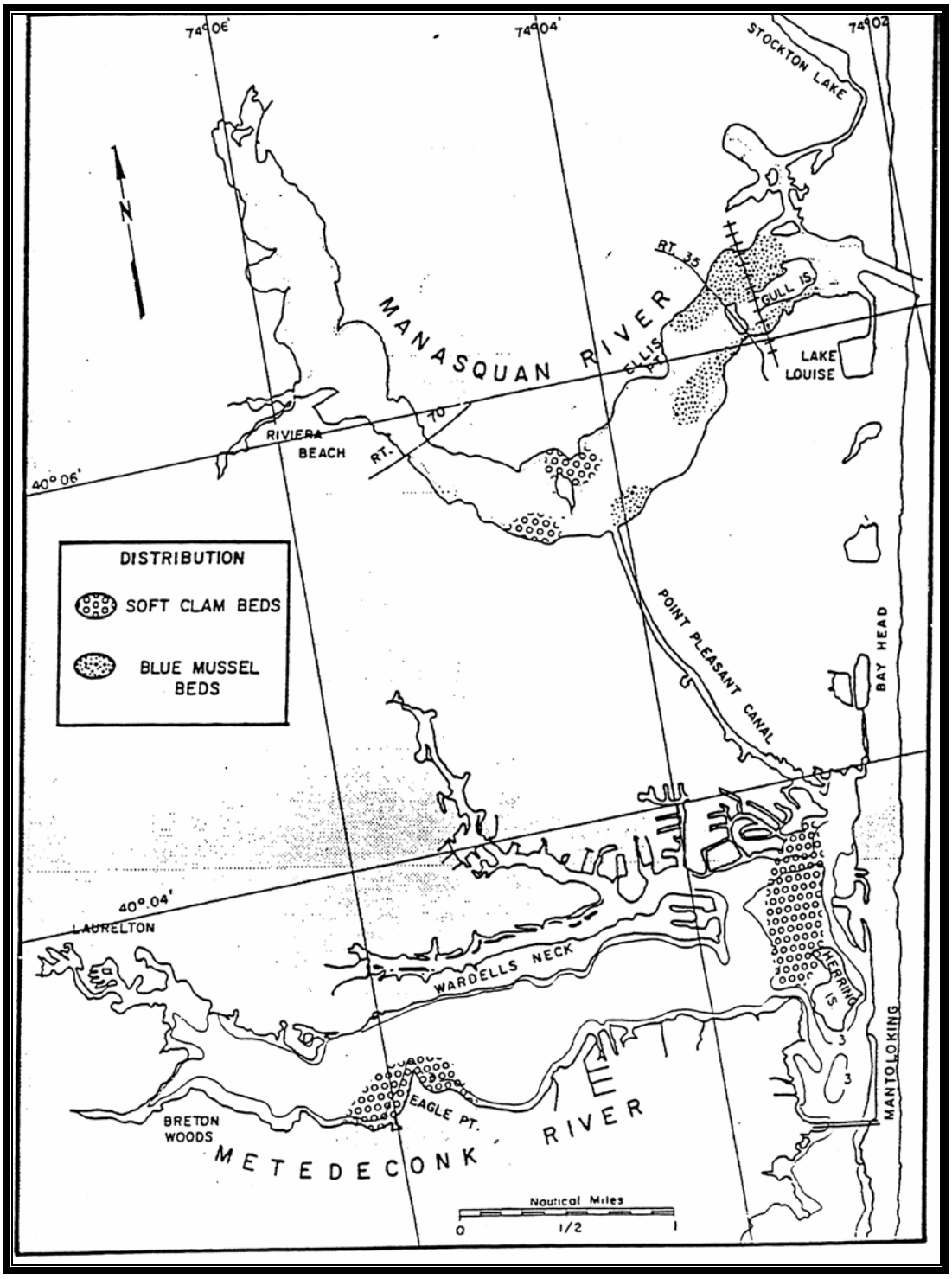


FIGURE 13: CLAMMERS IN THE MANASQUAN RIVER

FIGURE 14: COMMERCIAL CLAMMING BOATS NEAR THE MANASQUAN INLET

IDENTIFICATION AND EVALUATION OF POLLUTION SOURCES

The USEPA noted the top five pollution sources in the Manasquan River as "urban runoff, upstream sources, wildlife, individual wastewater treatment systems, and wastewater treatment plants" (USEPA, 1998). The NJDEP also attributes some of the poor water quality to the pollutants from marinas, agricultural areas, and suburban development.

EFFLUENT DISCHARGES

There are no direct discharges into the waters of the Manasquan River. The Northern Water Pollution Control Facility in Brick Township (below the Metedeconk River) treats the waste material of Bay Head, Brick Township, Point Pleasant Beach, Point Pleasant Borough, Lakewood Township, and Jackson Township. This facility was built in 1976 and is currently in the final stages of improvements to increase the reliability of the plant, decrease the odor coming from the plant, and to deal better with the seasonal pressures (OCUA, 2003 & 2005). On average, the flow from the facility is 32 million gallons per day. Once treated, the effluent is 'disinfected and discharged' one mile into the Atlantic Ocean via an outfall pipe.

There is one pump-and-treat groundwater remediation system in Point Pleasant that remains a NJPDES permitted discharge (Watershed Management Area 12, 2003).

INDIRECT DISCHARGES

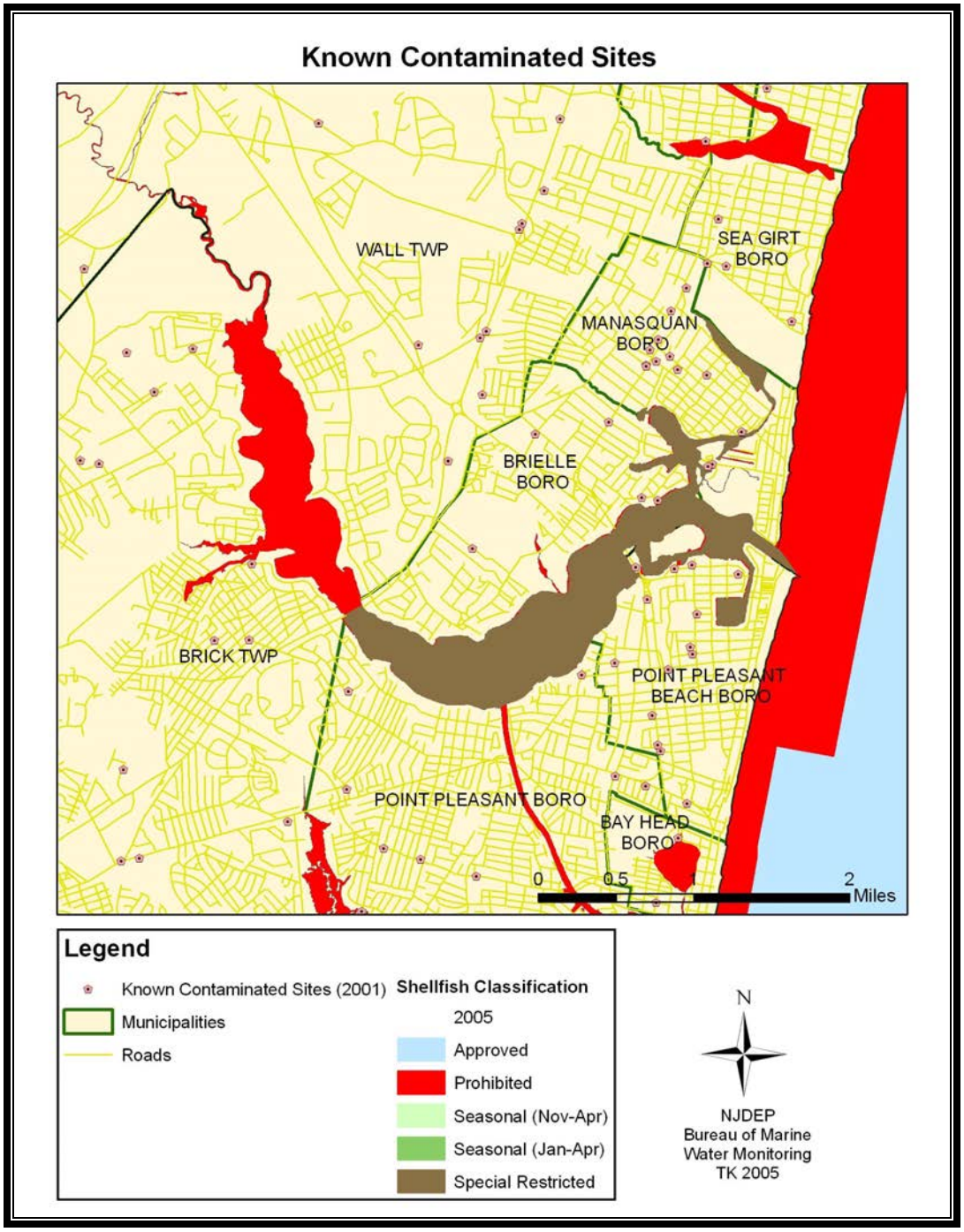
Known contaminated sites are scattered throughout this region, mostly within urban areas (see Figure 15). Less than half of the known contaminated sites are in close proximity to the shoreline and, since the whole river is classified as either *Prohibited* or *Special Restricted*, any legally harvested shellfish must go through further processing before going to market. For that reason, the likelihood of humans consuming contaminated shellfish is minimized.

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 waterbodies, causing high bacteria counts.

FIGURE 15: INDIRECT DISCHARGES TO THE WATERS OF THE MANASQUAN RIVER



STORMWATER 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 16). 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 to the Manasquan River (see Figure 18). Storm water outfalls are perhaps the most significant non-point source of pollution. Storm drains along roads collect runoff and transmit it to storm water outfalls. The outfalls deposit the runoff into the river (or other body of water). Therefore, pollutants in the runoff gradually make their way to ocean waters.

The first flush after a rain event often carries the most pollutants. Stormwater outfalls are mostly found in urban areas, and are especially common within lagoon communities. Although there are no lagoons in this area, there are areas that resemble lagoons near the Glimmer Glass section and the Manasquan Inlet (see Figure 17). Lagoon stormwater discharges are especially harmful because lagoons see little tidal flushing, heavy boat usage, and high quantities of bulkheading.

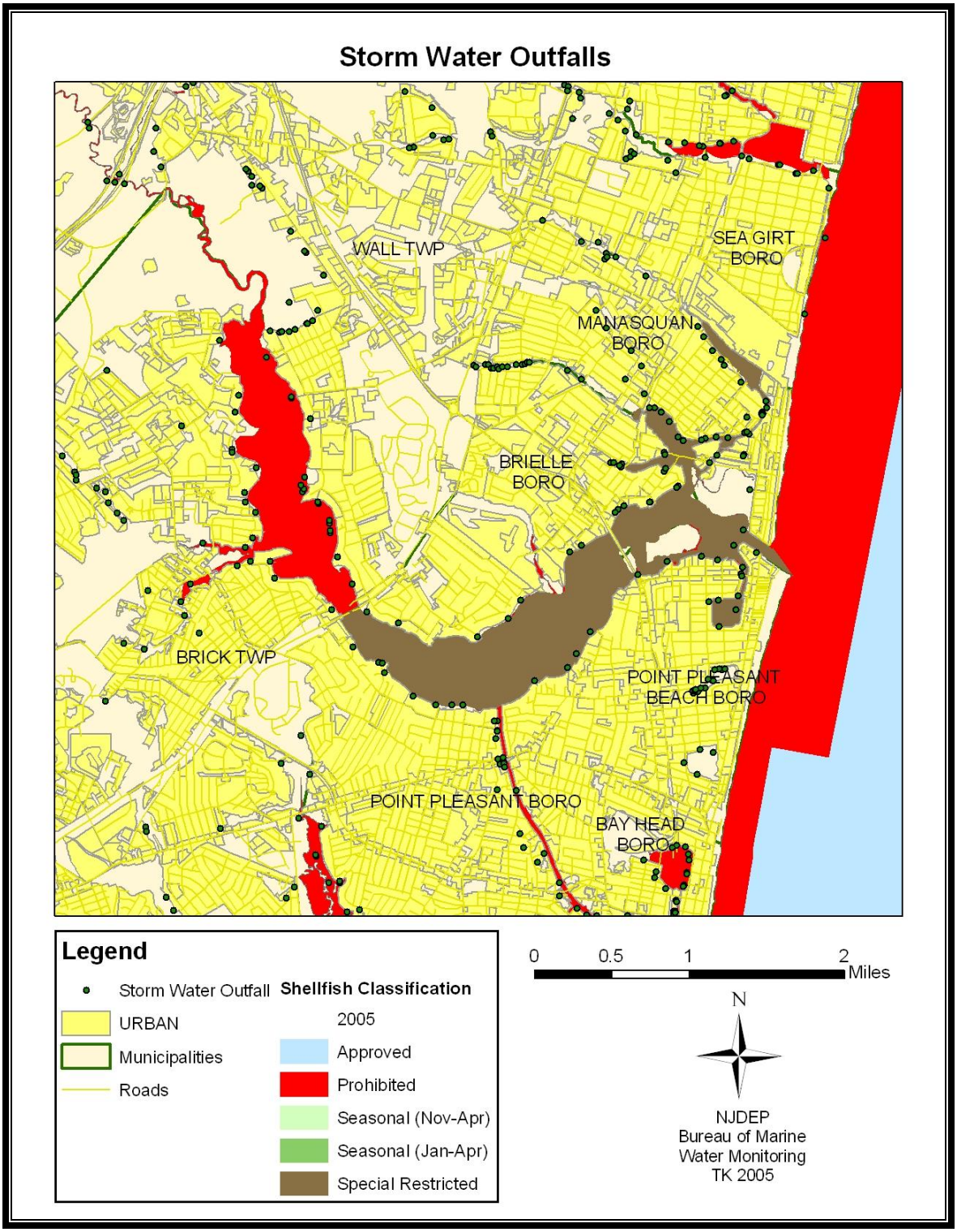
As mentioned above, contaminated runoff reaching stormwater outfalls is a major contributor to the pollution of waterbodies. Pesticides, carrion, animal wastes, and petroleum products are among the harmful materials in runoff. Seeing the substantial amount of outfalls in this area, it is crucial to understand 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 are no stormwater projects planned or ongoing for the Manasquan River.

FIGURE 16: STORM WATER OUTFALL

FIGURE 17: GLIMMER GLASS REGION OF THE MANASQUAN RIVER

FIGURE 18: STORM WATER INPUTS TO THE WATER OF THE MANASQUAN RIVER



MARINAS

Boating is a very popular summertime activity within the Manasquan River, and there are also many commercial boats that work year-round. In the Manasquan River there are a total of 38 marinas (see Figures 19 & 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 waterbodies. 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" and designates the confines of the marina as *Prohibited* for the harvest of shellfish (N.J.A.C. Chapter 12 7:12-1.2, 12-4, 1994-2005). Adjacent waters are classified using a dilution analysis formula.

It is recognized by the NSSP *Guide for the Control of Molluscan Shellfish,* 1999 Revision, 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.

Most of the marinas in this growing area are in the vicinity of the inlet. The waters enclosed by the marina are classified as *Prohibited.* Depending on the size of the marina and the water quality, the water immediately adjacent to each marina may be classified as *Prohibited*, *Special Restricted*, or *Seasonal* (no harvest during summer months when the marina is active).

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.

In the past, the marinas and boats in this growing area were considered to be a leading contributor to the poor water quality. Since then, many marinas have attempted to improve their practices in order to contribute less pollution. The EPA, with efforts from the Monmouth-Ocean Alliance and the NJDEP, also declared the Manasquan a "No Discharge Zone" in 1998 (USEPA, 1998).

FIGURE 19: MARINA ON THE MANASQUAN RIVER

FIGURE 20 : MARINA FACILITIES LOCATED IN THE MANASQUAN RIVER

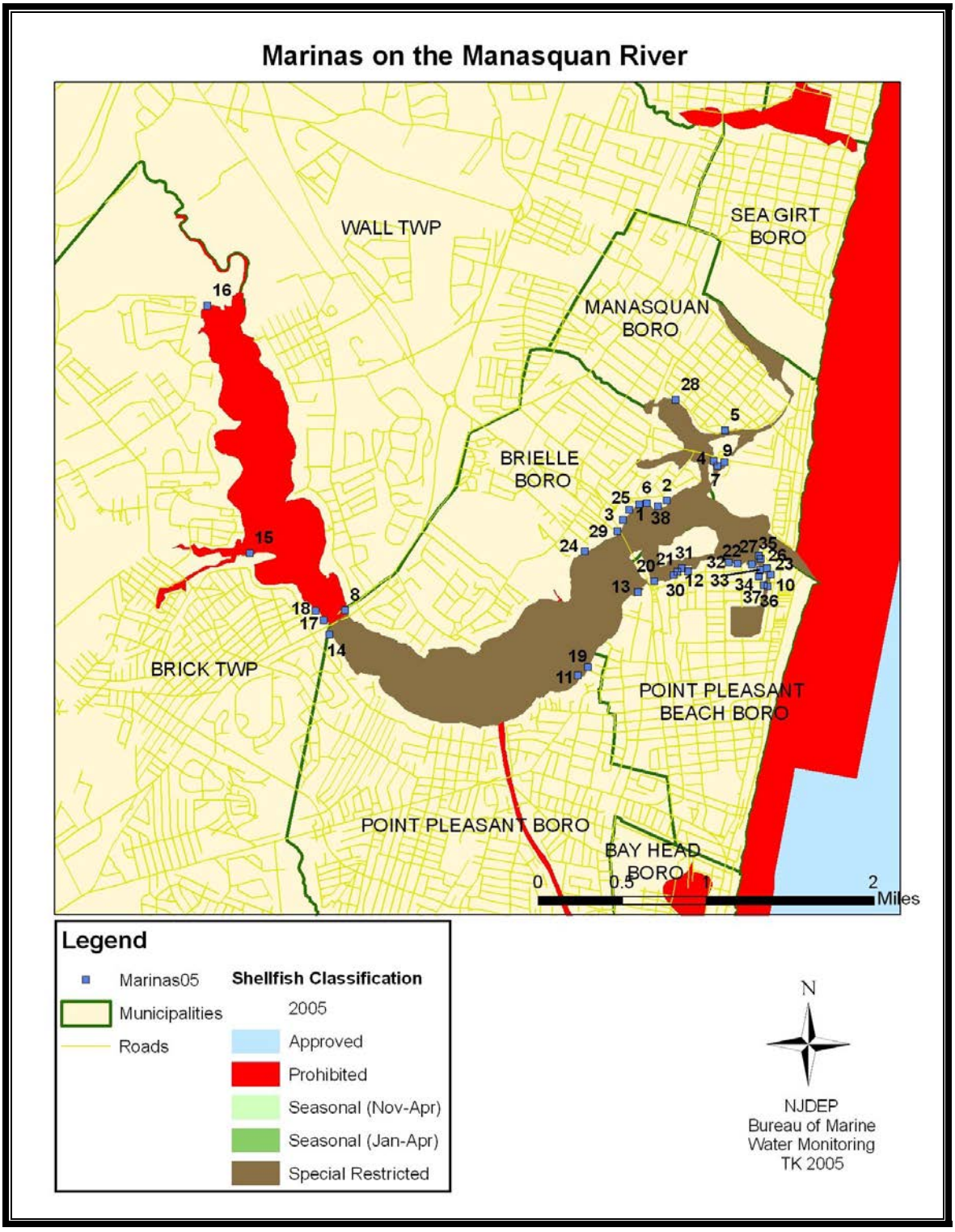


TABLE 4: MARINA FACILITIES LOCATED IN THE MANASQUAN RIVER

Map Key	Marina Name	# of Slips	Size of Buffer Area (acreage)
1	Union Landing Rest. & Marina	50	49
2	Brielle Anchorage	16	18
3	Ship Wreck Marina	19	21
4	Drawbridge Marina	37	42
5	Manasquan Municipal Marina	125	86
6	Brielle Marine Basin	75	84
7	Strictly Marina	35	18
8	McCarthys Marine	125	234
9	Robinsons Anchorage	10	14
10	Kens Landing	20	22
11	Clarks Landing	188	352
12	Southside Marina	47	53
13	Garden State Marina	70	131
14	Crystal Point Yacht Club	185	346
15	Manasquan River Club Marina	200	374
16	Cove Haven Marina	150	142
17	Marina Grille	40	75
18	Marine Max Mid-Atlantic	220	412
19	NE5_Private Property1	8	15
20	Kingsbridge Marina	80	150
21	Canyon River Club Marina	10	3
22	Jack Bakers Lobster Shanty	10	11
23	The Shrimp Box	5	6
24	Manasquan River Yacht Club	31	30

Map Key	Marina Name	# of Slips	Size of Buffer Area (acreage)
25	Brielle Yacht Club aka Dockmaster	116	130
26	Coast Guard	10	11
27	Fishermens Dock Cooperative	9	17
28	Perrine Blvd Marina	16	7
29	Bogans Deep Sea Fishing Center	5	3
30	Queen Mary Charter Boats	5	10
31	Sea Devil Charter Boat	10	11
32	Point Lobster	10	11
33	Co-Op Seafood	10	11
34	Broadway Basin	8	9
35	Inlet Dock	7	8
36	Sea Birdy	12	0
37	Sail Cove Marina Condo	12	0
38	Hoffman's Anchorage	50	49

SPILLS OR OTHER UNPERMITTED DISCHARGES

Spills reported to the DEP hotline (1-877-WARN-DEP) 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 spills requiring the closure of shellfish waters in the Manasquan River during the October 1, 1994 to September 30, 2005 time period.

HYDROGRAPHY AND METEOROLOGY

PATTERNS OF PRECIPITATION

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

Between 1994 and 2005 there were 18 sampling dates that had more than 0.1 inch of rain (including sampling day and up to 2 days prior), nine during the summer season and nine during the winter season. The winter season, typically, has lower total coliform values than the summer season. This may be because the summer season generally has higher coliform levels to begin with, or they may be a result of the summer runoff from the rain. The first areas to see higher values after rainfall appear to be north of the Route 70 bridge and the area of Glimmer Glass and Stockton Lake. However, these are areas that do have slightly higher coliform values to begin with, so it is unclear how much impact is only due to rainfall.

There have been no significant changes in hydrography since the last reappraisal in 2000 (see Table 5). 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.

The Manasquan River has a semi-diurnal tidal exchange with the Atlantic Ocean via the inlet. The tidal range of the ocean water near the Manasquan Inlet is four feet; this tidal range gradually decreases over the course of the river. The tidal influence within the Manasquan River extends beyond the shellfish waters to the area of the Garden State Parkway (MWMG, 1999).

TABLE 5: CLIMATOLOGICAL DATA

Rainfall Recorded at NOAA's Toms River, 8816, Station
*Secondary Station, Newark (6026), was used when data was unavailable at Primary Station

Sampling Date	Precipitation in Inches			Average Temperature (°F)
	Day of Sampling	1 day prior	2 days prior	
10/14/1994	0	0	0	60*
10/17/1994	0	0	0	59*
10/27/1994	0	0	0.005	54*
12/9/1994	0	0.005	0.01	37
3/6/1995	0.02	0.025	0.03	47*
4/17/1995	0	0	0.005	51*
8/2/1995	0	0	0	87*
9/11/1995	0	0	0	65
3/23/1998	0	0.03	0.37	48*
9/8/1998	0.5	0.5	0.5	67*
10/29/1999	0	0	0	53
11/12/1999	0	0	0	43
7/5/2000	0	1.1	1.1	76
3/28/2001	0	0	0	32
4/4/2001	0	0	0	46*
7/3/2001	0	0.45	0.45	62
10/30/2001	0	0	0	45
12/18/2003	0.25	0.67	0.67	44
2/27/2004	0	0	0.005	32
3/11/2004	0	0	0.25	38
8/17/2004	0.68	0.83	2.46	67
8/25/2004	0	0	0.005	69
9/9/2004	0.05	0.12	0.16	77
9/15/2004	0	0	0	70
10/25/2004	0.005	0.005	0.005	47
1/11/2005	0.56	0.56	0.565	37
2/22/2005	0.005	0.085	0.485	39
2/28/2005	0.95	0.95	0.95	32
3/14/2005	0	0.005	0.155	37
3/29/2005	0.005	1.255	1.565	46
4/11/2005	0	0.005	0.255	49
4/21/2005	0	0	0	71
5/9/2005	0	0.005	0.405	55
6/8/2005	0	0.27	0.275	78
7/11/2005	0	0.005	1.805	75
7/20/2005	0.005	0.145	0.285	83

WATER QUALITY STUDIES

BACTERIOLOGICAL QUALITY

The data for this report was collected from 44 stations in the Manasquan River. A total of 1,369 surface water samples were analyzed from this growing area for total coliform during the period of October 1, 1994 through September 30, 2005 (see Table 6).

East of the Route 70 bridge is classified as *Special Restricted* and west of the bridge is classified as *Prohibited*. The Point Pleasant canal is also classified as *Prohibited*. Any sampling stations located in *Prohibited*, *Special Restricted* or *Seasonal* waters have the potential for an upgrade in classification based on improved total coliform bacteriological water quality. Any waters classified as *Approved, Seasonal*, or *Special Restricted* can be downgraded if the coliform levels exceed criteria.

This report drew data from October 1, 1994 to September 30, 2005. 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. Excluding those stations in *Prohibited* waters, the sample size must be at least 30 according to the Systematic Random Sampling strategy (NSSP, 2001 Revision). Stations in *Prohibited* waters do not need to be sampled according to NSSP regulations; however, our Bureau makes an effort to retrieve these stations anyway. Total coliform tests were run on all samples.

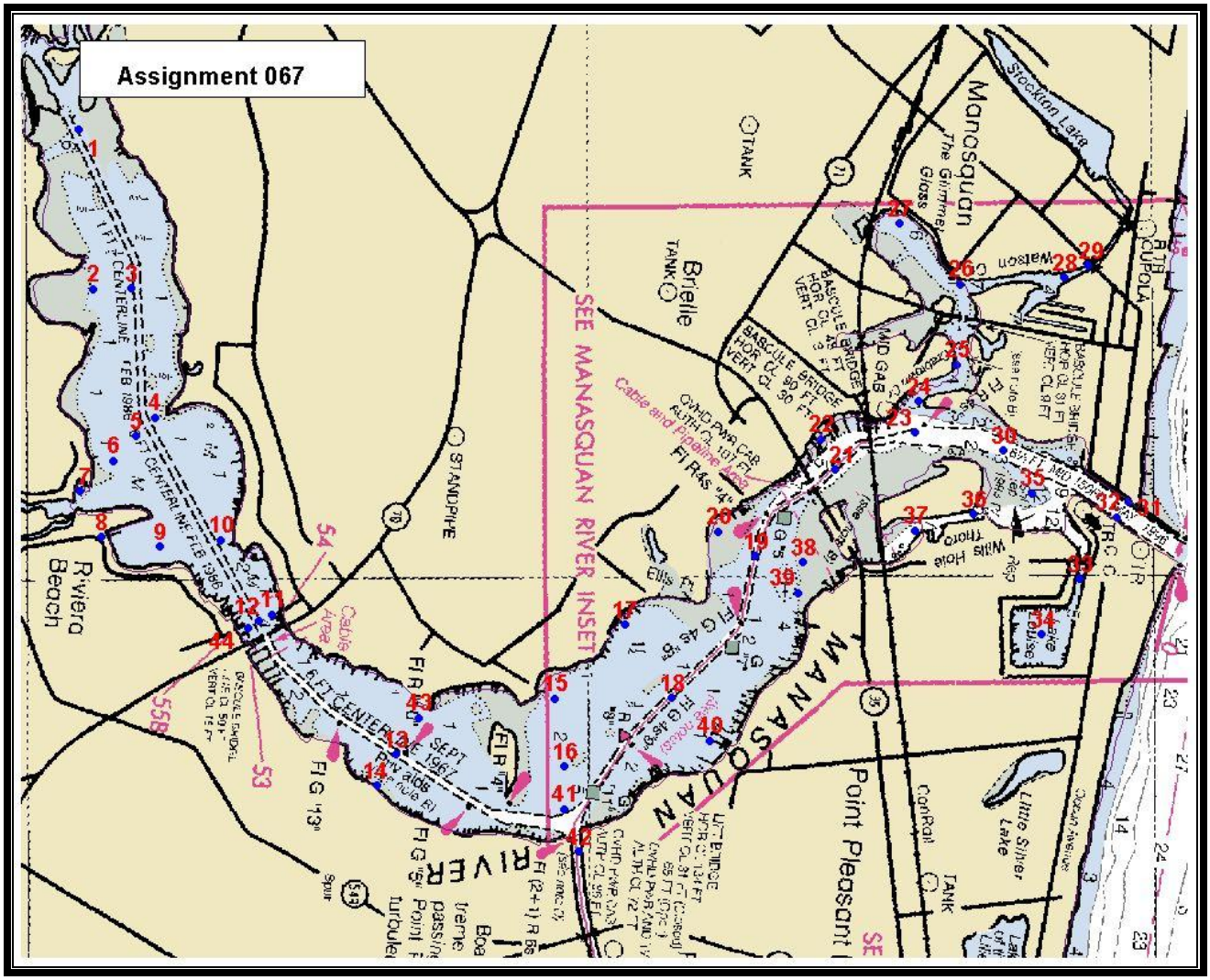
One assignment run is required for this growing area; all 44 stations are sampled during this assignment run (see Figure 21). This particular assignment run is done 10 times during a year. These assignment runs provided sufficient samples for evaluation.

TABLE 6: WATER QUALITY SUMMARY: SRS STATIONS (10/01/1994 – 9/30/2005)

Station	Status	Year Round			Summer			Winter		
		Geo.Mean	Est. 90th	N	Geo.Mean	Est. 90th	N	Geo.Mean	Est. 90th	N
1300	SR	10.6	113.2	35	9.6	71.7	19	11.9	195.3	16
1300A	SR	10.8	100.9	33	11.1	82.8	17	10.5	130.1	16
1301	SR	12.6	98.9	33	16.8	133.7	17	9.2	71.1	16
1301A	SR	42.5	440.6	35	77.3	624.4	19	20.9	219.7	16
1301B	SR	79.9	788.9	34	158.6	1213.6	18	36.9	336.3	16
1301C	SR	84.6	747.6	31	212.8	1330.2	16	31.6	193.6	15
1302	SR	48.3	578.4	34	73.0	869.9	17	32.0	386.6	17
1302A	SR	33.6	237.2	35	49.1	324.9	19	21.4	147.4	16
1302B	SR	28.7	196.1	35	33.2	182.3	19	24.2	215.6	16
1303	SR	47.4	571.4	33	130.5	921.2	17	16.1	158.6	16
1303A	SR	83.6	1186.3	34	146.8	1245.4	18	44.4	887.0	16
1303B	SR	64.1	608.9	32	111.4	572.9	16	36.9	493.0	16
1303C	SR	57.8	649.1	34	120.9	779.4	18	25.2	332.5	16
1303D	SR	65.2	890.6	32	169.3	1335.2	16	25.1	332.7	16
1304	SR	26.1	363.3	33	57.8	903.9	17	11.2	89.2	16
1304A	SR	11.5	99.4	35	19.1	172.3	19	6.3	41.6	16
1305	SR	11.1	95.7	33	10.4	44.2	17	11.8	189.0	16
1305A	SR	11.8	79.5	35	14.9	105.4	19	9.0	56.8	16
1306	SR	18.3	164.4	35	26.8	161.7	19	11.6	145.6	16
1306A	SR	12.1	86.5	36	11.4	69.8	19	12.9	114.5	17
1306B	SR	24.1	164.8	34	44.5	253.7	19	11.1	61.4	15
1307	SR	25.0	178.0	36	36.2	189.4	19	16.5	147.2	17
1307A	SR	20.8	160.6	35	29.5	203.3	19	13.7	113.0	16
1307B	SR	24.4	169.1	35	34.8	237.4	19	15.9	103.7	16
1308	SR	38.6	379.3	36	47.1	202.8	19	30.8	605.5	17
1308A	SR	32.9	316.9	33	62.8	390.4	17	16.6	183.5	16

1308B	SR	23.2	193.1	35	29.9	245.5	19	17.3	145.7	16
1308C	P	33.4	320.9	35	52.4	413.5	19	19.5	206.8	16
1309	SR	42.0	360.1	35	59.7	255.6	19	27.7	417.4	16
1309A	SR	58.6	729.6	35	88.6	481.2	19	35.8	874.3	16
1309B	SR	44.4	620.8	33	80.7	797.1	17	23.6	390.3	16
1310	P	103.4	1304.7	23	146.7	1191.9	11	75.1	1380.4	12
1310A	P	88.7	1703.9	25	117.3	1533.2	13	65.6	1956.7	12
1310B	P	71.6	931.2	24	82.8	797.4	13	60.2	1187.3	11
1311	P	133.4	2389.3	25	153.9	2397.5	13	114.2	2638.7	12
1311A	P	166.1	2202.1	23	226.4	1618.1	11	125.1	2745.9	12
1311B	P	193.0	2240.7	23	276.7	2743.6	11	138.7	1893.5	12
1312	P	192.4	2027.6	23	344.8	3056.3	11	112.7	1225.7	12
1312A	P	154.5	1279.8	25	214.1	1352.5	13	108.4	1160.5	12
1312B	P	228.3	2435.4	23	420.5	3275.4	11	130.4	1574.4	12
1312C	P	225.9	1862.3	23	362.5	2257.0	11	146.5	1418.7	12
1313A	P	258.8	3051.6	25	416.9	3081.7	13	154.4	2612.2	12
1313B	P	271.8	3782.3	23	586.9	2627.3	11	134.3	3152.7	12
1314A	P	320.3	3883.6	25	615.1	3967.7	13	158.0	2709.2	12

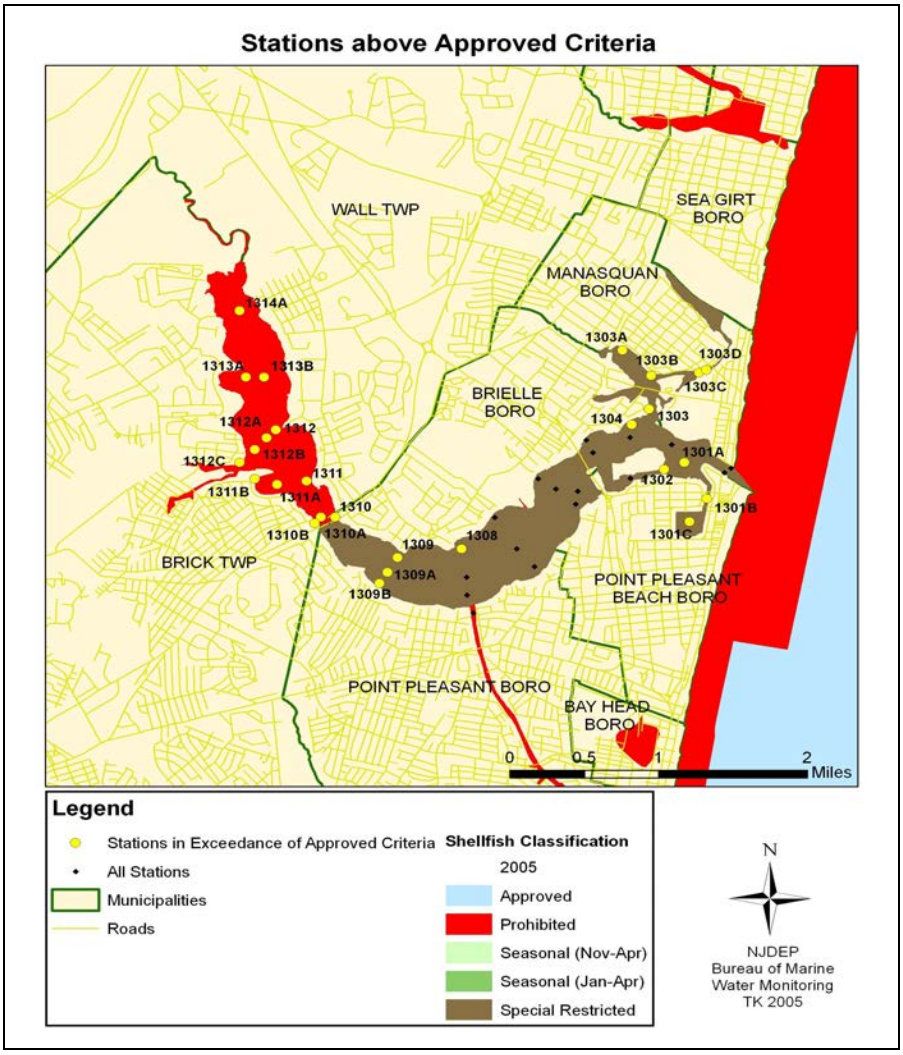
FIGURE 21: SAMPLING STATIONS IN THE MANASQUAN RIVER



COMPLIANCE WITH NSSP *APPROVED* CRITERIA

Each sampling station must comply with their respective criteria in the National Shellfish Sanitation Program (NSSP) Model Ordinance (2001 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 fecal coliform Est. 90th Percentile must be below 300 MPN/100ml. Twenty-seven stations exceeded the *Approved* criteria (see Figure 22 and Table 6); however, there are no *Approved* waters in the Manasquan River. Therefore, no changes in classification are recommended as a result of the NSSP *Approved* criteria.

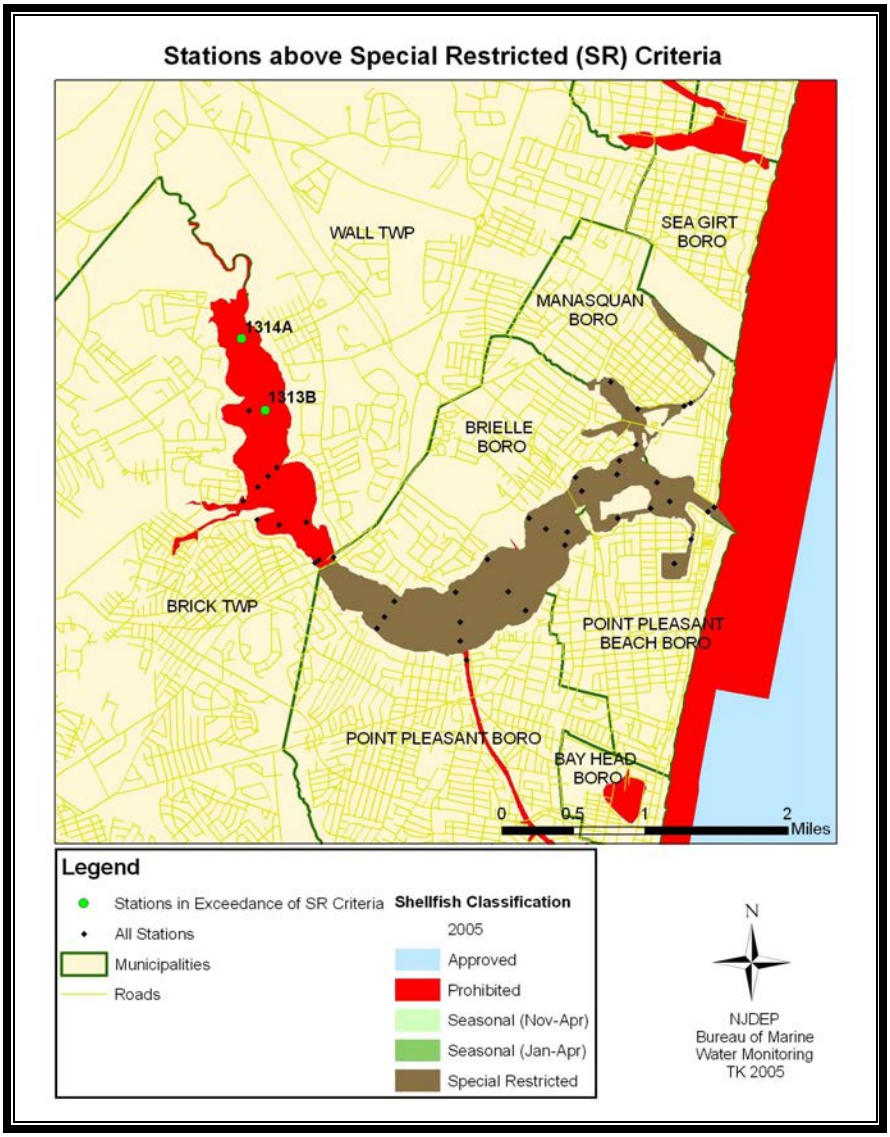
FIGURE 22: STATIONS IN EXCEEDANCE OF SRS *APPROVED* CRITERIA



COMPLIANCE WITH NSSP *SPECIAL RESTRICTED* CRITERIA

Two stations, 1313B & 1314A, exceeded the NSSP total coliform criteria for *Special Restricted* waters. For waters to be classified as *Special Restricted,* the total coliform geometric mean must be below 700 MPN/100ml and the Est. 90th Percentile must be below 3,300 MPN/100ml. These two stations are both located in *Prohibited* waters so no downgrade is needed based on the Special Restricted criteria (see Figure 23). However, the many of the remaining stations do not have low enough total coliform values to be considered for an upgrade at this time (see Table 6). Therefore, no changes in classification are recommended.

FIGURE 23: STATIONS EXCEEDING THE SRS *SPECIAL RESTRICTED* CRITERIA



COMPLIANCE WITH NSSP *APPROVED* CRITERIA DURING SEASONS

All Data (Summer and Winter)

The year-round data is 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.

Winter Data (November – April)

Twenty-three stations in the Manasquan River growing area exceeded the *Approved* total coliform criteria during the winter months (see Figure 24 for wintertime conditions). However, none of the sampling stations exceeded the *Special Restricted* criteria, so there is no discrepancy in classification since there are no *Approved* waters in the Manasquan River.

FIGURE 24: WINTERTIME ON THE MANASQUAN RIVER

Summer Data (May – October)

Twenty-six stations exceeded the *Approved* total coliform criteria during the summer season, but again, there are no *Approved* waters in the Manasquan (see Figure 25 for summertime conditions). One of these stations, 1314A, also exceeded the *Special Restricted* criteria; but this station is located in *Prohibited* waters. These results show that the total coliform levels are high during the summer months. This can be attributed to a number of factors, including runoff, septic/sewage problems, high temperature, and boat usage. While many of these factors also exist in the winter months, they tend to be more influential during the summer months.

FIGURE 25: SUMMERTIME ON THE MANASQUAN RIVER

TIDAL EFFECTS

Ocean water enters the river through the Manasquan Inlet, which creates a semi-diurnal exchange. Tidal exchange is a mechanism that mixes the impaired water with higher quality water. There is a decent amount of mixing and dilution occurring around the inlet which

helps to improve the water quality of some impaired regions. Further inland there is little tidal exchange, which is a leading cause for the impaired water quality of the Manasquan.

The tidal range of the Manasquan is about 4 feet; this leaves portions of the river very little depth at low tide. There is also low clarity, especially in the upstream waters. The bottom is often not visible when there is only three feet of water.

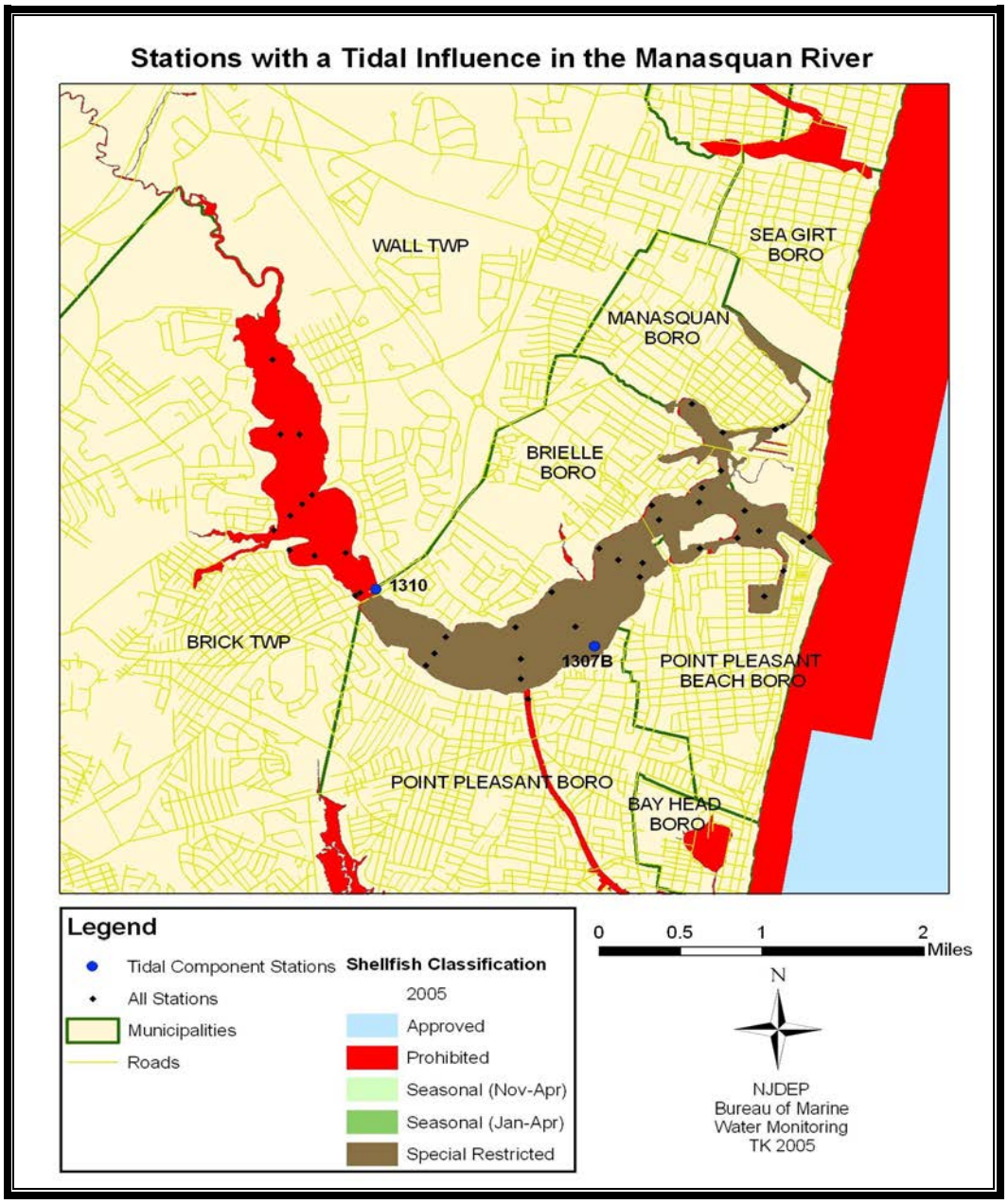
Two stations, 1307B & 1310, have a tidal component since their T-statistic probability is less than or equal to 0.050 (See Table 7). The geometric mean was higher during ebb than during flood for station 1310, which is located in *Prohibited* waters. Station 1307B is located in *Special Restricted* waters and has a higher geometric during flood tide (see Figure 26).

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

TABLE 7: TIDAL EFFECTS

Station	Status	t-Statistic Probability	Ebb Geo Mean	Ebb Sample Size	Flood Geo Mean	Flood Sample Size	Year-Round Geo Mean	Year-Round Est. 90th
1307B	SR	0.029	15.1	*20*	46.1	*15*	24.4	169.1
1310	P	0.040	230.0	*12*	43.2	*11*	103.4	1304.7

FIGURE 26: SAMPLING STATIONS AFFECTED BY TIDE IN THE MANASQUAN RIVER



SEASONAL EFFECTS

A seasonal component was observed at ten stations (see Figure 27). The T-statistic probability must be less than or equal to 0.050 for a station to have a seasonal component (see Table 8). All of the stations are within the *Special Restricted* waters of the Manasquan River.

All of the stations have higher geometric mean values in the summer than in the winter. High summer values are typical, often because of recreational uses contributing to coliform levels.

No changes in classification are needed as a result of the seasonal components at these stations.

It is important to understand the factors that contribute to high total coliform levels and which season these factors impact. Temperature is one such factor; bacteria's optimum temperature for growth occurs during the summer months. There are also many factors stemming from human populations. Boat use is a major factor in this area considering that more than 2,500 boats are harbored within the estuary and most recreational boating occurs during the summer. Runoff from agricultural and urban areas is perhaps the most influential factor on the coliform levels in this growing area. Runoff occurs year round, however, things like pesticides and bug sprays are used more heavily in the summer season.

This area also sees a population surge in the summer, which increases sewage use, as well as other utilities. Therefore, it is very probable that the stations with a seasonal component are affected by non-point source pollution from increased summer population and/or increased use of water related activities (boating, etc.) during the summer. Overall, there are more factors that increase the levels of coliform during the summer than during the winter season.

Presently, all stations that were impacted by season remain in compliance with their respective classification criteria.

FIGURE 27: SAMPLING STATIONS AFFECTED BY SEASON

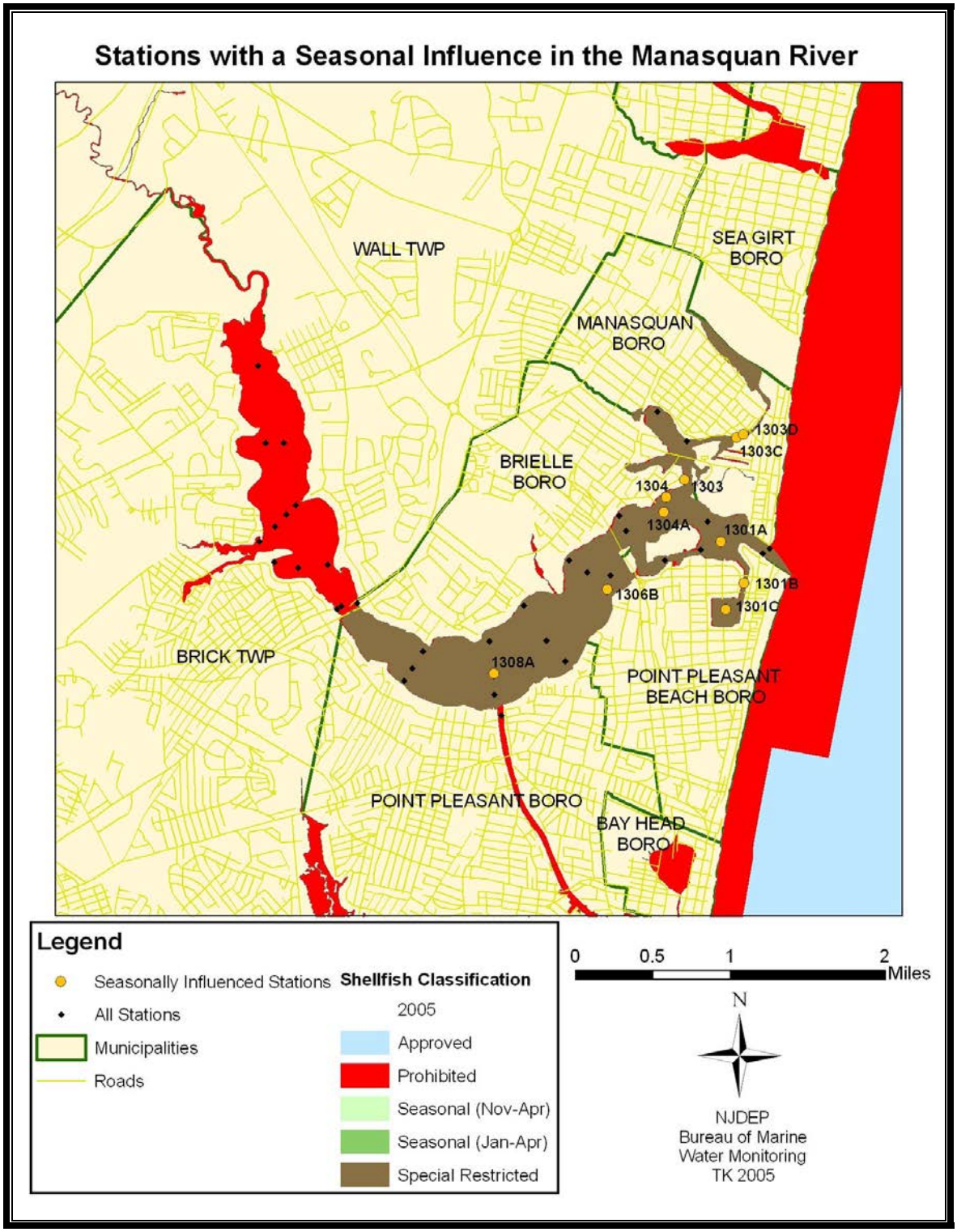


TABLE 8: SEASONAL EFFECTS

Station	Status	t-Statistic Probability	Summer Geo Mean	Summer Sample Size	Winter Geo Mean	Winter Sample Size	Year Round Geo Mean	Year-Round Est. 90th
1301A	**SR**	**0.033**	77.3	*19*	20.9	*16*	42.5	440.6
1301B	**SR**	**0.015**	158.6	*18*	36.9	*16*	79.9	788.9
1301C	**SR**	**0.001**	212.8	*16*	31.6	*15*	84.6	747.6
1303	**SR**	**0.001**	130.5	*17*	16.1	*16*	47.4	571.4
1303C	**SR**	**0.013**	120.9	*18*	25.2	*16*	57.8	649.1
1303D	**SR**	**0.006**	169.3	*16*	25.1	*16*	65.2	890.6
1304	**SR**	**0.019**	57.8	*17*	11.2	*16*	26.1	363.3
1304A	**SR**	**0.050**	19.1	*19*	6.3	*16*	11.5	99.4
1306B	**SR**	**0.006**	44.5	*19*	11.1	*15*	24.1	164.8
1308A	**SR**	**0.028**	62.8	*17*	16.6	*16*	32.9	316.9

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 wastes that enter the stormwater collection system.

The Bureau of Marine Water Monitoring has begun to identify particular storm water outfalls that discharge excessive bacteriological loads during storm events. In some cases, specific discharge points can be identified. When specific outfalls are identified as significant sources, the Department works with the county and municipality to further refine the source(s) of the contamination and implement remediation activities.

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 can not be done.
- Data collected after rainfall in the normal sampling regime may miss the effects of the 'first flush'.

- Rainfall data is based on the closest established NOAA station. Since rainfall patterns along the coastline, particularly during the summer months, tend to include locally heavy rainfall, the rainfall amounts recorded at the NOAA station may not accurately reflect the rainfall at the sampling station(s).

Historically, rainfall issues have existed in the Manasquan River. However, this current data set appears to have a high percentage of dry days, which may interfere with the test for a significant rainfall effect.

First, the wet/dry relationship within the Manasquan River was determined. Once it was revealed that 0.1 inches of rain triggers the most t-statistic probabilities (below 0.050), the data were then analyzed at 0 hours, 24 hours, and 48 hours (see Figures 28-30). The Manasquan River seems to be most impacted by 0.1 inches of rain or more over 24 hours. It is particularly evident that rainfall triggers high levels in total coliform, especially in the western portion of the river. It is recommended that a stormwater impact study be performed to identify the predominant pollutant sources as soon as resources permit.

The Monmouth County Health Department prepared a report entitled "The Manasquan River Watershed: A Trend Analysis focusing on impacts to water quality", which states that the water quality in the Manasquan River has generally improved over the years. "However, river water quality continues to be impacted by commercial, residential, and agricultural activities, especially when it rains" (MWMG, 1999).

FIGURE 28: RAINFALL IMPACT IMMEDIATELY AFTER 0.1 INCH OF RAIN

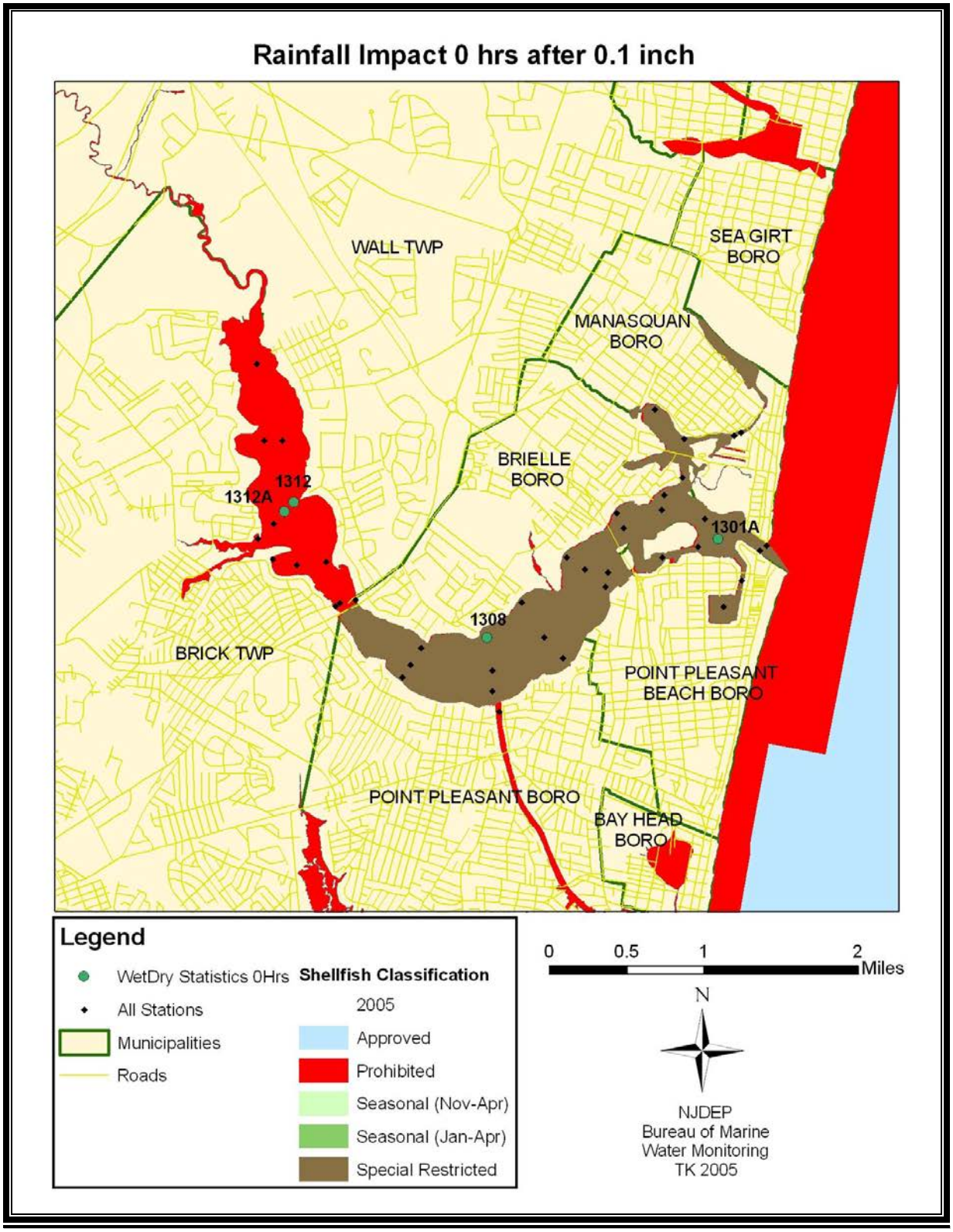


FIGURE 29: RAINFALL IMPACT 24 HOURS AFTER 0.1 INCH OF RAIN

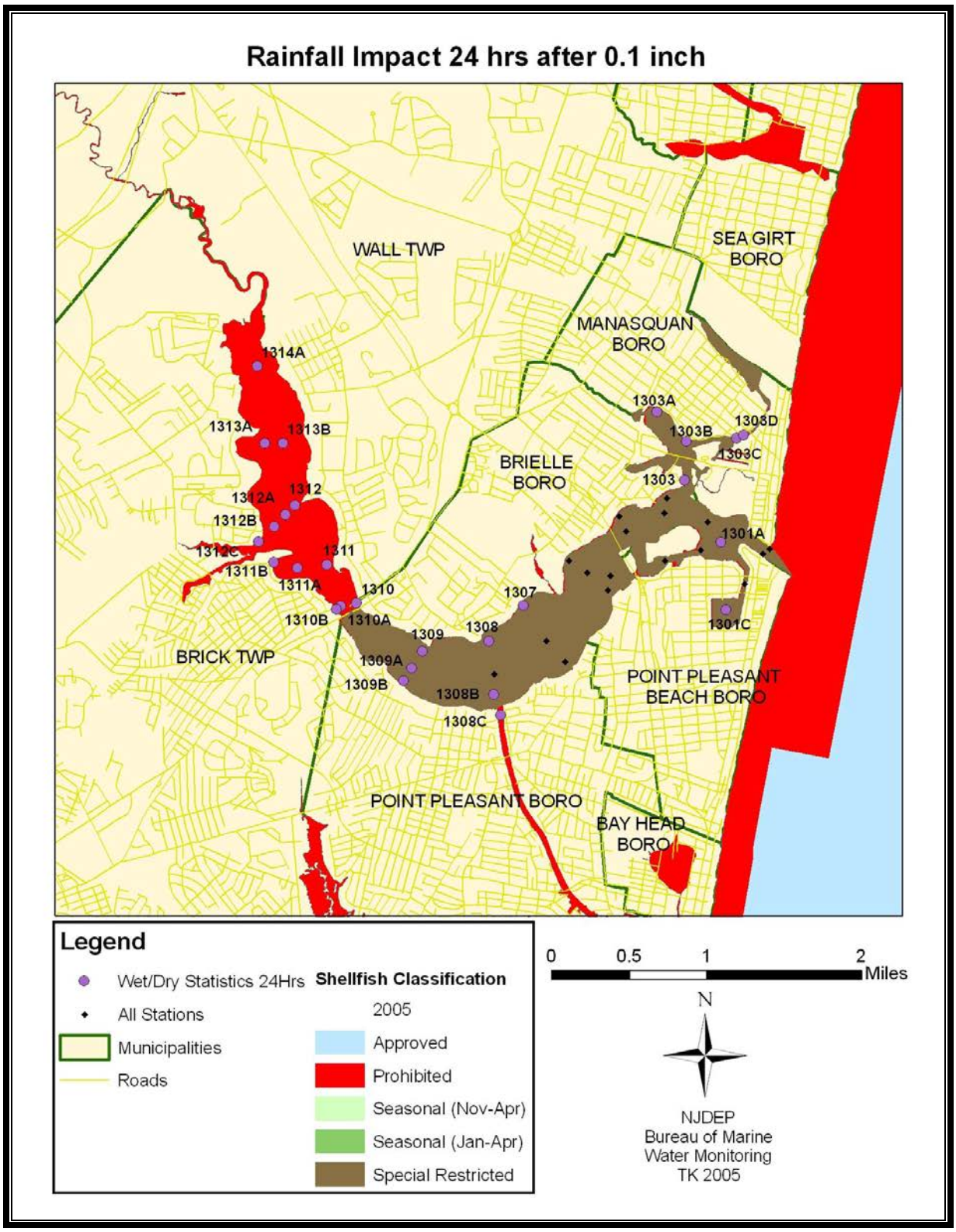
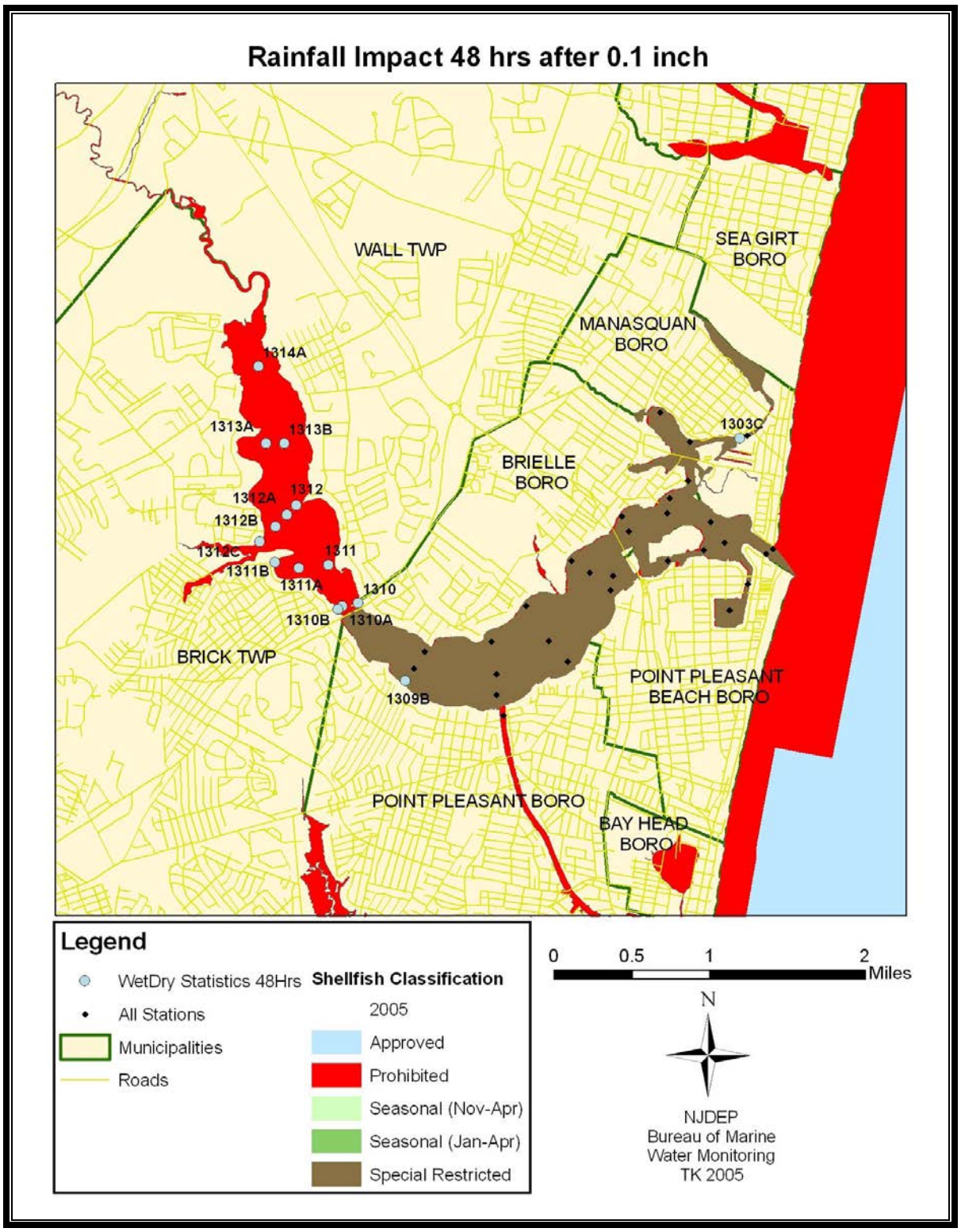


FIGURE 30: RAINFALL IMPACT 48 HOURS AFTER 0.1 INCH OF RAIN



RELATED STUDIES

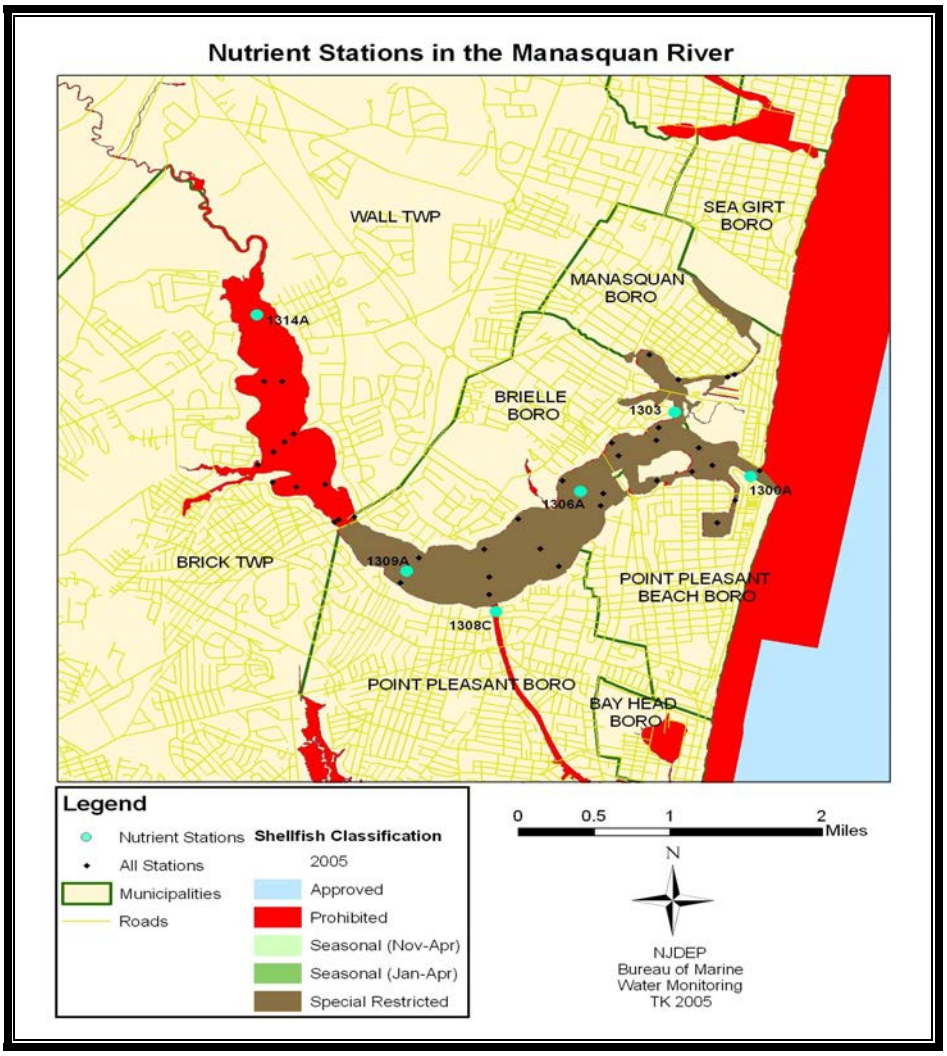
The Bureau of Marine Water Monitoring assesses coliform levels, but there are many other tests that can be run on the retrieved water samples. In addition to testing for total coliform, all samples retrieved prior to June 2003 were also tested for fecal coliform (the Manasquan River is currently being tested for total and fecal coliform, although only total coliform is used in the analysis). Other capabilities include testing New Jersey waters for levels of phytoplankton, toxins (in Atlantic and Cape May Counties), and nutrients.

NUTRIENTS

There are six stations in this shellfish growing area that are sampled under the estuarine monitoring program for chemical parameters including nutrients. These six stations are 1300A, 1303, 1306A, 1308C, 1309A, and 1314A (see Figure 32). Water quality at these stations is consistent with the water results found throughout the State.

More detailed information concerning dissolved oxygen and nutrient levels (i.e salinity, ammonia, etc.) can be found in the Estuarine Monitoring Report published by the NJDEP. These reports are available from the Bureau of Marine Water Monitoring at www.state.nj.us/dep/wms/bmw.

FIGURE 31: SAMPLING SITES WHERE ADDITIONAL DATA HAS BEEN COLLECTED FOR NUTRIENTS



INTERPETATION AND DISCUSSION OF DATA

BACTERIOLOGICAL

Bacteriological Evaluation

The water quality data obtained from the sampling period of October 1, 1994 through September 30, 2005 are listed in Appendix E. 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.

There were two stations with a tidal component and ten with a seasonal component, but on analysis it was found

that all stations impacted by season and/or tide remain in compliance with their respective classification criteria. There is a spike in coliform levels after 24 hours when it rains at least 0.1 inch of rain.

CONCLUSIONS

BACTERIOLOGICAL EVALUATION

Twenty-seven of the 44 stations exceeded the **year round** *Approved* total criteria. This is not an issue since there are no *Approved* waters in the Manasquan River. Twenty-three stations in the Manasquan River growing area did not meet the total coliform *Approved* criteria during the **winter** months. Twenty-six of the 44 stations did not meet the *Approved* criteria during the **summer** months. However, all of these stations are within *Special Restricted* or *Prohibited* waters, so there are no discrepancies with the current classification based on the *Approved* criteria.

Two stations exceeded the *Special Restricted* total coliform criteria, but these stations are within *Prohibited* waters. All of the sampling stations met the total coliform *Special Restricted* criteria during the **winter** months. One station, 1314A, exceeded the *Special Restricted* criteria during the **summer** months, however, station 1314A is within *Prohibited* waters. Since many stations still exceed the Approved criteria, upgrades are not being considered at this time.

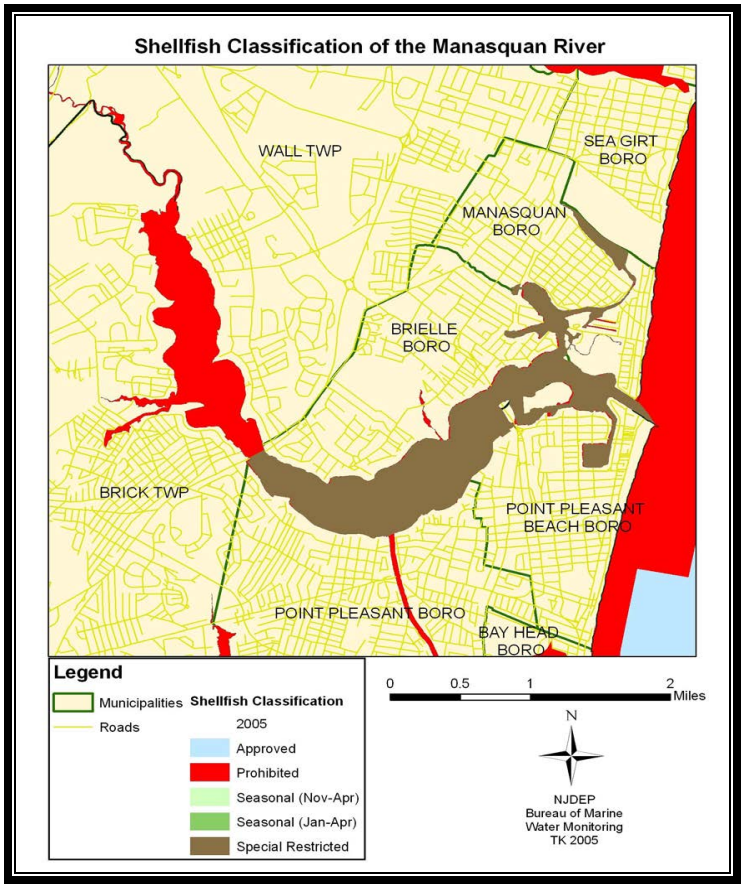
RECOMMENDATIONS

BACTERIOLOGICAL EVALUATION

RECOMMENDED CLASSIFICATION CHANGES

There are currently no changes in classification recommended for the Manasquan River (see Figure 34). All stations fit within their respective classification criteria.

FIGURE 32: CURRENT SHELLFISH CLASSIFICATION IN THE MANASQUAN RIVER



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 44 stations and ten runs are done per year.

RECOMMENDATIONS FOR FURTHER STUDY

There are currently no special studies planned for the Manasquan River. High priority projects are currently in the works across the state, but a stormwater study in the western portion of the Manasquan River might be carried out in the next three years. As seen in the rainfall evaluation, the western portion of the river is heavily impacted with as little as 0.1 inch of rain, especially in the area of Bass Point Rd in Wall Township.

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APPENDICES

A. Statistical Summary

B. Tidal Evaluation

C. Seasonal Evaluation

D. Precipitation

Rainfall Correlation

Cumulative Rainfall

Wet Weather Statistical Summary (0 hour, 24 hours, and 48 hours at 0.1 inch)

E. Data Listing – October 1, 1994 through September 30, 2005

Ambient Monitoring Program

Manasquan River – NE5

Sanitary Survey

February 2007

State of New Jersey
Jon Corzine, Governor

Department of Environmental Protection
Lisa Jackson, Commissioner