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Water Monitoring & Standards
Land Use Management
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REAPPRAISAL

Shrewsbury River (NE 3)

October 1, 1998 – September 30, 2003

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REAPPRAISAL

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New Jersey Department of Environmental Protection
BRADLEY M. CAMPBELL
COMMISSIONER

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EXECUTIVE SUMMARY

Water samples from the Shrewsbury River were collected (using the Systematic Random Sampling strategy) and analyzed from 43 sampling stations for total coliform during the period of October 1, 1998 through September 30, 2003 for this Reappraisal Report. All sampling stations comply with their respective criteria for *Seasonal* or *Special Restricted* classification. The results of this data evaluation prove to be consistent with the existing shellfish growing water classifications. No changes in classification are recommended for this area. The monitoring schedule will remain the same, except that stations 1137B, 1138, and 1140A will be reactivated for the 2006 sampling season in Branchport / Troutman's creek in order to reevaluate their current classifications. There are no direct discharges into the Shrewsbury River, although there are numerous storm water outfalls and some other indirect discharges.

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.

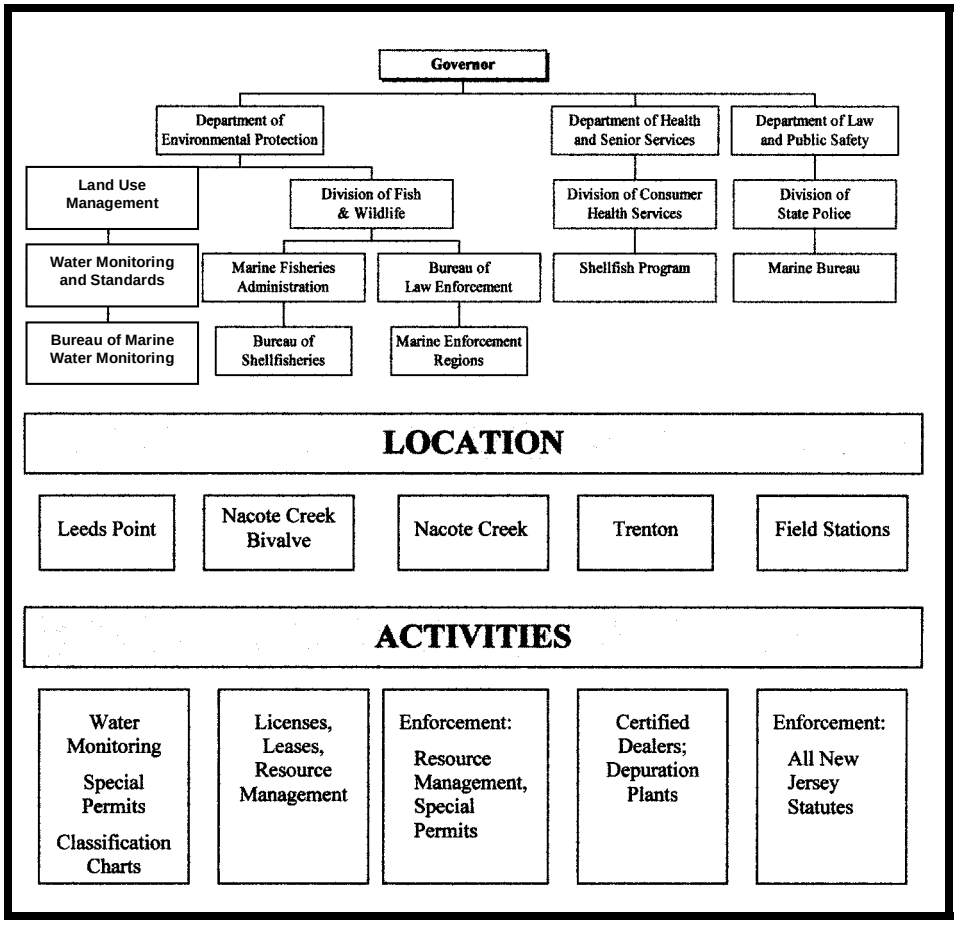
The Bureau of Shellfisheries, in the Division of Fish and Wildlife, issues harvesting licenses and leases for shellfish grounds under the Authority of N.J.S.A. 50:2 and N.J.A.C. 7:25. This bureau, in conjunction with the BMWM, administers the Hard Clam Relay Program.

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 1: 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 reappraisal of the Shrewsbury 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 three year reappraisal. Additionally, a partial shoreline survey was completed.

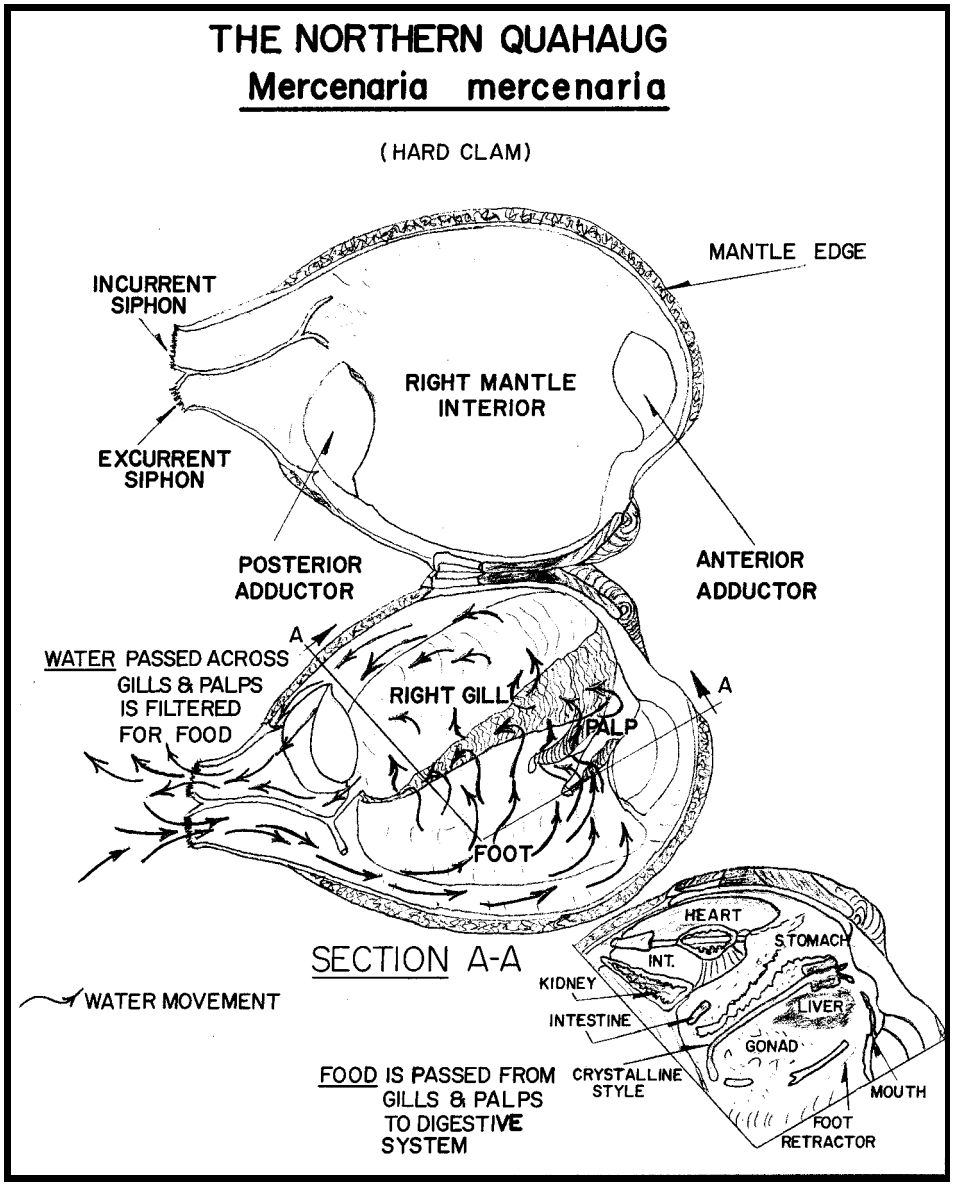


FIGURE 2: MERCENARIA MERCENARIA

PROFILE OF THE GROWING AREA

LOCATION OF THE GROWING AREA

The Shrewsbury River is located in northern Monmouth County. Tidal waters enter the Navesink River via Sandy Hook Bay. A narrow channel then connects these water bodies to the Shrewsbury River (see Figure 4). The Navesink River is part of the Shrewsbury River Basin, but for the purpose of this report, it is examined as a separate growing area. There are numerous small creeks off of the Shrewsbury River including Little Silver Creek, Parkers Creek, Oceanport Creek, and Branchport Creek, although these creeks are not significant freshwater sources (see Figure 3 for Branchport Creek).

Seven municipalities surround the Shrewsbury River; they are Rumson Borough, Little Silver Borough, Shrewsbury Borough, Oceanport Borough, Long Branch City, Monmouth Beach Borough, and Sea Bright Borough (see Figure 5). In total, the Shrewsbury River drains an area of 27 square miles.

This area is displayed on chart # 2 of the current State of New Jersey Shellfish Growing Water Classification Chart. The population statistics for the adjacent municipalities are shown in Table 1 (Census 2000).

FIGURE 3 : VIEW UP BRANCHPORT CREEK (PICTURE TAKEN ON 3-23-04)

FIGURE 4: OVERHEAD VIEW INCLUDING THE SHREWSBURY RIVER

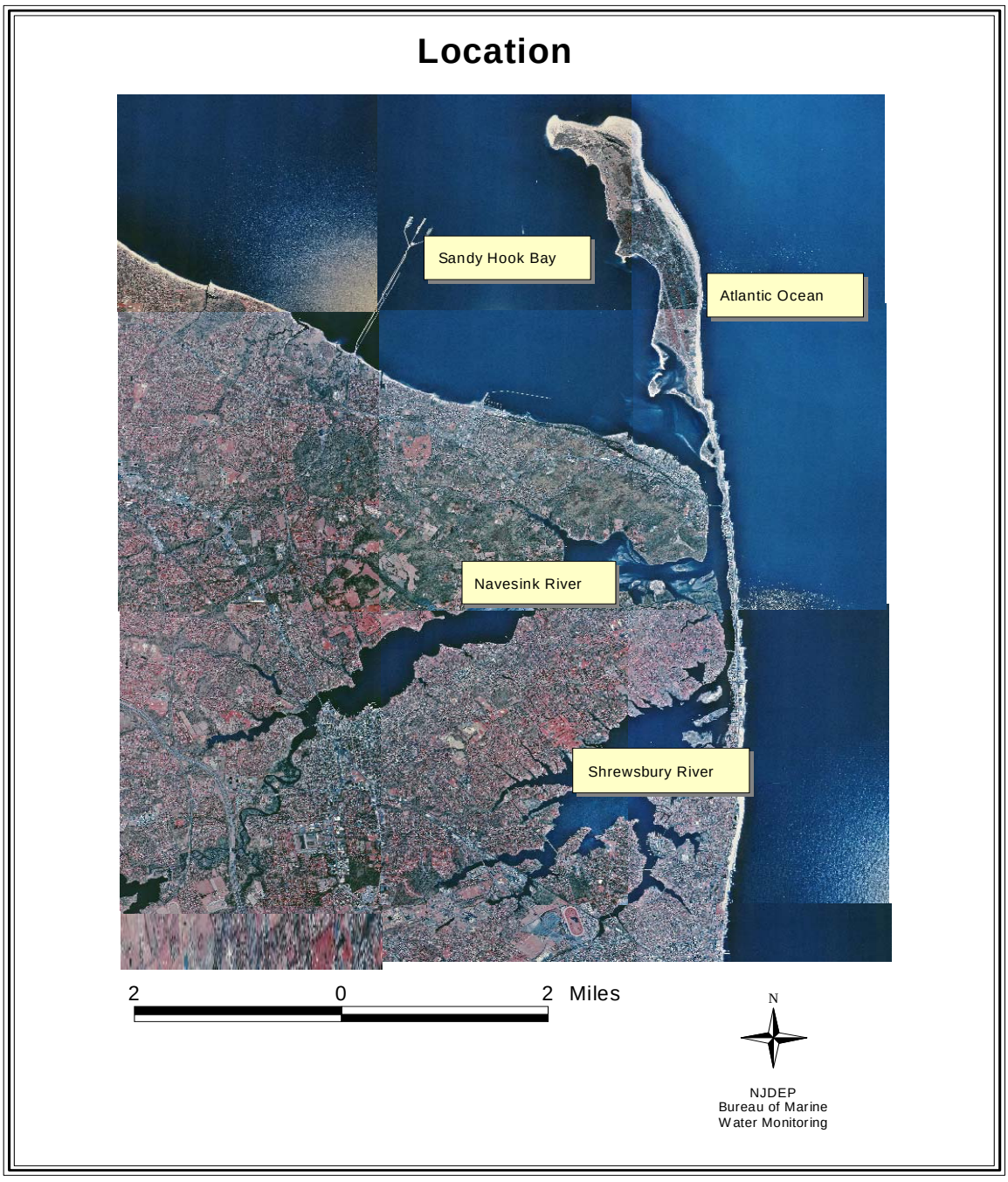


FIGURE 5: LOCATION AND MUNICIPALITIES OF THE SHREWSBURY RIVER GROWING AREA

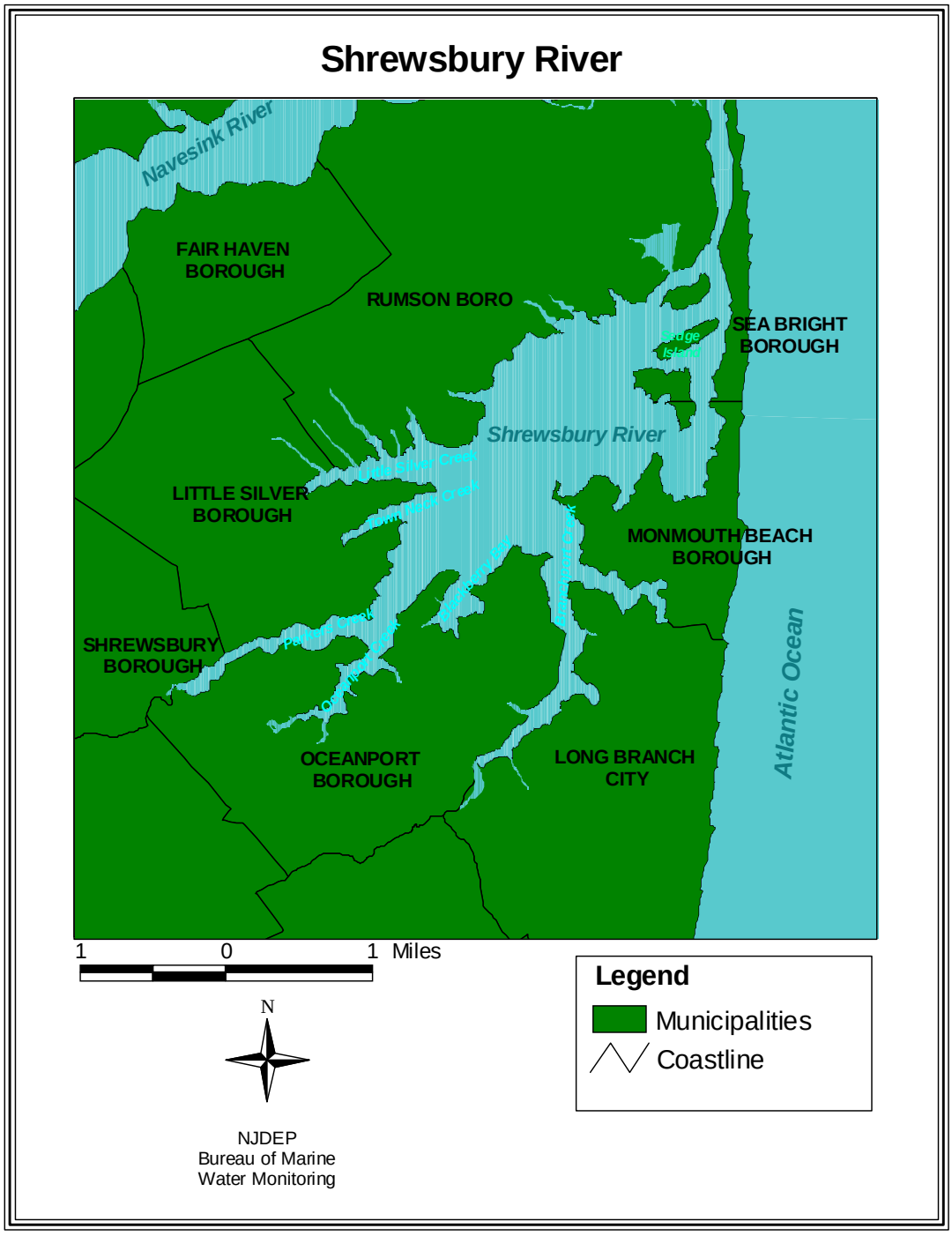


TABLE 1: POPULATION INFORMATION FOR THE SHREWSBURY RIVER GROWING AREA

Community	Area (Sq. Mi.)*	Population (2000 Census)	Population Density (Population/Sq. Mi.)
Rumson Borough	5.2	7,137	1,372
Little Silver Borough	2.8	6,170	2,204
Shrewsbury Borough	2.3	3,590	1,561
Oceanport Borough	3.1	5,807	1,873
Long Branch City	5.1	31,340	6,145
Monmouth Beach Borough	1.1	3,595	3,268
Sea Bright Borough	0.6	1,818	3,030

* Area (Square Miles) obtained from the Monmouth County Planning Board

DESCRIPTION OF THE GROWING AREA

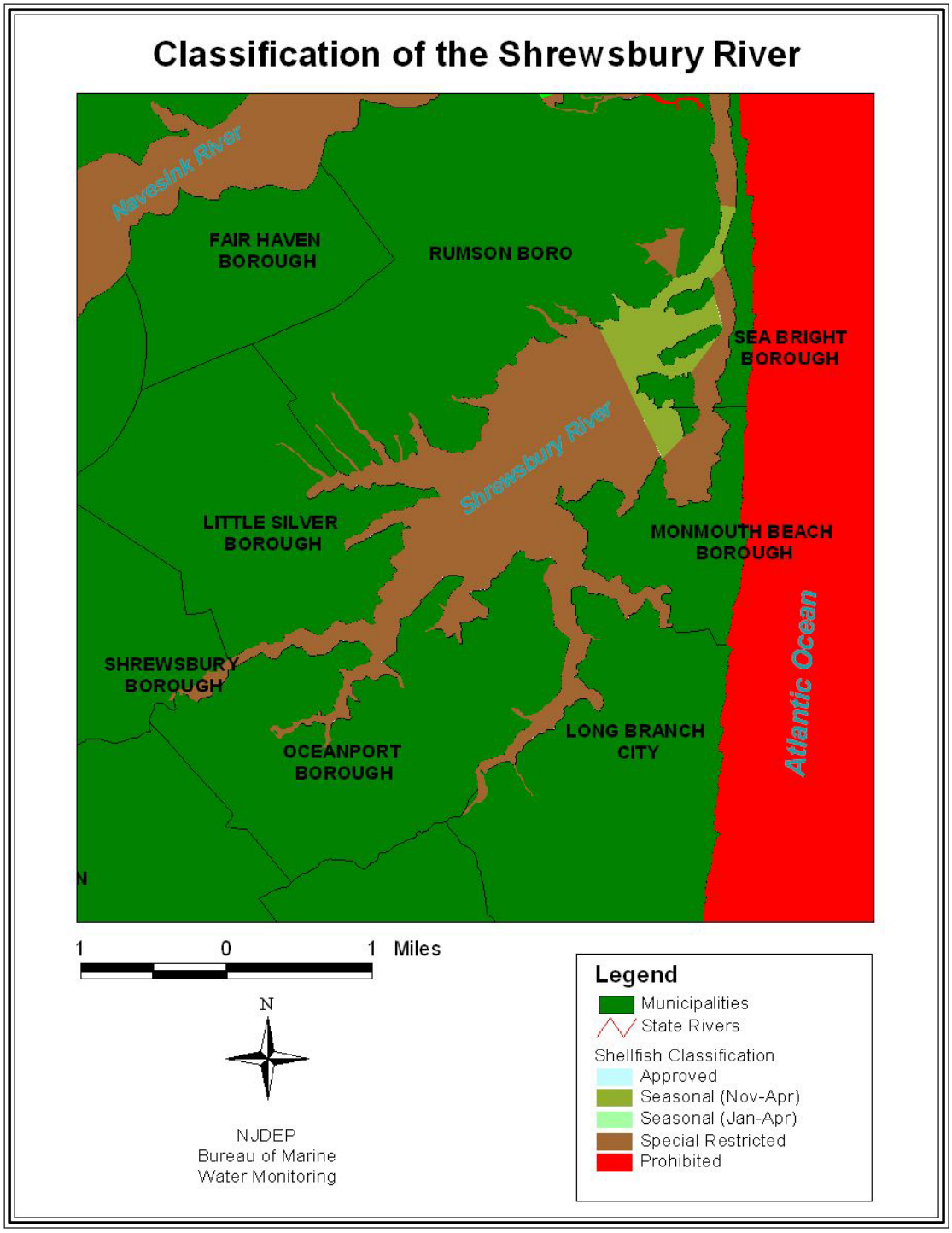
The majority of the Shrewsbury River is classified as *Special Restricted*. This means that shellfish can only be harvested pending further processing (depuration or relay). Recreational harvest of shellfish is not permitted from *Special Restricted* waters. In the last Sanitary Survey (2000), 422 acres in the eastern portion of the Shrewsbury River were upgraded from a *Special Restricted* classification to a *Seasonal (Nov-Apr)* classification (see Figure 6). This upgrade was based on improving water quality in the area. A *Seasonal* classification only allows harvest during specific months. This particular area is open for harvest from November through April.

The greater part of this growing area is made up of urban lands, with areas of wetlands interspersed. There are also small sections of agricultural and forested lands, and even fewer sections of barren lands.

Monmouth County's population increased 11.2% from 1990 to 2000 (Census, 2000). Long Branch is the most densely populated municipality and the only city within this growing area (see Table 1).

Monmouth Park RaceTrack is located in Oceanport Borough, along Branchport Creek. Fort Monmouth is also located in Oceanport, along Parkers Creek.

FIGURE 6: CURRENT CLASSIFICATION OF THE SHREWSBURY RIVER



HISTORY OF THE GROWING AREA

The last sanitary survey of this area was completed in May of 2000 and included data from 1994-1999 (1991-1999 data were used for the seasonal evaluation). Until 1998, this area was sampled under the Adverse Pollution Condition of rainfall. It is now sampled under the Systematic Random Sampling Strategy since there are no point sources contributing to bacterial contaminants in this area.

The 2000 sanitary survey report concluded that the discharge of untreated waste from the Monmouth Racetrack was properly controlled and treated. The data have since shown improvements in the water quality of the Shrewsbury River.

A portion of the eastern part of the Shrewsbury River was upgraded in the last sanitary survey. Four hundred and twenty-two acres, once classified as *Special Restricted,* are now classified as *Seasonal (Nov-Apr*). This opening allows harvesting during November through April without further processing (as with clams harvested from *Special Restricted* waters).

Although this is a very positive step, some problems did arise from this upgrade. Waterfowl hunters also use the Shrewsbury River during this time of year, and thus conflicts arose between hunters and baymen. However, both parties decided to respect each other and adopted a policy of 'first come, first served' (NJDEP Fish and Wildlife, 2001).

In May of 2000 the Environmental Protection Agency approved the NJ Department of Environmental Protection's plan to make the Shrewsbury River a "no discharge zone" (Atlantic Highlands Herald, 2000). This means that no boats may dump treated or untreated sewage into the waters of the Shrewsbury River.

METHODS

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

Approximately 1,975 water samples were collected for total coliform testing between October 1, 1998 & September 30, 2003 and analyzed by the three tube MPN method according to APHA (1970). Figure 7 shows the Shellfish Growing Water Quality monitoring stations in the Shrewsbury River. Nearly 1,640 stations are monitored for coliform levels during each year throughout the state; 43 of these stations are located in the Shrewsbury River.

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).

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,* 1999 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 Shrewsbury River growing area is sampled under the Systematic Random Sampling strategy described above (see Figure 7 for the sampling stations in the Shrewsbury 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.

These sets of criteria were developed by the NSSP to ensure that shellfish harvested from the designated waters would be safe for human consumption.

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).

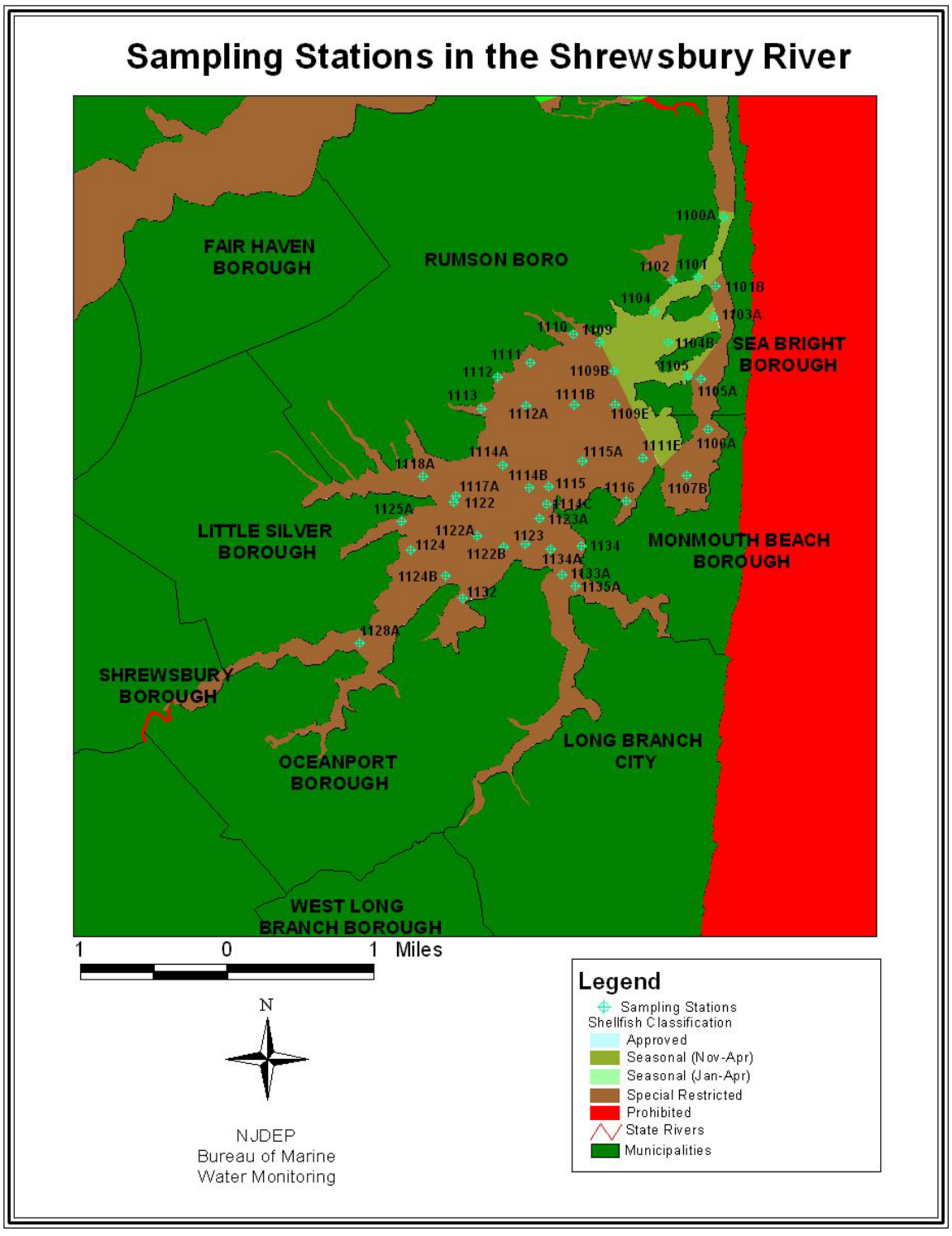
TABLE 2: CRITERIA FOR ADVERSE POLLUTION CONDITION SAMPLING STRATEGY

	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 90^{th} percentile** (MPN/100 mL)	**Geometric mean** (MPN/100 mL)	**Estimated 90^{th} percentile** (MPN/100 mL)
Approved Water Classification	70	330	14	49
Special Restricted Water Classification	700	3300	88	300

FIGURE 7: SAMPLING STATIONS IN THE SHREWSBURY RIVER



SHORELINE SURVEY

CHANGES SINCE LAST SURVEY

In 2000, the Shrewsbury River was declared a “no discharge zone”. This prevents boats from legally dumping treated or untreated sewage into the river. The Monmouth Racetrack also improved its wastewater system in 1994-1995, now discharging fewer pollutants into the Shrewsbury River. These changes have both proven beneficial to the river.

The Two River Water Reclamation Authority, previously known as the Northeast Monmouth Sewage Authority, is currently undergoing a multi-million dollar expansion and upgrade project, which will help to improve the local waste system.

Shoreline surveys were conducted on March 23, 2004, April 29, 2004, and May 4, 2004. The majority of the shoreline is urban land use. Most of the coastline is residential, but many of the houses are on large lots. There are also groups of condominium associations along the water, some of which fit within the State’s definition of a marina. 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).

During the shoreline surveys there were observations of birds, mainly sea gulls and geese. Since bird waste can add to contamination of the waters, it is important to note the location of bird populations, which could contribute to high coliform values. Oftentimes, the waterfowl nest within the wetlands, where runoff washes directly over the land and into streams and bays. The majority of bird populations on these shoreline surveys were seen on the islands west of Sea Bright, which are mostly wetlands.

There is currently controversy surrounding a 16.4-acre marshy tract located on the Shrewsbury River, known as Widgeon’s Point. (see Figure 8). “[T]he board could not determine whether a 2000 settlement between Broadmoor Properties and the DEP permitted one or three houses to be built on the site. Questions about the presence of wetlands on the property, or whether the property could be defined as bay islands, which are restricted from development, also remain unanswered.” (Waldman, 2004).

Troutman’s Creek, off of Branchport Creek, has received considerable attention over the last couple of years (see Figure 9). In 2000, local residents formed a group called the Concerned Citizens Coalition and have since sought legal action against New Jersey Natural Gas, which now owns the site where the Long Branch Coal Gasification Plant once stood. The Coalition has complained of, “health effects from long term exposure to the contaminants and the increased exposure from remediation activities.” (Rutgers Environmental Law

Clinic, 2004). In recent years, testing of the soil, water, air, and crabmeat have shown contradicting reports. Some test results show high levels of possible carcinogenic materials, like PAH's (polycyclic aromatic hydrocarbons), that could have come from the coal plant. Other test results have concluded that all findings were within specified limits (Varno, 2004). The Long Branch Coal Generating Facility operated for almost a century, starting operation in the mid 1800's and stopping production of natural gas in the early 1950's (Varno, 2004).

The DEP's Site Remediation Program is currently overseeing the studies and cleanup activities at the pollution site. In order to reevaluate the classifications in Branchport Creek, stations 1137B, 1138, and 1140A will be reactivated for the 2006 sampling season. The last time these stations were tested was in July of 1985.

In the summer of 2004 the bridge on Oceanport Ave over Oceanport Creek was re-constructed. (see Figure 10).

FIGURE 8: WIDGEON'S POINT ON THE SHREWSBURY RIVER

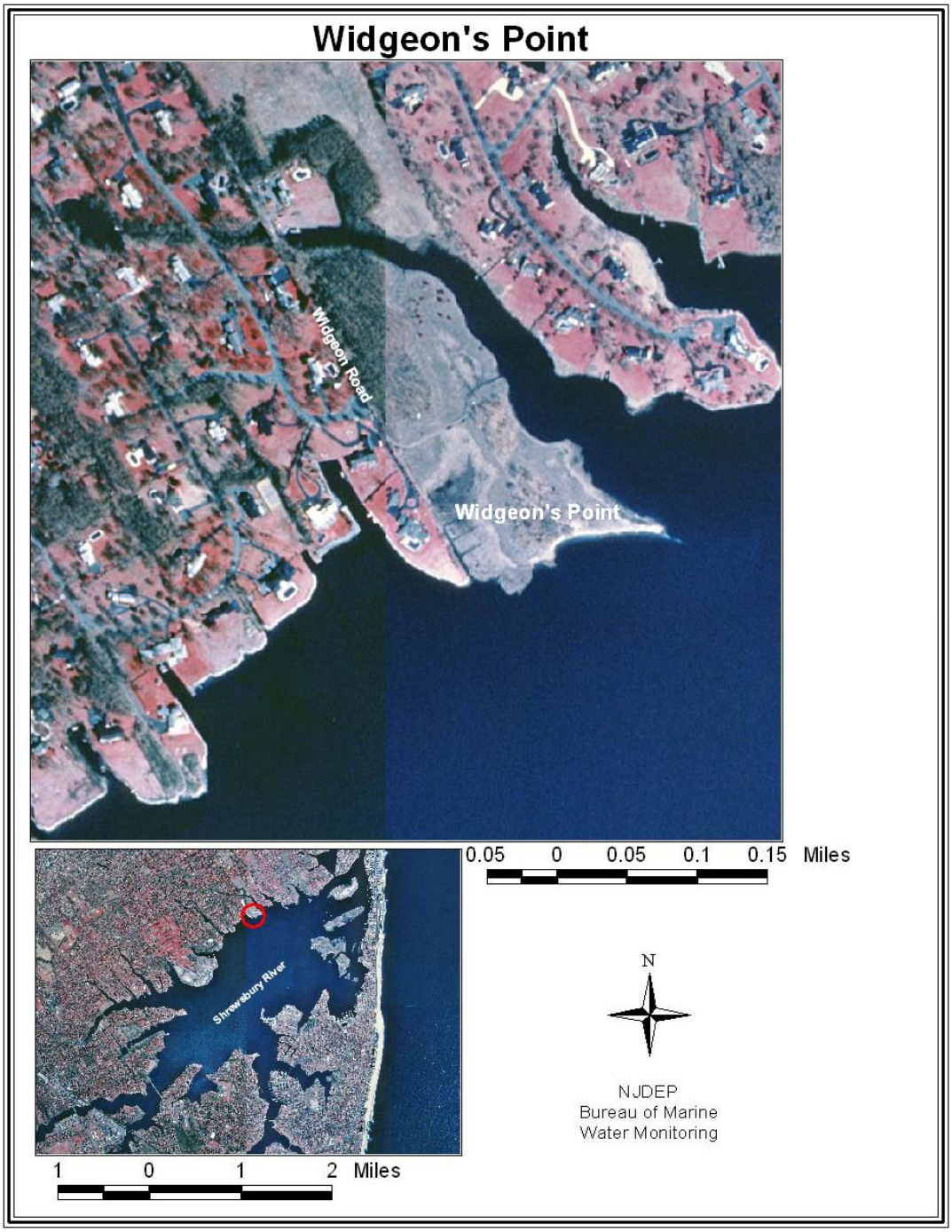


FIGURE 9 : TROUTMAN'S CREEK (PICTURE TAKEN ON 4-29-04)

FIGURE 10: OCEANPORT AVE BRIDGE (PICTURE TAKEN ON 4-29-04)

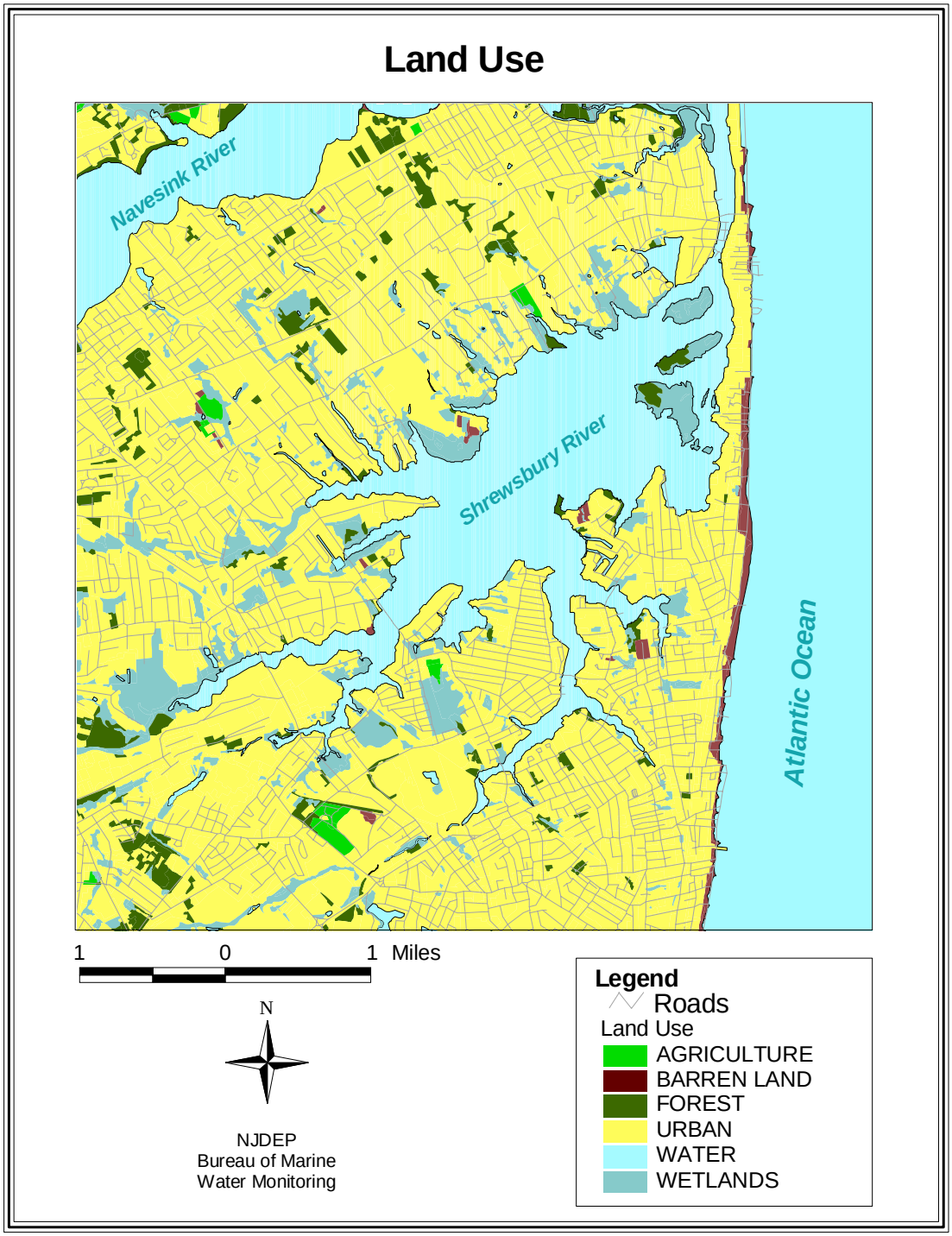
LAND USE

The current land use surrounding the Shrewsbury River is predominately urban, commonly residential. However, there are scattered regions of wetlands and speckles of barren lands, forests, and agricultural lands (see Figure 12). Seven municipalities surround the Shrewsbury River; they are Rumson Borough, Little Silver Borough, Shrewsbury Borough, Oceanport Borough, Long Branch City, Monmouth Beach Borough, and Sea Bright Borough. Most properties in this area contain a single family home. However, there are some condominium-type structures, primarily in Sea Bright Borough and Monmouth Beach Borough (see Figure 11).

Historically, most of this region has been urban land used for residential housing. Since this region is already developed there has not been much residential growth in recent years. However, high population and development growth throughout New Jersey has lead the state to implement 'Smart Growth', an effort to preserve the existing natural lands in New Jersey. There is also a statewide Brownfield program, which focuses on improving rundown urban areas to pull in businesses and residents that might otherwise construct new facilities on undisturbed land. Both of these initiatives are efforts to reduce the amount of natural land lost to urban growth.

FIGURE 11: CONDOS ACROSS THE SHREWSBURY (PICTURE TAKEN ON 3-23-04 FROM PLEASURE BAY MARINA)

FIGURE 12: LAND USE PATTERNS OF THE SHREWSBURY RIVER GROWING AREA



EVALUATION OF BIOLOGICAL RESOURCES

The Shrewsbury River has moderate to high densities of hard clams (according to the last clam census in the 1980's done by DEP's Fish & Wildlife, see Figure 13). Populations of soft clams also reside within this estuary (see Figure 14). 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. Herons, ducks, and egrets are common sights. Other species in the area include the endangered piping plover and the roseate tern.

Vegetation is an essential part of the marine ecosystem, offering habitat and nursery grounds for numerous species. In the Shrewsbury River, the submerged aquatic vegetation (SAV) is prevalent in shallow areas. Some of the most common species of SAV include widgeon grass (*Ruppia maritima*), sago pondweed (*Potamogeton pectinatus*), horned pondweed (*Zannichellia palustris*) and eelgrass (*Zostera marina*).

FIGURE 13: HARD CLAM DENSITIES IN THE SHREWSBURY RIVER

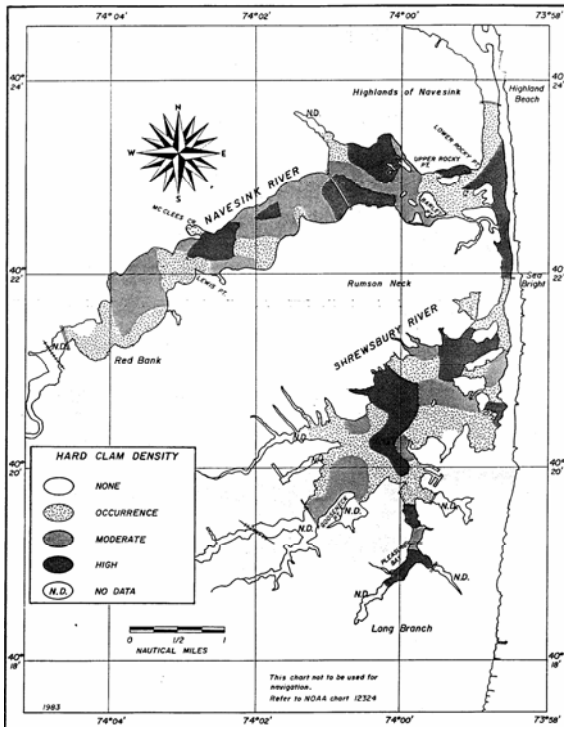
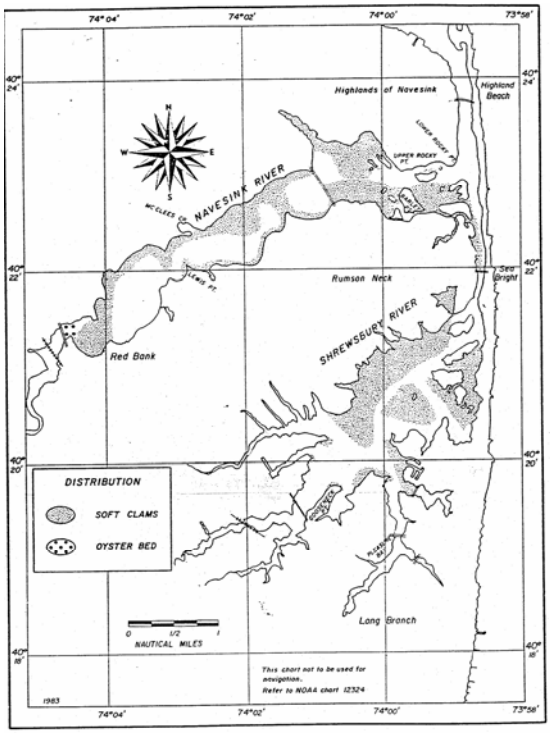


FIGURE 14: SOFT CLAM DENSITIES IN THE SHREWSBURY RIVER



IDENTIFICATION AND EVALUATION OF SOURCES

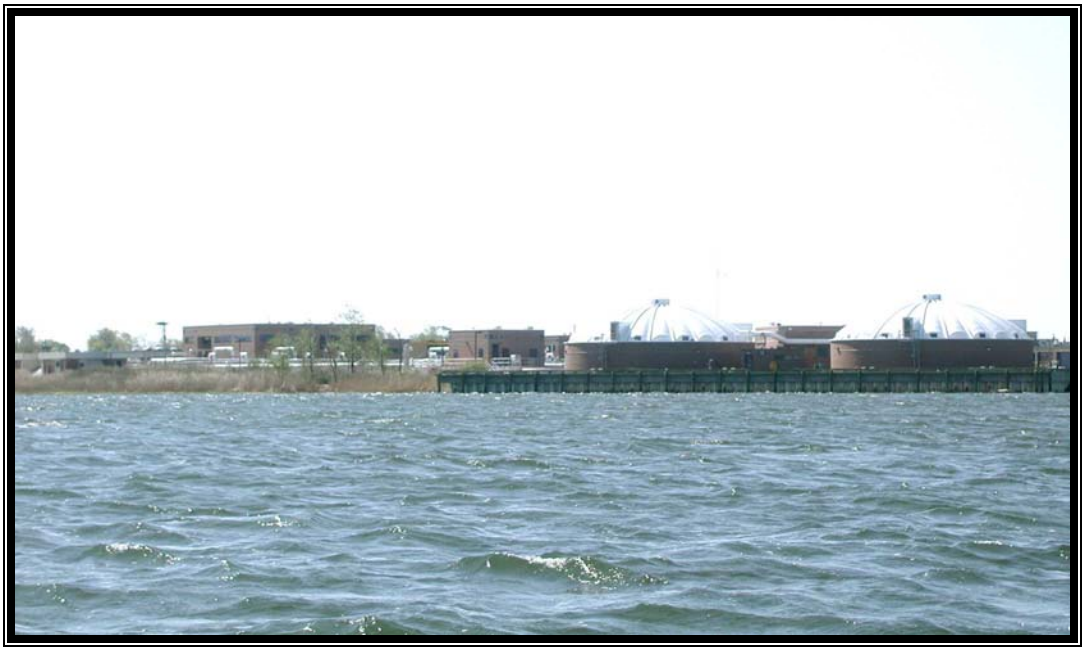
EFFLUENT DISCHARGES

There are no direct discharges into the waters of the Shrewsbury River. However, there are two domestic treatment facilities in the general vicinity. The Two River Water Reclamation Authority, previously known as the Northeast Monmouth Sewage Authority, and the Long Branch Sewerage Authority; both discharge treated wastewater into the Atlantic Ocean.

The Two River Water Reclamation Authority is currently undergoing a multi-million dollar expansion and upgrade project. The original completion date was March 17, 2003, but this has now been extended to into the late 2004 due to legal battles and other complications (Conohan, 2003a). This facility currently has an average capacity of 11.4 million gallons per day (MGD), and the upgrades will increase this capacity to 13.8 MGD (see Figure 15).

"The [Two River Water Reclamation] Authority was founded in 1965 and had its first flow in 1971. It has six member towns: Monmouth Beach, Fair Haven, Little Silver, Shrewsbury, Oceanport and West Long Branch. It also has six customer towns: Sea Bright, Rumson, Red Bank, Eatontown, Shrewsbury Township and part of Tinton Falls, plus Fort Monmouth and Camp Charles Wood." (Conohan, 2003b).

FIGURE 15: TWO RIVERS WATER RECLAMATION AUTHORITY (PICTURE TAKEN ON 5-4-04)



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.

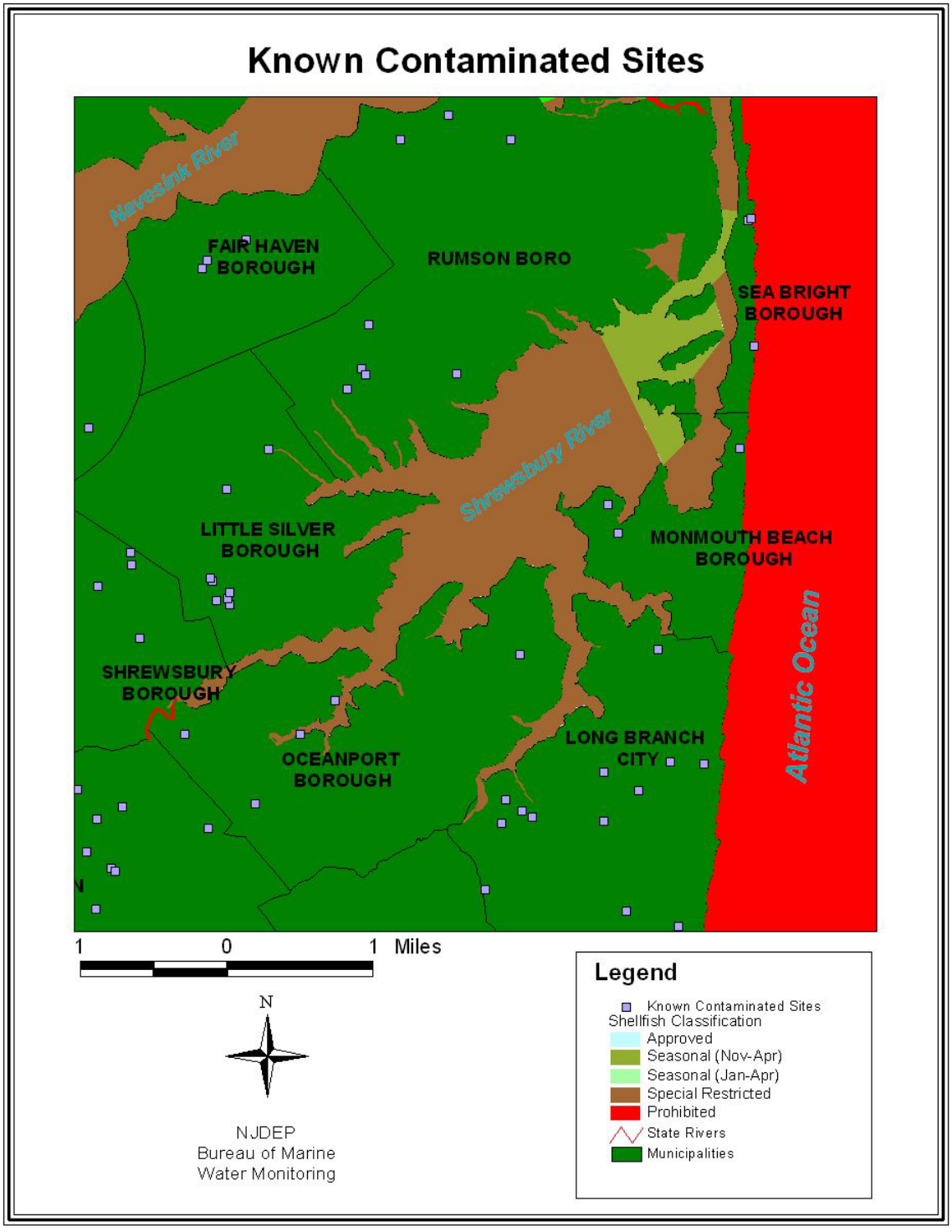
Since most of the Shrewsbury River is classified as *Special Restricted*, any legally harvested shellfish from the *Special Restricted* area must go through further processing before going to market. For that reason, the likelihood of humans consuming contaminated shellfish is lessened, although not prevented. In fact, the depuration process does little to rid the shellfish of any toxins that many come from these known contaminated sites, since toxins may be incorporated into the shellfish tissue (Lehane, 2000).

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 16: KNOWN CONTAMINATED SITES NEAR THE SHREWSBURY 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 storm water outfalls. The outfalls deposit the runoff into streams, bays, oceans, and other bodies of water. Storm water 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 storm water inputs into the Shrewsbury River and its tributaries (see Figure 17). These numerous storm water inputs have the potential to negatively impact the water quality within this growing area. Figure 18 shows a storm water outfall that drains a parking lot on the Shrewsbury River and Figure 19 shows the amount of trash that appears to have come from that outfall.

Historically, the Shrewsbury River is heavily impacted by rain events; it was sampled under the Adverse Pollution Condition of rainfall prior to 1998. The rain impact appears to have lessened slightly in recent years, probably due to better waste management at horse farms.

The impact of animal waste on water contamination is of significant concern. 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 the sicknesses of 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.

"Horse farms, construction activities, and urban runoff are believed to be the principal nonpoint sources of pollution in this region [Shrewsbury River]. These have brought about siltation, nutrient loading, and excess bacterial contamination in the local rivers. Bacteria from horse farms and urban runoff [have] contaminated many of the shellfish harvesting beds in the downstream reaches of these rivers" (NJ Waters, 2000).

In 1994-1995, the Monmouth Park Racetrack modified the existing waste management system to prevent the introduction of wastes into the storm water system, which drains into Branchport Creek. Do to this altercation, the Monmouth County Health Department samples have shown lower bacterial levels in Branchport Creek. The Bureau of Marine Water Monitoring does not currently sample Branchport Creek, but stations 1137B, 1138, and 1140A are being reactivated for the 2006 sampling season.

As mentioned above, 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 storm water projects to help lessen the effect of storm water 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 storm water project planned for the Shrewsbury River.

FIGURE 17: STORM WATER OUTFALLS IN THE SHREWSBURY RIVER

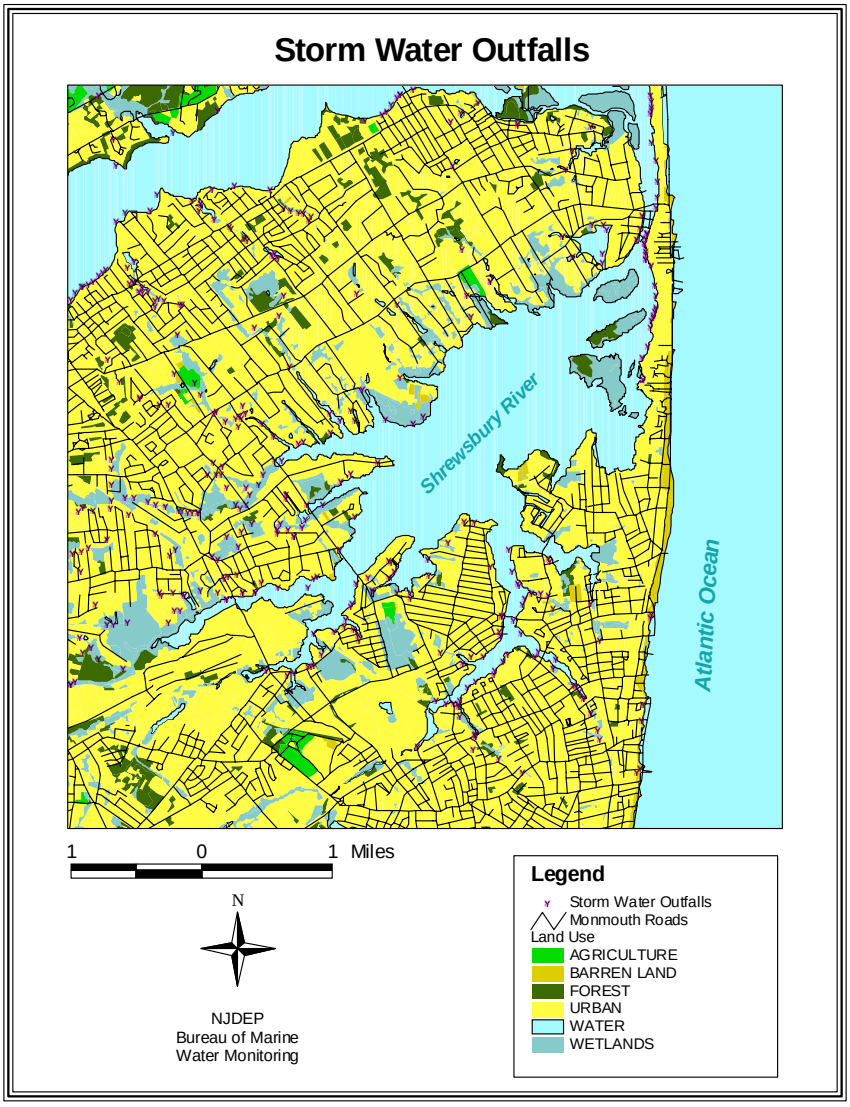


FIGURE 18: STORM WATER OUTFALL ON THE SHREWSBURY RIVER (PICTURE TAKEN ON 3-23-04 AT BREAKWATER COVE CONDOS)

FIGURE 19: TRASH TO THE RIGHT OF FIGURE 18 (PICTURE TAKEN ON 3-23-04 AT BREAKWATER COVE CONDOS)

MARINAS

Boating is a popular summertime activity within the Shrewsbury River. In this growing area there are a total of 23 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,* 1997, 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 23 marinas in the Shrewsbury River, as shown in Table 4. Most of these marinas are located on the eastern shoreline of the river (see Figure 21, Channel Club Marina). 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 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.

FIGURE 20 : MARINA FACILITIES LOCATED IN THE SHREWSBURY RIVER

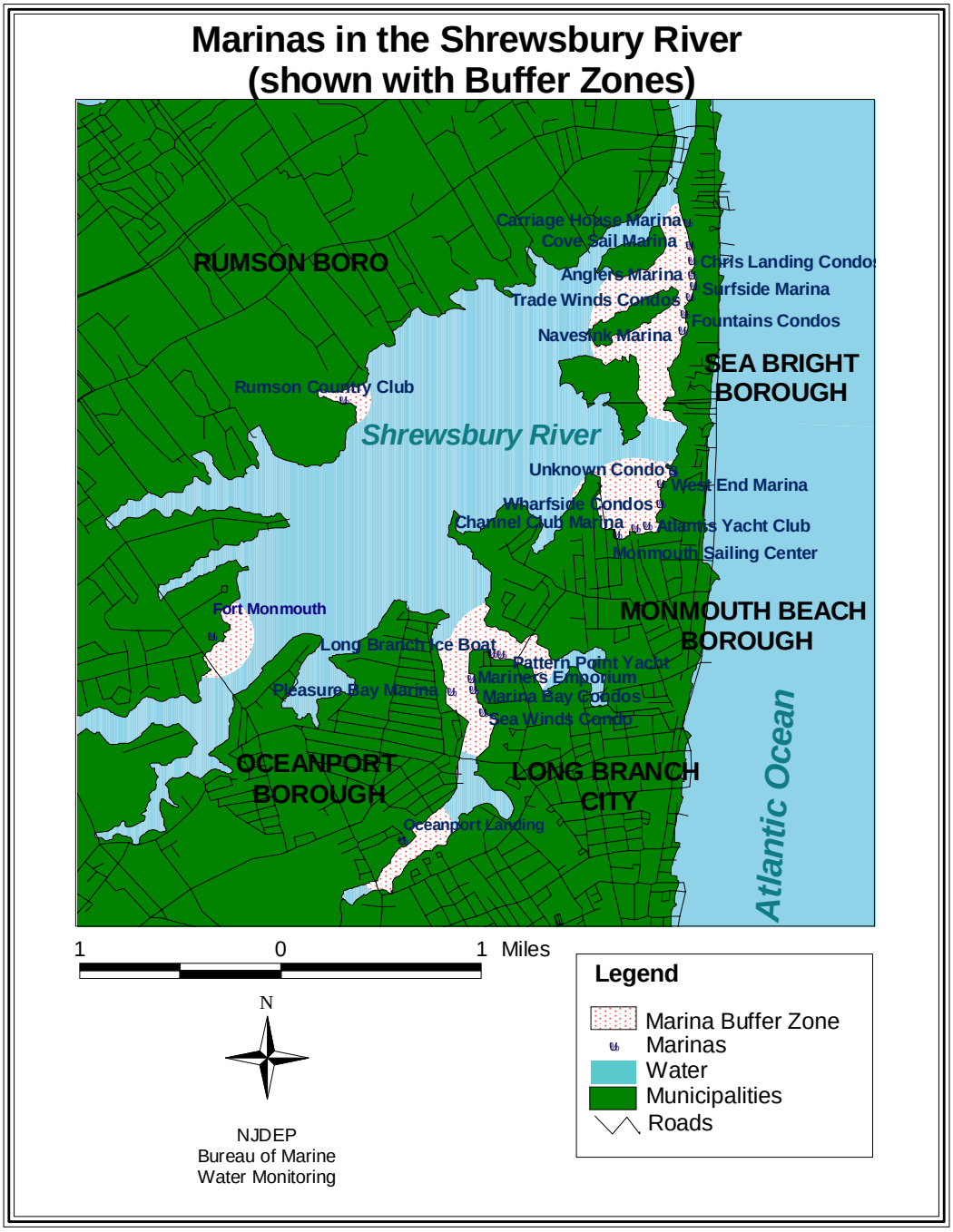


TABLE 4: MARINA FACILITIES LOCATED IN THE SHREWSBURY RIVER

	Marina Name	# of Slips	Size of Buffer Area (radius; feet)
1	Carriage House Marina	37	609
2	Cove Sail Marina	65	1,007
3	Chris Landing Condominiums	50	896
4	Angler's Marina	54	545
5	Surfside Marina	55	684
6	Trade Winds Condominium	20	567
7	Fountains Condominium	50	475
8	Navesink Marina	115	1,036
9	Unidentified Condominium	25	323
10	Weston's Marina	28	666
11	Wharfside Condominiums	79	1,126
12	Atlantis Yacht Club	55	1,213
13	Channel Club	146	1,853
14	Monmouth Sailing Center	135	1,156
15	Patten Point Yacht Club	75	1,417
16	Long Branch Ice Boat	60	1,006
17	Mariner's Emporium	78	1,198
18	Marina Bay Marina	72	1,102
19	Sea Winds Condominium	50	1,157
20	Pleasure Bay Yacht Club	90	1,167
21	Rumson Yacht Club	33	739
22	Fort Monmouth Marina	73	886
23	Oceanport Landing	85	1,089

FIGURE 21: CHANNEL CLUB MARINA (PICTURE TAKEN ON 3-23-04 AT BOAT RAMP AT CHANNEL CLUB MARINA)

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.

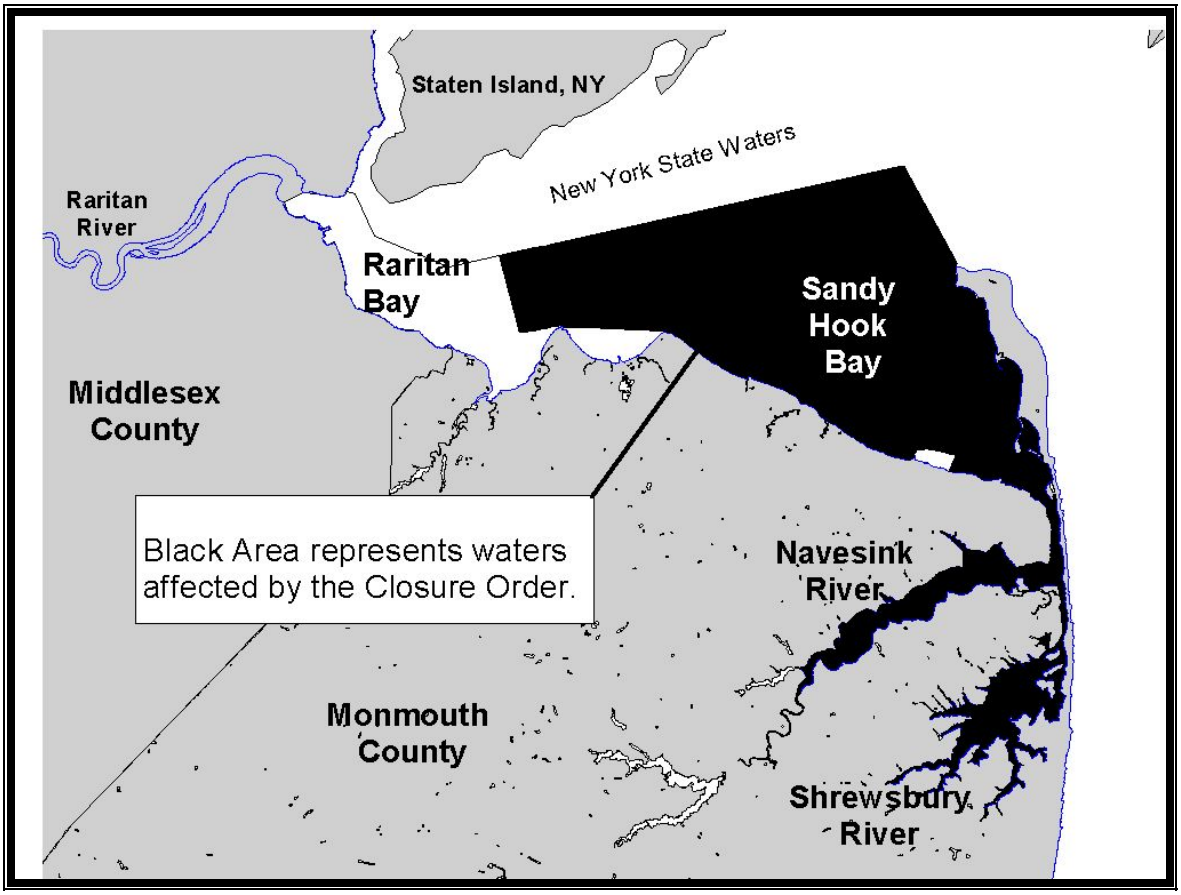
On March 4, 2003 a major portion of New Jersey shellfish beds were closed in response to the March 2, 2003 Sayreville Sewage Spill. The Raritan Bay, Sandy Hook Bay, Navesink River, and Shrewsbury River were all closed as a result of this spill (see Figure 22). Although the actual sewage spill was in the Raritan Bay, the public health risk was enough to close the waters of the Shrewsbury River. Most of the Shrewsbury River is classified as *Special Restricted* and clams harvested from these areas are sent for further processing, usually to a depuration plant, before going to market. The depuration plants in New Jersey are located along Sandy Hook Bay. These depuration plants were closed because their inflow pipe was bringing in potentially harmful water to 'cleanse' the clams.

The Middlesex County Utilities Authority worked on fixing the sewage breakage. In the meantime, they offered to truck in water classified as *Approved* to the depuration plants so clammers

could harvest *Special Restricted* areas not affected by the closure. On April 4th 2003, 6,000 acres within the Sandy Hook Bay, Navesink River, and Shrewsbury River were re-opened for harvesting. As of April 17, 2003, an additional 20,000 acres were reopened for harvesting. It was also announced that the *Seasonal* areas within the Shrewsbury River and Navesink River would reopen on May 1, 2003, however, harvesting is only permitted from November through April in this *Seasonal* area. For further information see NJDEP's website at http://www.state.nj.us/dep/newsrel/releases/03_0036.htm .

There were no other significant spills or unpermitted discharges concerning the Shrewsbury River during the October 1998 through September 2003 time period.

FIGURE 22: SAYREVILLE SEWAGE SPILL CLOSURE AREA



*Please note that some portions of the Raritan Bay and the Sandy Hook Bay are already classified as *Prohibited* and therefore do not show as part of the closure area.

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. The data from these months show no obvious impact on the water quality of the Shrewsbury River. There were no other major tropical storms or hurricanes in this area between October of 1998 and September of 2003.

The major inputs of water into the Shrewsbury River are from a combination of precipitation, groundwater inflow, runoff, streams, and tidal exchange. The river drains an area of 27 square miles. There is an average range of 4 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 Sandy Hook Bay. (USDI-GS).

The Shrewsbury River precipitation inputs for the period October 1, 1998 through September 30, 2003 are shown in Table 5. There have been no significant changes in hydrography since the last sanitary survey in 2000. The primary weather station for this area is Newark. The secondary weather station for this area is Toms River. The secondary station data are used when data from the primary station are incomplete.

TABLE 5: CLIMATOLOGICAL DATA

Rainfall Recorded at NOAA's Newark (6026) Station
Temperature Recorded at NOAA's Newark (6026) Station
* Temperature Recorder at NOAA's Toms River (7886) Station

Sampling Date	Precipitation in Inches			NOAA WSO Number	Average Daily Temperature
	Day of Sampling	Day of Sampling & Previous Day	Day of Sampling & Two Previous Days		
10/5/1998	0	0.04	0.19	0626	62
11/4/1998	0	0	0	0626	45
12/15/1998	0	0	0	0626	38
3/2/1999	0	0.15	0.88	0626	43
4/5/1999	0	0.01	0.01	0626	48
5/4/1999	0.46	0.5	0.5	0626	57
5/10/1999	0	0	0.1	0626	64
6/2/1999	0.005	0.005	0.005	0626	81
7/6/1999	0	0	0.005	0626	92
8/3/1999	0	0	0	0626	80
9/28/1999	0	0	0	0626	72
9/29/1999	0.005	0.005	0.005	0626	72
10/7/1999	0	0	1.35	0626	54*
10/13/1999	0	0	0.4	0626	55*
10/26/1999	0	0	0	0626	55*
12/2/1999	0	0	0	0626	39
12/13/1999	0.26	0.26	0.26	0626	39
4/3/2000	0	0	0	0626	63
5/3/2000	0	0.05	0.05	0626	57
7/19/2000	0.11	0.11	0.11	0626	67
8/1/2000	0.15	0.74	0.76	0626	72
8/28/2000	0.22	0.34	0.34	0626	76
10/24/2000	0	0	0	0626	52
11/9/2000	0	0	0	0626	52
11/30/2000	0.14	0.14	0.14	0626	44
12/11/2000	0.02	0.02	0.025	0626	33
2/15/2001	0	0	0	0626	41
5/22/2001	0.82	1.89	1.89	0626	59
6/6/2001	0	0	0	0626	72
7/18/2001	0.01	0.4	0.4	0626	75
7/31/2001	0	0	0	0626	74
8/27/2001	0	0	0	0626	79
10/22/2001	0	0	0	0626	63
11/7/2001	0	0	0	0626	56
11/29/2001	0.06	0.06	0.06	0626	54
12/17/2001	0.23	0.23	0.23	0626	44
2/26/2002	0	0	0	0626	54
4/9/2002	0.07	0.07	0.07	0626	66
5/21/2002	0	0	0	0626	53
7/23/2002	0.01	0.01	0.01	0626	86
5/14/2003	0	0.005	0.025	0626	58
6/25/2003	0	0	0	0626	82
7/14/2003	0.005	0.005	0.005	0626	73
9/9/2003	0	0	0	0626	69
9/22/2003	0.005	0.005	0.005	0626	67

WATER QUALITY STUDIES

BACTERIOLOGICAL QUALITY

The data for this report were collected from 43 stations in the Shrewsbury River. A total of 1,975 surface water samples were analyzed from this growing area for total coliform (TC) during the period of October 1, 1998 through September 30, 2003.

The majority of waters within the Shrewsbury River are classified as *Special Restricted;* there is *Seasonal (November-April)* area in the eastern portion (see Figure 23).

This report drew data from October 1, 1998 to September 30, 2003; 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 way the different assignment runs can have differing sampling strategies and, if necessary, special instructions. One assignment run is required for this growing area. This run is sampled 10 times a year. This report examined the data from the assignment runs retrieved between October 1, 1998 and September 30, 2003. 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.

All stations within the Shrewsbury River met the year-round SRS *Approved* criteria. This is an improvement from previous years and a good sign that the waters of the Shrewsbury River are improving.

If the water quality remains the same or improves there is a possibility of an upgrade in the next few years.

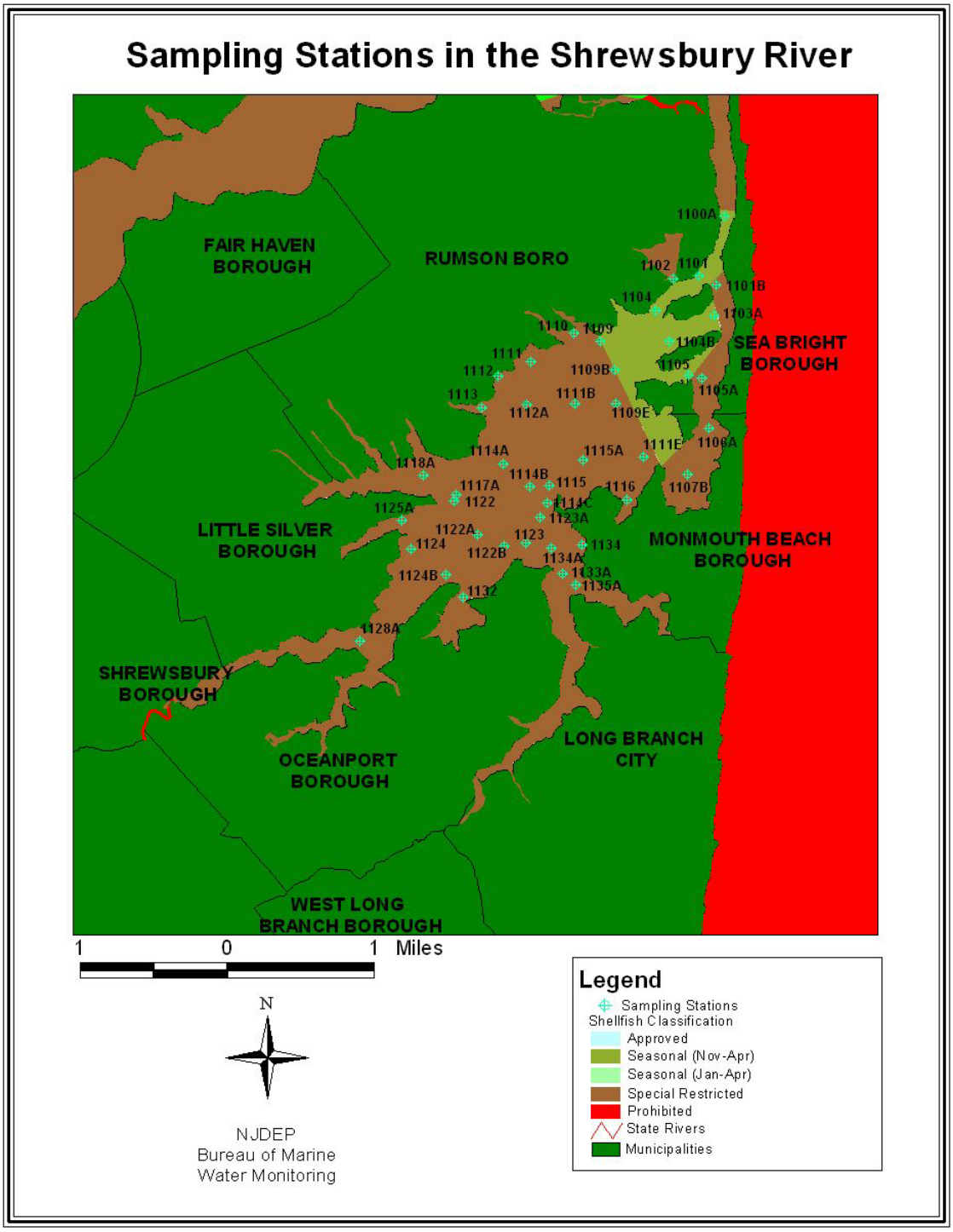
Overall, no waters in the Shrewsbury River need downgrading based on the *Approved* criteria.

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. 90^{th} Percentile must be below 3300 MPN/100ml.

No stations need downgrading based on the *Special Restricted* criteria. However, the small creeks that feed into the Shrewsbury River should be examined further. The closest sampling stations to these creeks appear to be contributing higher coliform levels (although, not above criteria) after rain events, so perhaps a storm water study will provide the information needed to assess the potential sources of contamination.

FIGURE 23: SAMPLING STATIONS FOR THE SHREWSBURY RIVER



COMPLIANCE WITH NSSP *APPROVED 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.

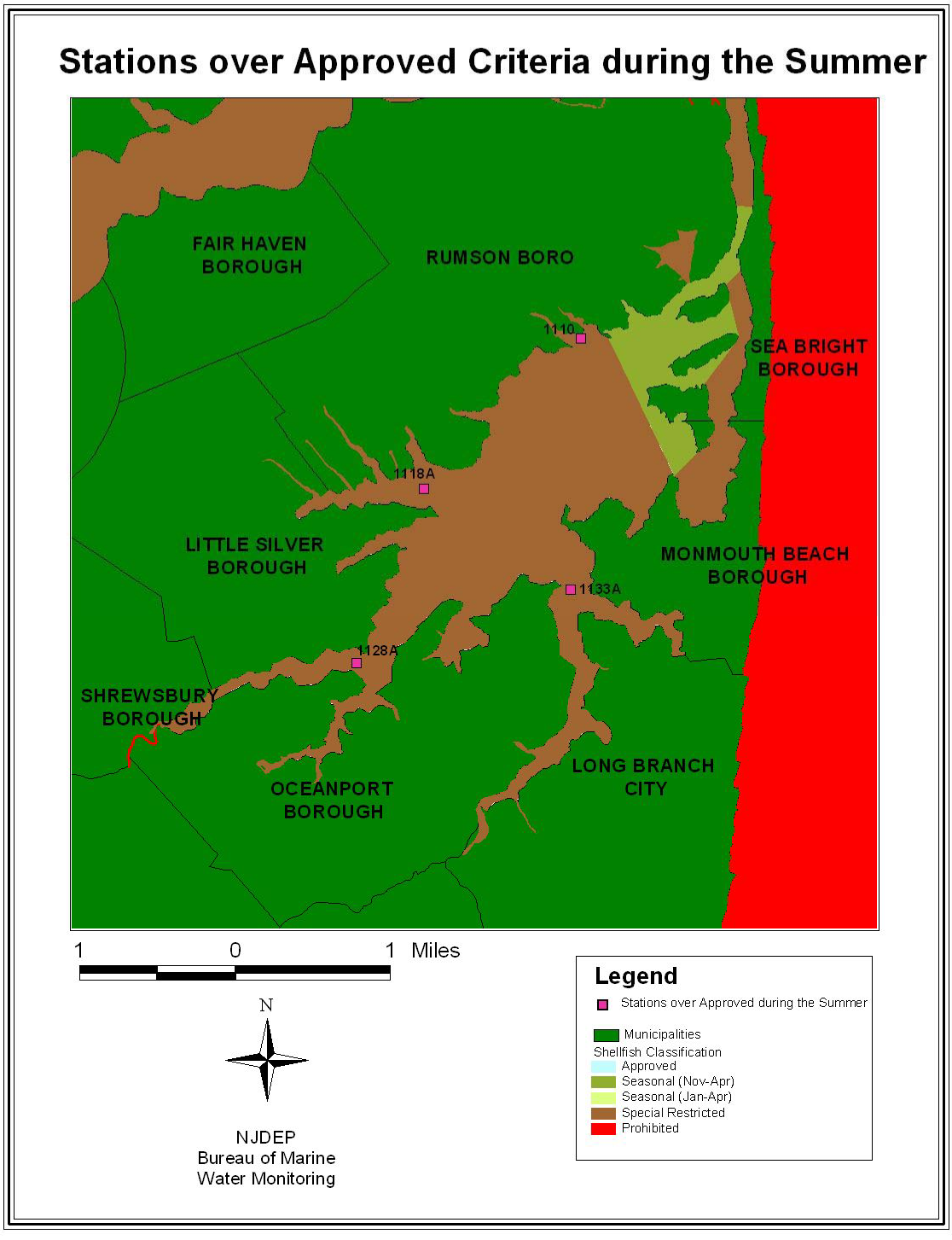
Winter Data (November – April)

All stations in the Shrewsbury River growing area met the total coliform *Approved* criteria during the winter months.

Summer Data (May – October)

Four stations in the Shrewsbury River growing area did not meet the total coliform *Approved* criteria during the summer months. These stations, 1110, 1118A, 1128A, & 1133A, are all located in *Special Restricted* waters, therefore, these four stations are presently not a concern (see Figure 24). It is helpful to note that even if any of the *Special Restricted* waters were upgraded to *Seasonal (Nov – Apr)*, then the stations in that particular area would still fit within criteria since those waters can only be harvested during the winter months.

FIGURE 24: SAMPLING STATIONS EXCEEDING APPROVED CRITERIA DURING THE SUMMER MONTHS



TIDAL EFFECTS

Tidal exchange causes a mixing of impaired water with higher quality water. This mixing also helps to improve the water quality of sections adjacent to the urban shorelines, which are often 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 25). The Geometric Means were higher during ebb than during flood for all of the noted stations (the 90th percentile is not available for the ebb and flood designations). The high geometric means on the ebb tide show that the respective tributaries are probably affecting stations 1117A and 1133A. Station 1117A is located at the mouth of the Little Silver Creek tributary and station 1133A is located at the mouth of the Branchport Creek tributary. This shows that these tributaries are potential sources of contamination. Station 1106A also has a higher geometric mean on the ebb tide, which is probably influenced by the bird populations and the wetlands of Sedge Island. All of these stations are located in *Special Restricted* waters and do not exceed the criteria. When the time frame is extended back to October of 1993 in order to evaluate 30 samples (required for the SRS protocol) for both ebb and flood tides, there are six stations with a tidal component, however, they all fit within the present classification.

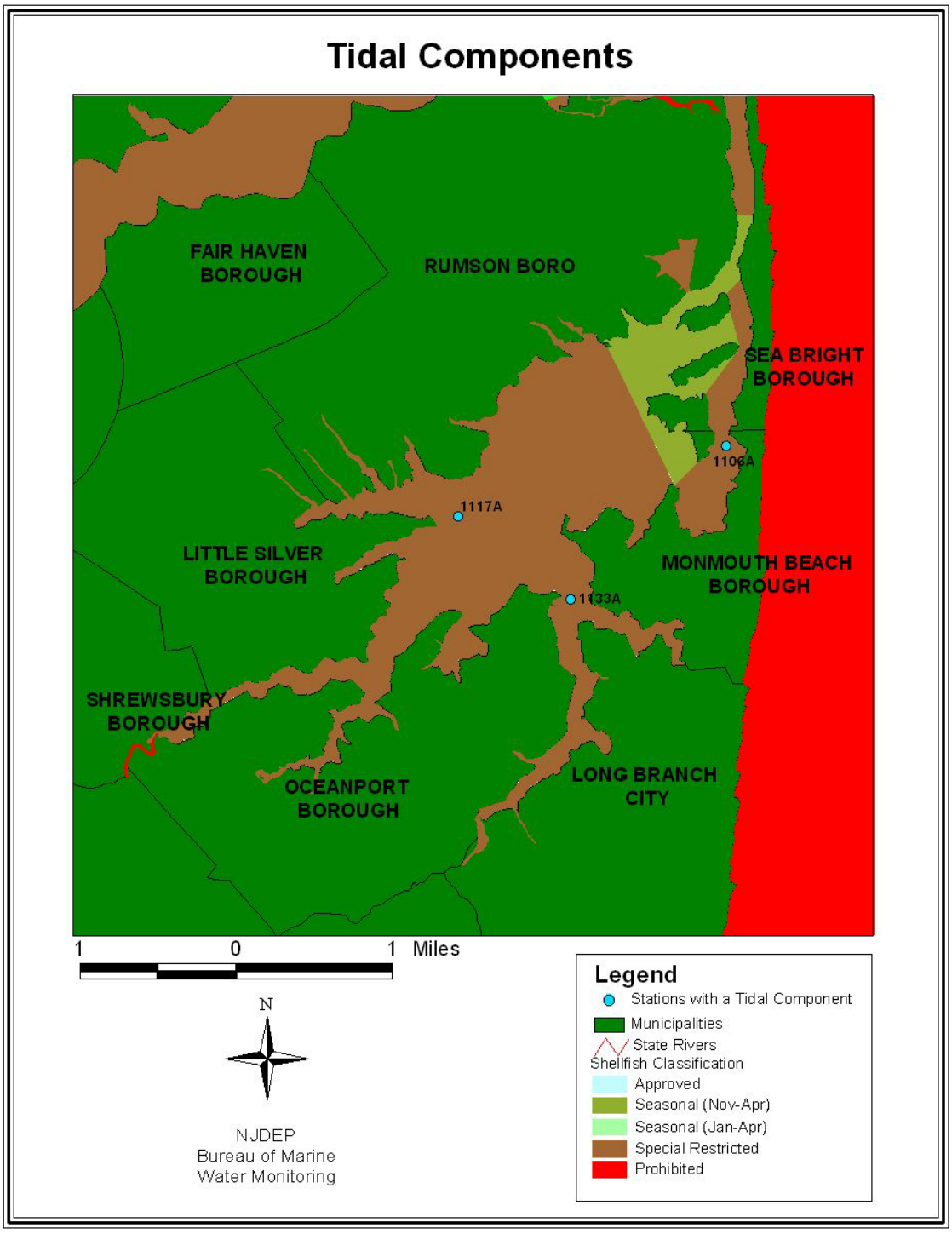
These particular stations do not have a very high tidal exchange due to their location. These are areas that tend to have shallow depths and are not located in the main current of the river.

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	Flow	
1106A	30.5	13.0	**0.028**
1117A	26.6	8.1	**0.026**
1133A	51.9	16.6	**0.026**

FIGURE 25: SAMPLING STATIONS AFFECTED BY TIDE



SEASONAL EFFECTS

Statistically significant seasonal impacts were observed at 22 stations (see Figure 26). The T-statistic probability must be less than 0.050 for a station to be considered significant (see Table 7). This means there are significant differences between the winter data and the summer data at these 22 stations.

All stations had higher geometric means in the summer; however, none of these stations had a geometric mean that exceeded the established values for the present classifications. The est. 90^{th} percentile values for these stations also fit within criteria (see Appendix for 90^{th} percentile values).

All seven stations in the *Seasonal (Nov-Apr)* section of the Shrewsbury River have a seasonal component, and the rest of the affected stations are in *Special Restricted* waters.

The areas with seasonal components tend to be areas surrounding marinas and/or coastline development. Summertime pressures are more likely to impact these waters. These areas endure heavy boat travel, and boat usage greatly increases during summer months. Usually the higher summer temperatures and seasonal recreational uses, like boating, contribute to high summer coliform values. These stations may also be affected by other non-point sources from increased summer population and/or increased use of recreational water activities.

When the timeframe is extended back to October of 1993 in order to get the 30 SRS samples for both summer and winter, there are seventeen stations with a seasonal component. However, none of these stations conflict with their present day classifications.

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

FIGURE 26: SAMPLING STATIONS AFFECTED BY SEASON

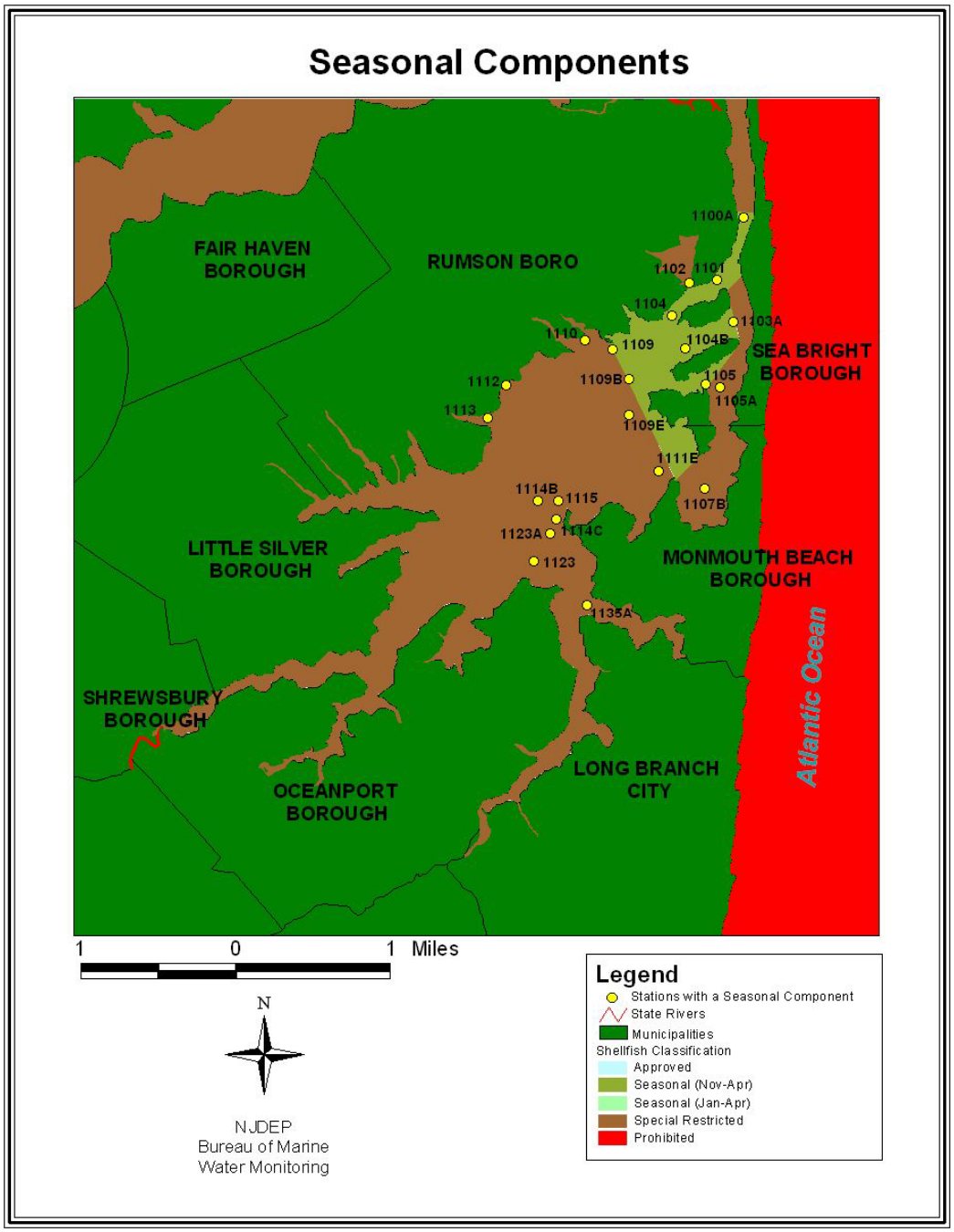


TABLE 7: SEASONAL EFFECTS

Station	Total Coliform Geometric Mean		Probability > [T]
	Summer	Winter	
1100A	11.8	5.4	**0.042**
1101	23.8	7.6	**0.017**
1102	21.5	5.2	**0.003**
1103A	13.8	5.4	**0.013**
1104	15.6	6.1	**0.006**
1104B	15.7	6.1	**0.029**
1105	25.2	9.1	**0.014**
1105A	22.1	8.0	**0.021**
1107B	40.7	13.5	**0.018**
1109	26.8	9.0	**0.018**
1109B	12.7	3.9	**0.001**
1109E	19.7	6.4	**0.010**
1110	40.4	7.6	**0.001**
1111E	28.1	9.7	**0.009**
1112	19.8	6.3	**0.038**
1113	32.6	10.3	**0.034**
1114B	26.4	5.7	**0.003**
1114C	30.2	7.4	**0.005**
1115	17.9	6.9	**0.025**
1123	26.5	10.4	**0.037**
1123A	27.0	10.4	**0.033**
1135A	44.9	12.0	**0.006**

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.

The Bureau of Marine Water Monitoring has begun to identify particular storm water outfalls that discharge excessive bacteriological loads during storm events in special areas of concern. There is currently not a storm water project in the Shrewsbury River.

In some cases, specific discharge points can be identified. When specific outfalls are identified as significant sources, the Department of Environmental Protection works with the county and municipality to further refine the source(s) of the contamination and implement remediation activities.

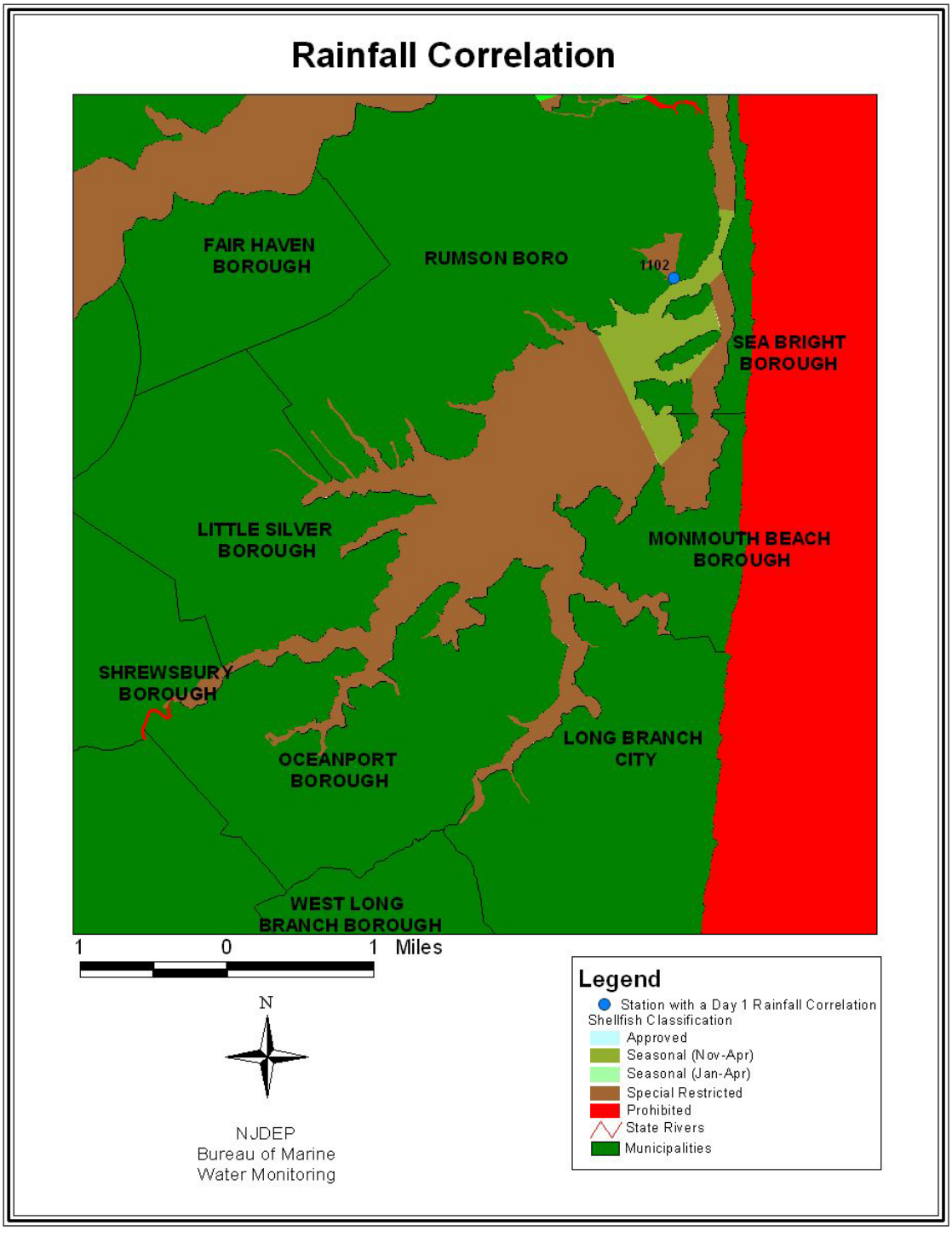
It should be noted that a particular short-term data set might not indicate significant rainfall effects even if the historical data indicate that a significant effect occurs in a particular area. This is due to one or more of the following factors:

- 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 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.

At this time, there is only one station with a rainfall correlation greater than 0.600 (see Figure 27). A relationship between rainfall amounts and total coliform levels is suggested if the rainfall correlation coefficient is greater than 0.600. Station 1102 shows a rainfall correlation (0.649) on the day before sampling. Rainfall does not appear to be a very significant factor for the rest of the stations located in this growing area (see Appendix for data).

FIGURE 27: RAINFALL CORRELATION



RELATED STUDIES

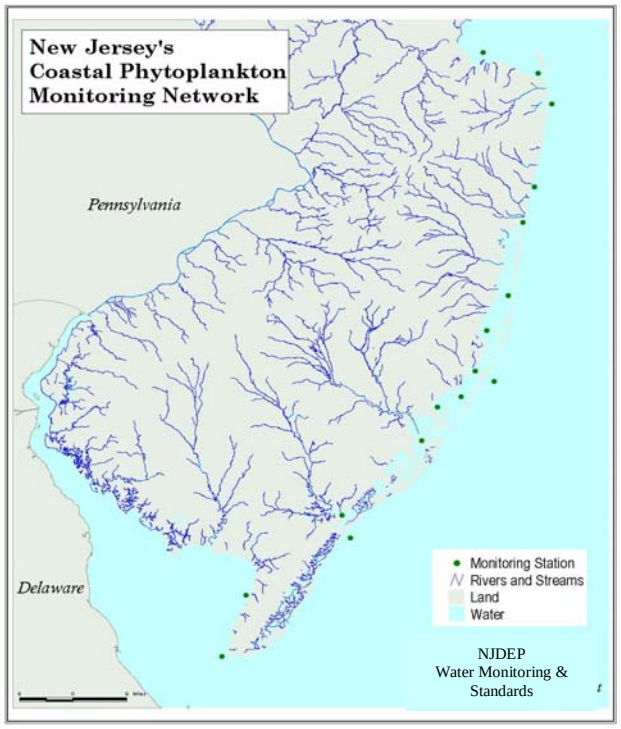
Although the Bureau of Marine Water Monitoring assesses classification based on total coliform bacteria, the laboratory is capable of running many other tests on the water samples. In addition to testing for total coliform, all samples retrieved prior to June of 2003 were also tested for fecal coliform (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, metals (awaiting funding), and nutrients.

Phytoplankton

Phytoplankton are photosynthetic algae that play a critical role at the base of aquatic food webs. Phytoplankton studies are used to show what species are present and in what concentration.

The Bureau of Marine Water Monitoring and USEPA (United States Environmental Protection Agency) Region 2 conduct routine helicopter surveillance throughout the summer to determine the occurrence of species of marine phytoplankton that could produce biotoxins (see Figure 28). The Bureau of Marine Water Monitoring, in accordance with the NSSP requirements, also analyzes the data. There have been no incidents of algal blooms with acute toxic phytoplankton in New Jersey during this report's time period (NJDEP Phytoplankton Reports, 1998-2002). The Sandy Hook and Raritan Bays, which connect to the Shrewsbury River, had some occurrences of mixed diatoms including the *Prorocentrum spp.* and *Skeletonema costatum* species. "The toxic species *Prorocentrum spp.* was present late in the 2002 sampling season, August and September, but below toxic or bloom concentrations. Historical blooms of *Prorocentrum spp.* have occurred in excess of 10,000 cells/ml in New Jersey's coastal waters with no toxic human health effects reported. No water discoloration was observed." (NJDEP Phytoplankton Reports, 1998-2002). Complete Phytoplankton reports are available at the Bureau of Marine Water Monitoring website, http://www.nj.gov/dep/bmw/reports.htm

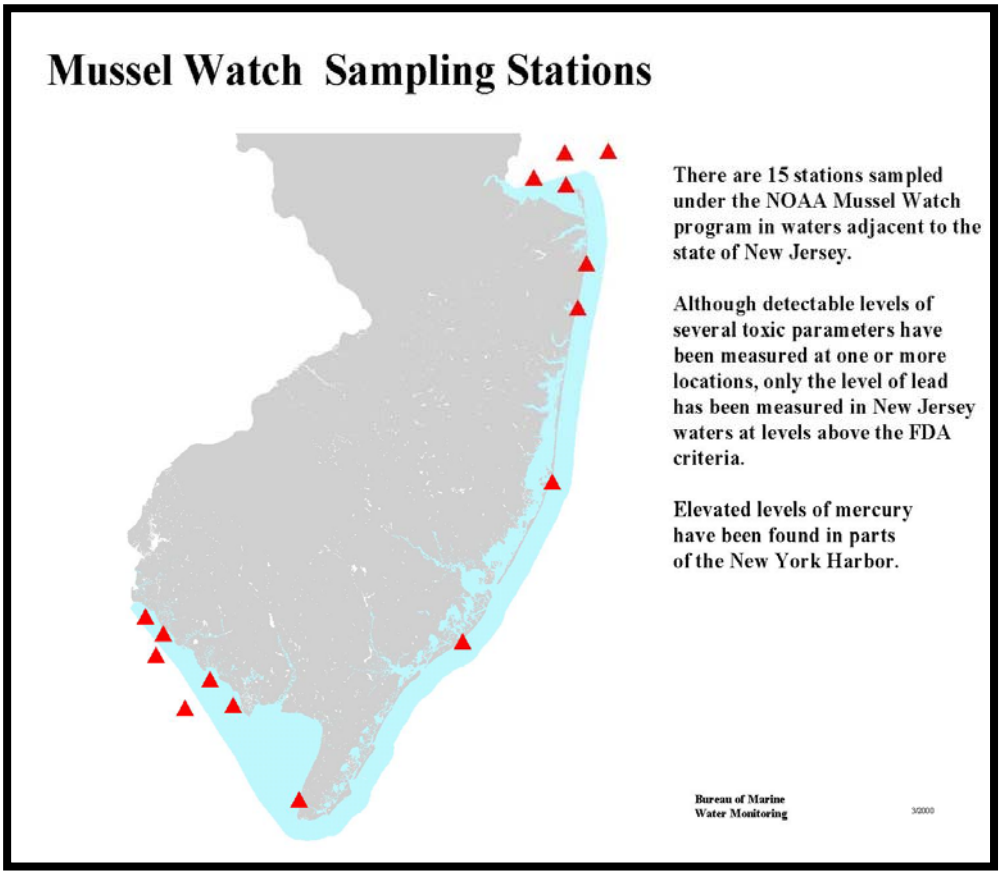
FIGURE 28: PHYTOPLANKTON STATIONS



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 not a mussel watch station within the Shrewsbury River Growing Area (see Figure 29).

FIGURE 29: SAMPLING SITES WHERE NOAA MUSSEL WATCH DATA HAS BEEN COLLECTED



NJDEP Shellfish Toxics Monitoring

In August 2000, the NJDEP collected a series of hard clam tissue samples from the Shrewsbury River that were analyzed for a suite of parameters. These included PCBs, PAH, and seven heavy metals (mercury, lead, copper, chromium, arsenic, nickel, and cadmium). Funding for these analyses was provided by the USEPA. Battelle Laboratories analyzed samples.

All results are significantly lower than the applicable FDA criteria (in the case of mercury) or level of concern (for other parameters). Most results are at least a factor of 10 and in many cases a factor of 100 less than the applicable standard.

Most results are, likewise, below the more stringent USEPA Screening Values updated in 2000 (based on updated IRIS values and consumption studies, see Table 8). These values are used as an indication of areas where more data are needed to make a determination regarding human and/or ecosystem health issues. Many of the arsenic values are close to or greater than the

USEPA Screening Value for arsenic (maximum value measured was 1.33 μg/g wet weight; screening value is 1.20 μg/g wet weight). When these screening values are exceeded, it is recommended that further analyses should be conducted. In addition, the samples were analyzed for total arsenic, rather than inorganic arsenic. The organic form of arsenic is not readily available within the tissue and is therefore of limited risk.

There is only one PAH, benzo(a)pyrene, for which the USEPA has developed a screening value (see Table 9). This compound has high carcinogenic capacity. All values were well below the screening value.

Contaminants, such as PCBs, accumulate in fatty tissue and increase in concentration as you move up the food chain. Shellfish are typically lower in lipids as compared to fish, and are low on the food chain. For these reasons, PCB levels in shellfish will be substantially lower compared to fish species in the same waters.

NCA Sediment Toxics

The EPA Region 2 Office in Edison, NJ has reported detecting PAH's in crabmeat from Troutman's Creek (a tributary to the Shrewsbury River).

TABLE 8: RESULTS OF METALS TISSUE ANALYSIS (MEAN VALUE, RESULTS IN μG/G WET WEIGHT)

Station	N	Cr	Ni	Cu	As	Cd	Pb	Hg
1100A	1	0.568	1.67	1.1	0.923	0.059	0.421	0.0107
1111B	1	0.477	1.07	2.36	1.33	0.148	0.554	0.0317
1118A	1	0.654	1.24	1.89	1.31	0.14	0.42	0.0351
1133A	1	3.74	3.89	0.854	0.728	0.049	0.186	0.0125
USEPA tissue screening level (USEPA, 2000)		Not available	Not available	Not available	1.2	4	Not available	0.4
USFDA tissue standard (ISSC, 2003)		13	80	Not available	86	4	1.7	1.0

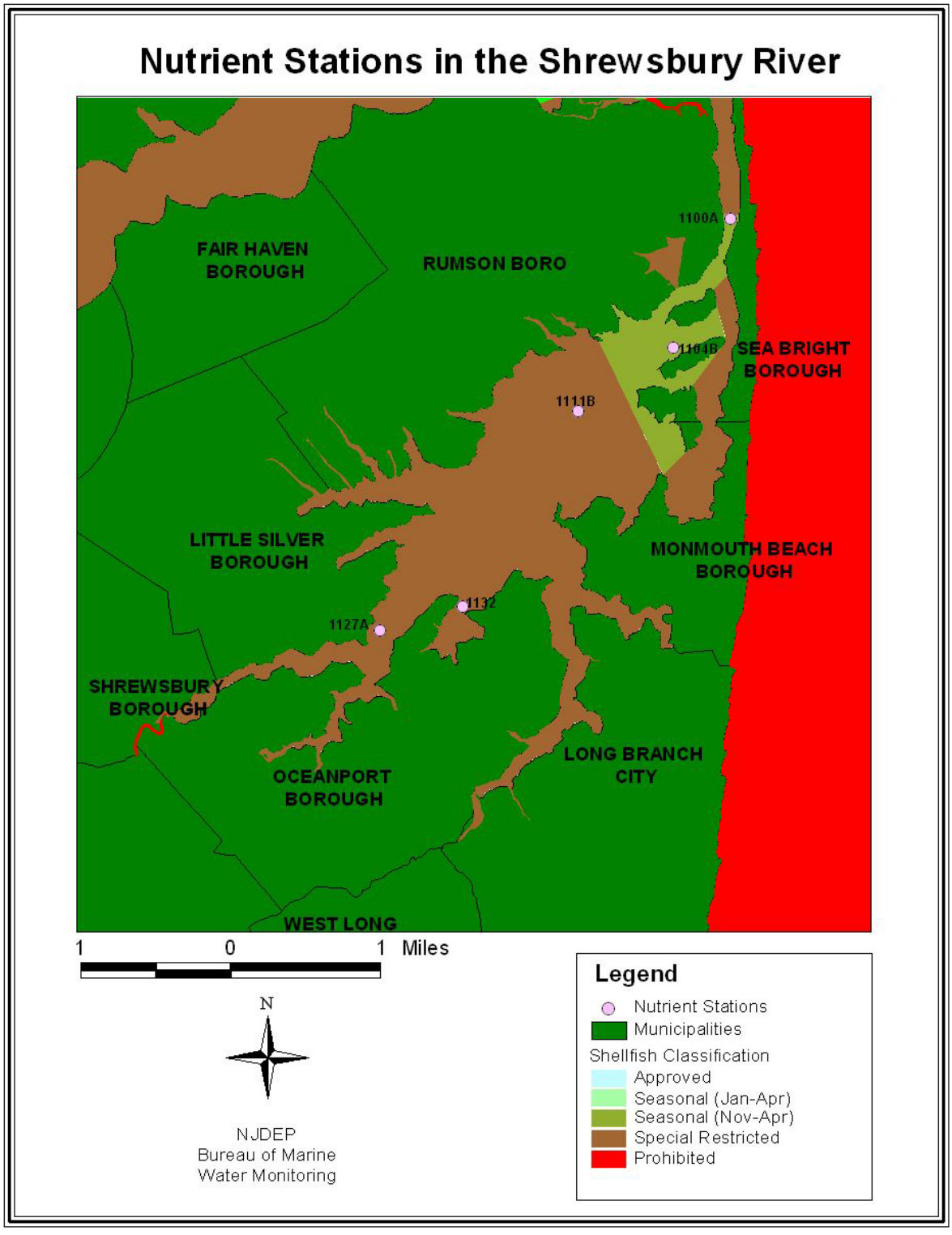
TABLE 9: RESULTS OF PCB AND PAH TISSUE ANALYSIS (MEAN VALUE, RESULTS IN µG/KG WET WEIGHT)

Station	N	Total PCB	Total PAH	Benzo(a)pyrene
1100A	1	7.49	12.36	0.08
1111B	1	3.11	12.61	0.07
1118A	1	7.07	14.49	0.24
1133A	1	6.33	17.18	0.14
USEPA tissue screening level (USEPA 2000)		20	Not available	5.46
USFDA tissue standard		2000	Not available	Not available

Nutrients

Nutrient and dissolved oxygen samples are collected at 5 stations, 1100A, 1104B, 1111B, 1127A, & 1132, within the Shrewsbury 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 last nutrient report was written in 1999 and contains data from 1993-1997. This report states that the waters of the Shrewsbury River on average tend to have oxygen supersaturation, especially during the winter. Oxygen supersaturation can inhibit clams from growing, and sometimes cause mortality (Flimlin, 2003).

FIGURE 30: 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 October 1, 1998 to September 30, 2003. 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 *Seasonal (Nov-Apr)* and *Special Restricted* classifications under the total coliform standard. Based on the data, this growing area is adequately classified. In fact, if there is a continuing trend of improving water quality, portions of the Shrewsbury River have the potential to be upgraded based on total coliform levels within the next few years.

There were 3 stations with a tidal component, 22 with a seasonal component, and one station was impacted by rainfall. On analysis it was found that none of these impacted stations require a change in classification.

CONCLUSIONS

BACTERIOLOGICAL EVALUATION

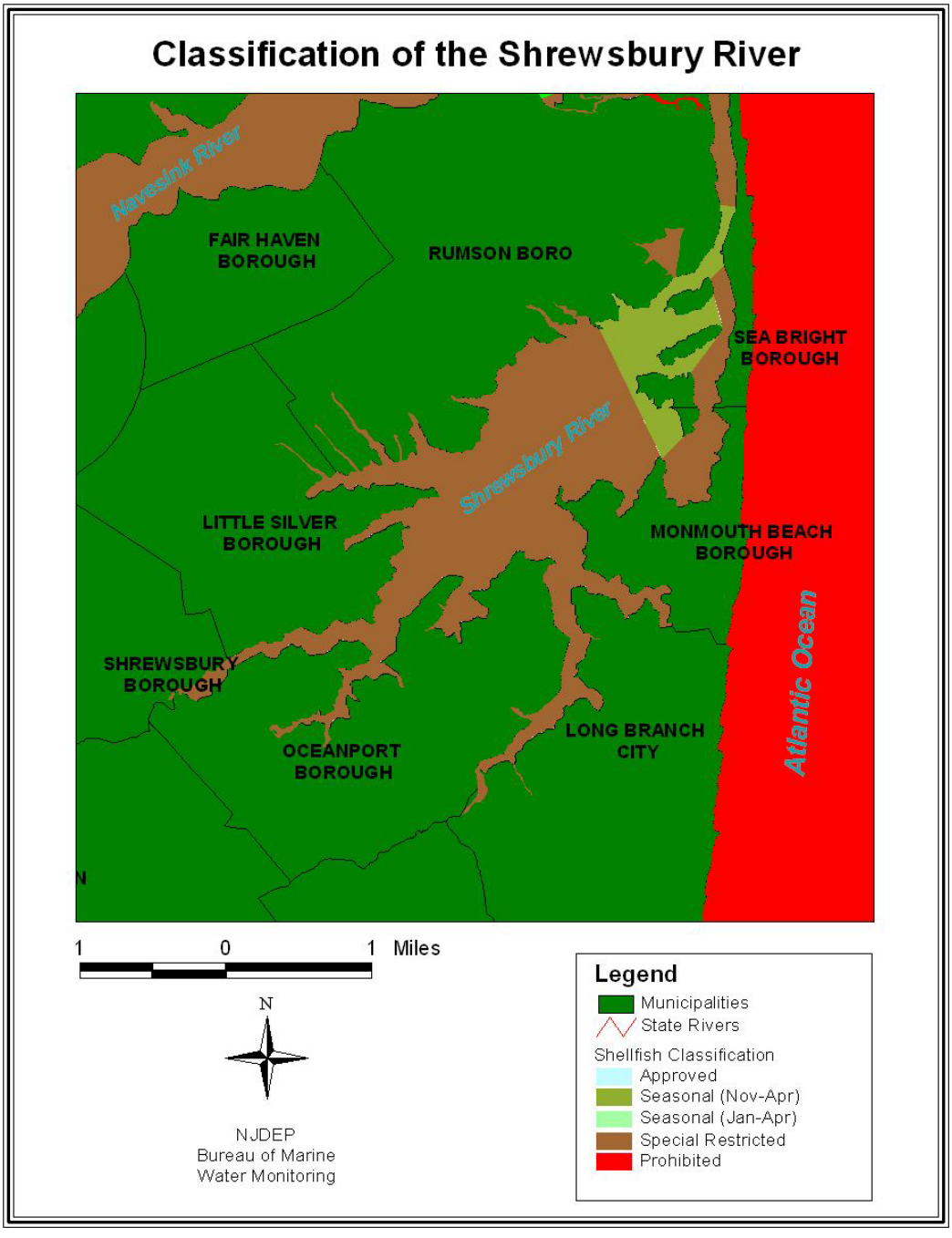
Analysis of the Shrewsbury River shellfish growing area samples indicate that the geometric mean and 90^{th} percentile total coliform levels meet the standards of the National Shellfish Sanitation Program (NSSP).

The *Seasonal (Nov-Apr)* portion of the Shrewsbury River is acceptably classified, as supported by the current coliform levels. This *Seasonal (Nov-Apr)* area contains some marinas, but they are only fully functional in the summer months, so the water remains safe for harvesting shellfish during the winter months.

Although all of the Shrewsbury River fits within the *Approved* criteria, it should be monitored for a few more years before a decision is made for an upgrade. The stations at the mouth of the small creeks of the Shrewsbury River, like Little Silver Creek and Oceanport Creek, in particular, should analyzed further when more rainfall data is obtained. The minimal amount of significant rainfall in this time period limits further exploration. An intensive storm water study may help to provide the necessary information to identify and

mitigate sources of contamination in the Shrewsbury River. Until further information is obtained, the bulk of the Shrewsbury River will remain classified as *Special Restricted* (see Figure 31).

FIGURE 31: CURRENT CLASSIFICATION



RECOMMENDATIONS

BACTERIOLOGICAL EVALUATION

Presently, there are no recommended classification changes. However, the continuing improvement to the water quality of the Shrewsbury River is a promising trend. Efforts such as those to make the Shrewsbury River a 'no discharge zone' and to improve the Monmouth Racetrack waste system have apparently helped to improve the water quality.

However, the small creeks of the Shrewsbury are not currently sampled, and the stations nearest to the mouths of these creeks tend to have high coliform levels after a significant rainfall. Starting in May of 2004, stations 1117A, 1118A, 1125A, 1128A, & 1132 will be tested using the three-tube, four-dilution standard total coliform fermentation test instead of the three-tube, three-dilution standard total coliform fermentation test. The upper limit of the four-dilution total coliform test is 24,000 MPN in comparison to the 2,400 MPN limit of the three-dilution test. The four-dilution will therefore capture those occurrences when the total coliform levels reach the 2,400 MPN limit on the three-dilution test, but have the potential of reaching a higher MPN number on the four-dilution test. The Bureau of Marine Water Monitoring is doing the four-dilution test on stations that regularly exceed the 2,400 MPN on the three-dilution test. The results from the four-dilution test will help in assessing the future classification of the Shrewsbury River.

In the meantime, the rainfall levels and the effect they have on the coliform levels will be closely monitored.

RECOMMENDED CLASSIFICATION CHANGES

There are currently no changes in classification for the Shrewsbury River. All stations fit within their respective classification criteria. A portion of this area may be considered for an upgrade in the next sanitary survey if the trend of improving water quality continues and the rainfall situation is addressed.

RECOMMENDED CHANGES IN MONITORING SCHEDULE

The recommendation for the 2006 sampling season is to reactivate stations 1137B, 1138, and 1140A in Branchport Creek/Troutman's Creek. The recommendation for the remaining portion of the Shrewsbury River is that the monitoring schedule be maintained. This area is currently sampled by one assignment run under the Systematic Random Sampling strategy. There are currently forty-three stations and ten runs are done per year.

RECOMMENDATIONS FOR FURTHER STUDY

A storm water study is recommended to provide the necessary information to identify and mitigate sources of contamination in the Shrewsbury River.

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APPENDICES

A. Statistical Summary

B. Tidal Evaluation

C. Seasonal Evaluation

D. Precipitation

Rainfall Correlation

Cumulative Rainfall

E. Data Listing – October 1, 1998 through September 30, 2003