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Water Monitoring and Standards
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Water Monitoring Project

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PARTIAL SANITARY SURVEY OF

SHELLFISH GROWING AREA SE-2:

LITTLE BAY TO BEACH THOROFARE

1999 - 2003

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PARTIAL SANITARY SURVEY OF SHELLFISH GROWING AREA SE-2 LITTLE BAY TO BEACH THOROFARE

1999-2003

New Jersey Department of Environmental Protection
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EXECUTIVE SUMMARY

The water quality data presented in this Partial Sanitary Survey Report for Shellfish Growing Area SE-2 were collected between October 1999 and September 2003. Shellfish growing area SE 2 is located in the southern part of New Jersey, in Atlantic County. This shellfish growing area encompasses several main water bodies, channels, thorofares, and inlets. The primary water bodies in this shellfish growing area are Absecon Bay, Reed Bay, and Little Bay. The current classifications for this shellfish growing area are *Approved*, *Seasonally Approved (November to April) and Seasonally Approved (January to April), Special Restricted, and Prohibited*. Data were collected using the Systematic Random Sampling (SRS) and the Adverse Pollution Condition (APC) strategies. Approximately 4,318 samples were collected from 113 sampling stations and were analyzed for total coliform (TC) and fecal coliform (FC) bacteria. The water quality of this shellfish growing area corresponded to the current classifications of *Approved*, *Seasonal, Special Restricted, and Prohibited*. With exceptionally good water quality data for the past nine years in the Absecon Bay area, it is recommended that a portion of Absecon Bay and Absecon Channel be upgraded from *Seasonal (November to April)* to *Approved* year-round. The proposed area will include portions of Absecon Bay and Absecon Channel, up to the Justice Vincent Haneman Bridge, and all of Wills Thorofare and Low Water Thorofare. The proposed areas for upgrade will be equivalent to approximately 1,916 acres.

INTRODUCTION

PURPOSE

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

FUNCTIONAL AUTHORITY

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

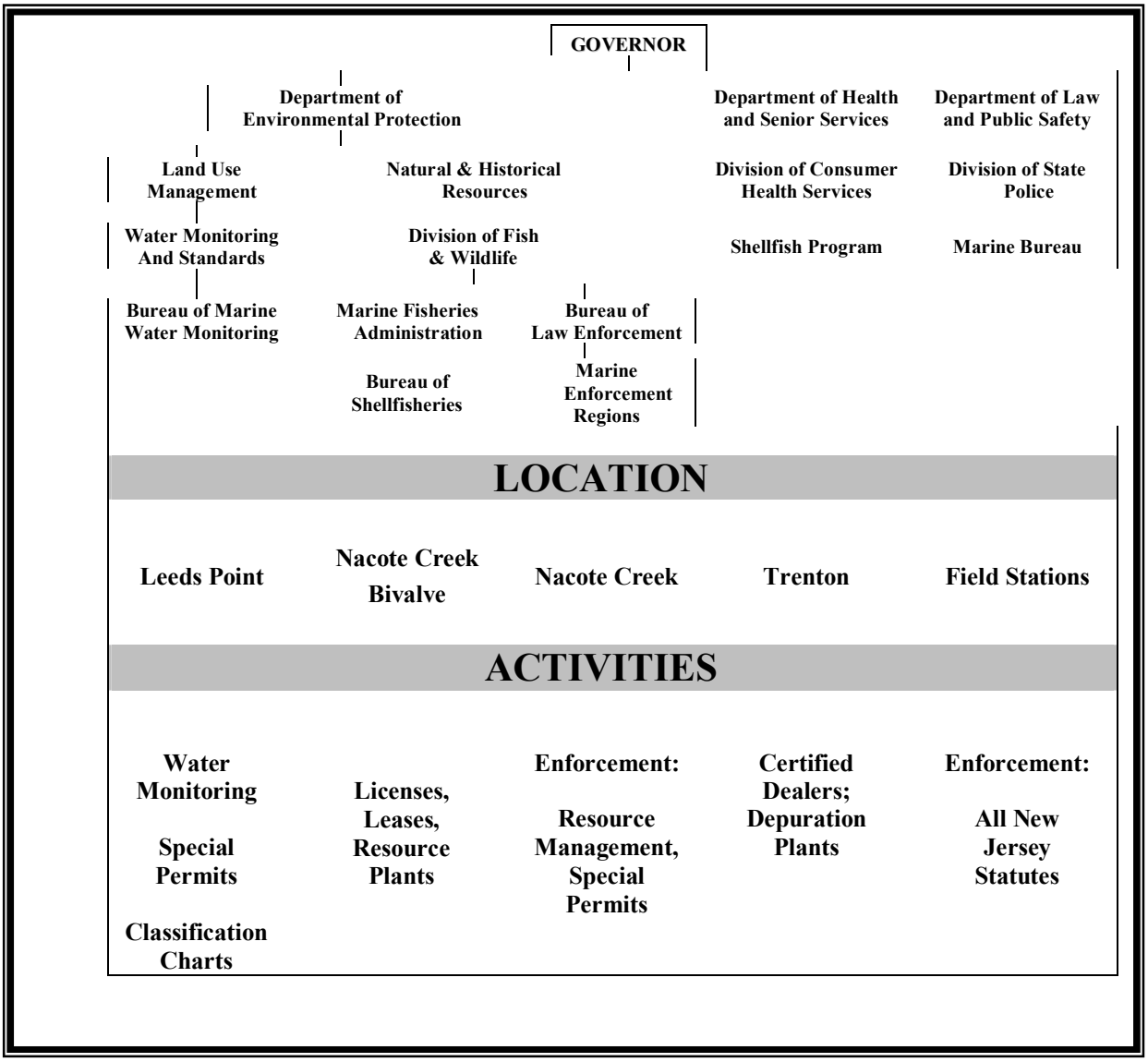
The Bureau of Shellfisheries, in the Division of Fish and Wildlife, issues harvesting licenses and leases for shellfish grounds under the Authority of N.J.S.A. 50:2 and N.J.A.C. 7:25. This Bureau, in conjunction with the Bureau of Marine Water Monitoring (BMWM), is responsible for administering and or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

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

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

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

FIGURE 1: STATE OF NEW JERSEY SHELLFISH AGENCIES



IMPORTANCE OF SANITARY CONTROL OF SHELLFISH

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

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

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

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

The following narrative constitutes this bureau's assessment of the above mentioned components and determines the current classification of the shellfish growing waters.

PROFILE

LOCATION

Shellfish growing area SE-2 is located in the southern part of New Jersey, in Atlantic County. This shellfish growing area encompasses several main water bodies, channels, thorofares, and inlets. The primary water bodies in this shellfish growing area are Absecon Bay, Reed Bay, and Little Bay. Enclosed in these water bodies are numerous thorofares, channels, and inlets. Some of the larger thorofares and channels are the Absecon Channel, Beach Thorofare, Bonita Tideway, and Brigantine Channel. There are also several coves in this shellfish growing area, which include Hammock Cove, Perch Cove, Somers Cove, and Turtle Cove (see Figure 2).

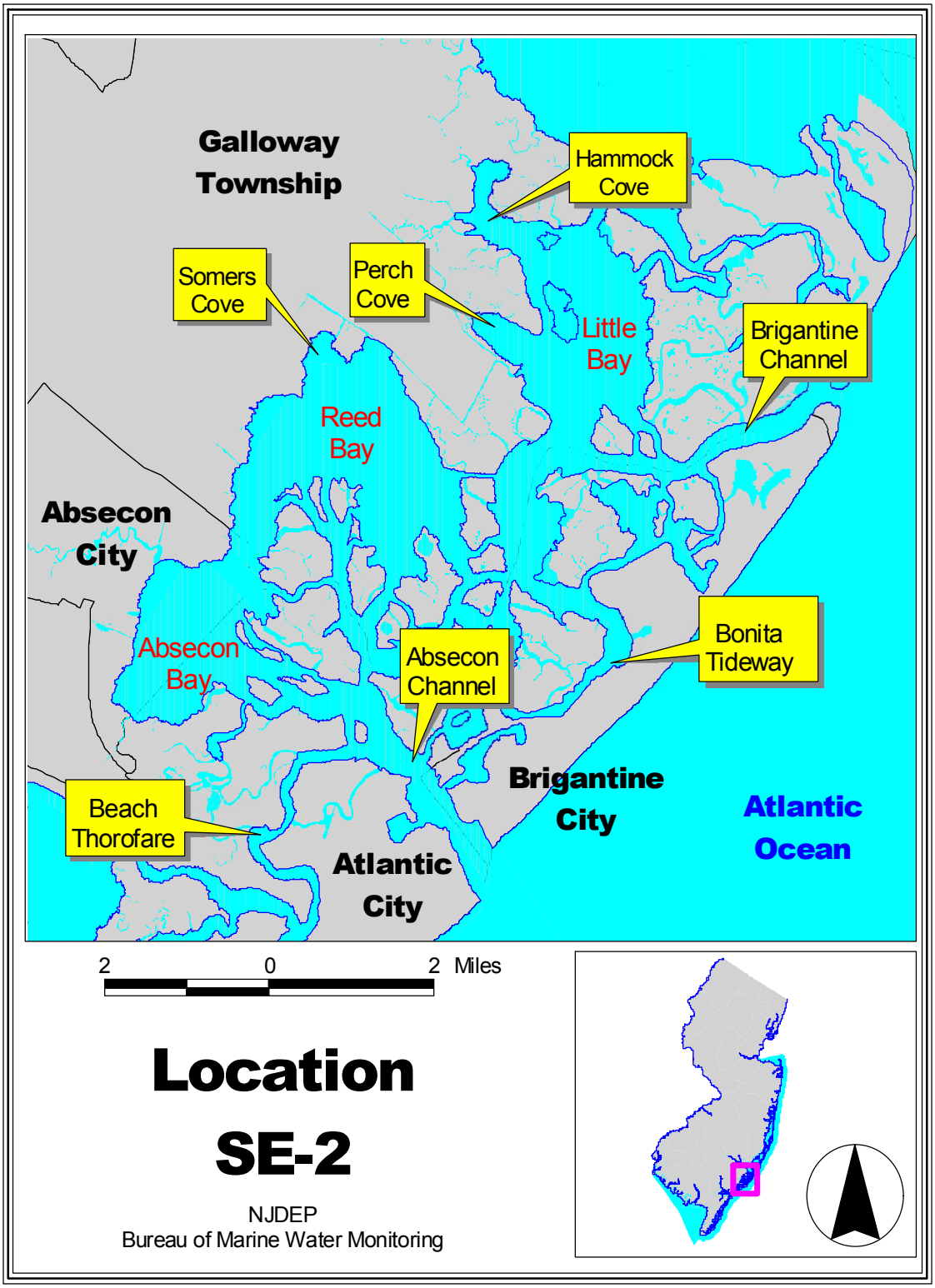
The location of shellfish growing area SE-2 can also be found on the "2004 State of New Jersey Shellfish Growing Water Classification," chart 6 and chart 7.

The following municipalities are adjacent to shellfish growing area SE-2, Absecon City, Atlantic City, Brigantine City, and Galloway Township. Within these four municipalities, Atlantic City has the highest residential population as well as the most amounts of people living in one square mile. This is mainly due to the expansion of the casino industry. See Table 1 for population information (US Census Bureau).

TABLE 1: POPULATION INFORMATION (SOURCE: WWW.CENSUS.GOV)

Community	Area (sq. mi.)	Population Census		2000 Population Density
		2000	1990	
Absecon City	5.72	7,638	7,298	1335
Atlantic City	11.35	40,517	37,986	3570
Brigantine City	6.43	12,594	11,354	1959
Galloway Township	90.43	31,209	23,330	345
Pleasantville City	5.80	19,012	16,027	3278

FIGURE 2: LOCATION AND MUNICIPALITIES OF SHELLFISH GROWING AREA SE-2



DESCRIPTION

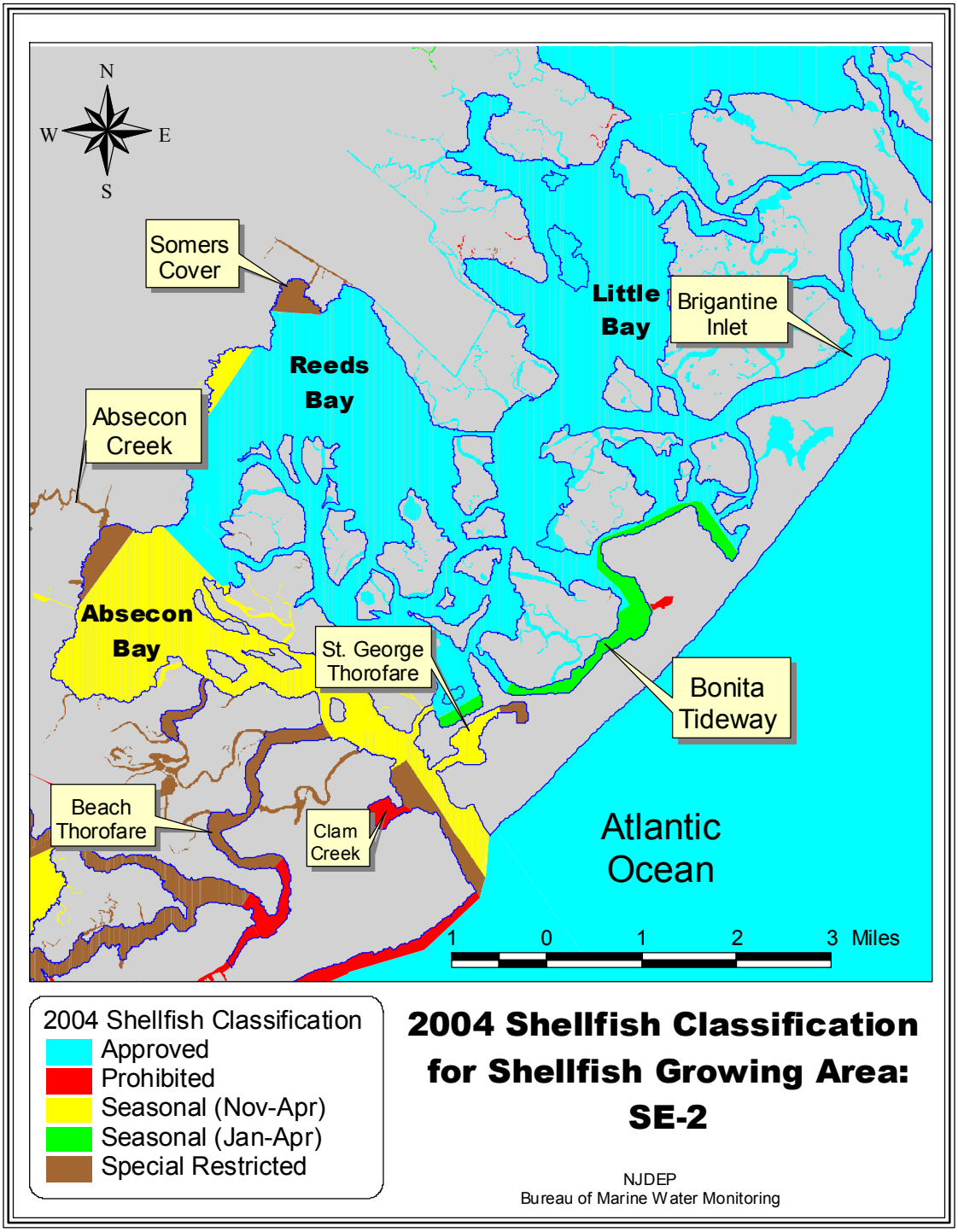
The principal bodies of waters in shellfish growing area SE-2 are Absecon Bay, Reeds Bay, Little Bay, Grassy Bay, and the Absecon and Brigantine channels. The current classifications for this shellfish growing area are *Approved*, *Seasonally Approved (November to April) and Seasonally Approved (January to April)*, *Special Restricted*, and *Prohibited*. The approximate size of this shellfish growing area is 14,260 acres, of which 10,500acres are classified as *Approved*, 2,498 acres are classified as *Seasonal (November to April)*, 373 acres are classified as *Seasonal (January to April)*, 824 acres are classified as *Special Restricted*, and 65 acres are classified as *Prohibited*.

The Absecon Bay, Absecon Channel, St. Georges Thorofare, and a portion of Absecon Inlet are classified as *Seasonally Approved (November to April*). *Seasonally Approved (January to April)* areas include Bonita Tideway, Wading Thorofare, and Obes Thorofare. Waters toward Atlantic City, including Beach Thorofare and Clam Creek, are either classified as *Special Restricted* or *Prohibited*. *Approved* waters can be found in Reeds Bay, Grassy Bay, and Little Bay.

Tidal flushing from the Atlantic Ocean is through Brigantine Inlet and Absecon Inlet or from Great Bay through Main Marsh Thorofare. The only major source of fresh water to this area comes from the Atlantic City Reservoir, which is approximately 2.49 miles northwest of the Absecon Bay. Waters from the reservoir flow directly to Absecon Creek, which then discharges to Absecon Bay. Absecon Creek is estimated to be 3.12 miles in distance from the tip of the reservoir to the mouth of Absecon Bay.

This shellfish growing area can be found on chart 6 and 7 of the "2004 State of New Jersey – Shellfish Growing Water Classification Charts" (NJDEP, 2004). Figure 3 shows the current Shellfish Classification for this area.

FIGURE 3: CURRENT CLASSIFICATION OF SHELLFISH GROWING AREA SE-2



HISTORY OF SHELLFISH GROWING AREA

During the 1960's, more than fifty percent of the waters in shellfish growing area SE-2 were classified as *Prohibited*. This included Absecon Bay, Absecon Channel, Bonita Tideway, Broad Creek, Beach Thorofare, and portion of Reeds Bay. The *Prohibited* classification was initiated by several contributing factors. One of the main attributes was due to the effluent discharge from the Atlantic City and Brigantine City Wastewater Treatment Facilities, which emptied directly into St. Georges Thorofare and Beach Thorofare.

Other contributing factors included malfunctioning septic systems and illegal dumping. During the 1960's and early 1970's, municipalities surrounding this shellfish growing area were still on septic systems. The Atlantic County Utilities Authority did not begin its operation until September 18, 1978.

By the 1980's, the water quality for the SE-2 area had greatly improved, due to the elimination of the Atlantic City wastewater plant and its discharge to the SE-2 area. A portion of the SE-2 area was then upgraded from *Prohibited* to *Special Restricted* and *Seasonally Approved*.

Since then, the water quality for shellfish growing area SE-2 continues to improve. Therefore, it is recommended that the section of the *Seasonally Approved (November-April)* waters located in Absecon Bay, Absecon Channel, and adjacent tributaries be upgraded to *Approved year-round*. See section on *Water Quality Studies* for further details.

METHODS

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

Approximately 4,318 water samples were collected for total and fecal coliform bacteria between 1999 and 2003 and analyzed by the three tube MPN method according to APHA (1970). Figure 23 shows the shellfish growing water quality monitoring stations in the SE-2 area. Approximately 113 stations are monitored during each year.

Water quality sampling, shoreline and watershed surveys were conducted in accordance with the NSSP *Guide for the Control of Molluscan Shellfish,* 1999 Revision.

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

BACTERIOLOGICAL INVESTIGATION AND DATA ANALYSIS

The water quality of each growing area must be evaluated before an area can be classified as *Approved, Seasonally Approved, Special Restricted,* or *Seasonal Special Restricted*. Criteria for bacterial acceptability of shellfish growing waters are provided in NSSP *Guide for the Control of Molluscan Shellfish,* 1999 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 coliforms 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 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 SE-2 area is sampled under both the Systematic Random Sampling strategy and Adverse Pollution Condition strategy as 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, it does make corresponding fecal coliform determinations for each sampling station. These data are viewed as adjunct information and are not directly used for classification.

The criteria were developed to ensure that shellfish harvested from the designated waters would be free of pathogenic (disease-producing) bacteria. Each classification criterion is composed of a measure of the statistical 'central tendency' (geometric mean) and the relative variability of the data set. For the Adverse Pollution Condition sampling strategy, variability is expressed as the percentage that exceeds the variability criteria (see Table 2). For the Systematic Random Sampling Strategy, variability is expressed as the 90^{th} percentile (see Table 3).

Areas to be approved under the *Seasonal* classification must be sampled and meet the criterion during the time of the year that it is approved for the harvest of shellfish.

TABLE 2: CRITERIA FOR ADVERSE POLLUTION 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

MARINE BIOTOXINS

The Department collects samples at regular intervals throughout the summer to determine the occurrence of marine algae that produce biotoxins. See Figure 4, for the location of Phytoplankton sampling stations. Certain planktonic species have the potential to adversely affect the suitability of shellfish for human consumption. These planktonic species cause algal blooms that deplete the dissolved oxygen levels in the water. No algal blooms capable of producing biotoxins were identified for this area. These data are evaluated weekly by the Bureau of Marine Water Monitoring in accordance with the NSSP requirements. An annual report is compiled and is available electronically at: *www.state.nj.us/dep/wms/bmw*.

FIGURE 4: LOCATION OF PHYTOPLANKTON SAMPLING STATION

SHORELINE SURVEY

CHANGES SINCE LAST SURVEY

The field surveys for this Partial Sanitary Survey Report were conducted in March and August of 2004. The last survey performed for this area was written in the 1998-2002 Reappraisal Report. Since then, there have been no major developments that would directly impact the water quality of this shellfish growing area. However, there were other developments that took place adjacent to shellfish waters.

New developments were in Absecon City and in Brigantine City. This included the construction of the Home Depot (opened 2003) and the Empire Inn (still under construction), both located on the White Horse Pike (Rte. 30), in Absecon City (see Figure 5 and 6). In Brigantine City, the construction of single family homes were being built along the shoreline of St. George Thorofare (a.k.a. Black Hole) and the removal of the old Brigantine Bridge was in progress (see Figure 7 and 8). These were the only developments that took place in close proximity to shellfish waters. All other developments were further inland and would have no potential impact to this shellfish growing area.

During the field survey, it was observed that the bird populations in this area were extremely high. In certain places, more than three hundred birds (mostly Brant) were found sitting in the shallow area of the bay (see Figure 9). When these birds disperse in the air, they would release their feces into the water below, thus contaminating the surrounding area.

FIGURE 5: THE NEW HOME DEPOT LOCATED ON THE WHITE HORSE PIKE IN ABSECON CITY

FIGURE 6: LOCATION OF THE NEW EMPIRE INN ON THE WHITE HORSE PIKE IN ABSECON CITY (STILL UNDER CONSTRUCTION)

FIGURE 7: CONSTRUCTION OF NEW HOMES WITHIN ST. GEORGE THOROFARE

FIGURE 8: REMOVAL OF THE OLD BRIGANTINE BRIDGE IN PROGRESS

FIGURE 9: MIGRATION OF BIRDS TO SHELLFISH GROWING AREA SE-2

LAND USE

This shellfish growing area is heavily developed with urban areas (see Figure 10). Absecon City, Brigantine City, and Galloway Township consisted primarily of residential populations with very few large commercial developments. However, Atlantic City is highly developed. It is known as the second biggest gambling city in the United States. The casino industry employs thousands of people and brings millions of tourists each year to this area. Therefore, the city is constantly under expansion. All of the municipalities adjacent to shellfish growing area SE-2 are connected onto a public sewer system, which is operated by the Atlantic County Utilities Authority, located at 1801 Absecon Blvd. (Rte. 30) in Atlantic City.

The shellfish waters of growing area SE-2 are enclosed by wetlands, which act as a barrier from the surrounding population center (see Figure 11). The wetland acts both as a purifier against pollutants as well as utilizes the nutrients obtained for plant growth. By doing so, the wetland helps to reduce pollutants entering into the shellfish growing area. A large portion of land use in this shellfish growing area is designated as wetlands (see Table 4). Most of these lands belong to the Edwin B. Forsythe National Wildlife Refuge.

FIGURE 10: LAND USE PATTERNS

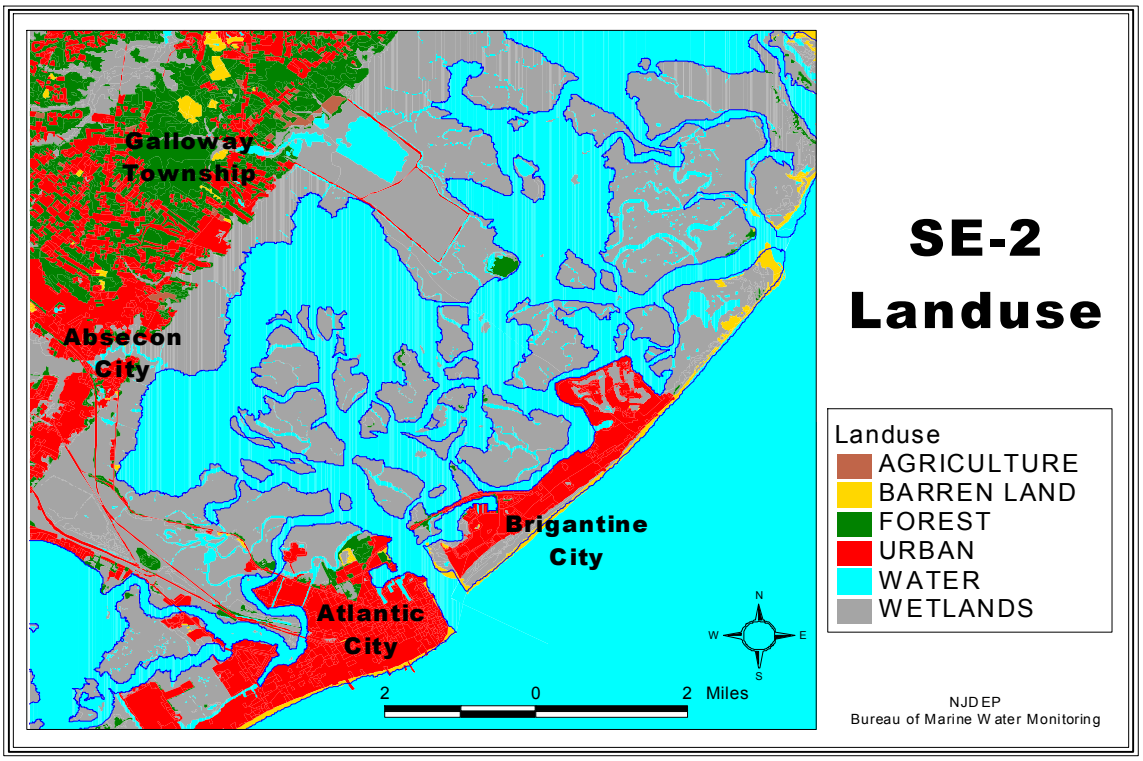


FIGURE 11: WETLAND SURROUNDING SHELLFISH GROWING AREA SE-2

TABLE 4: LAND USE FOR GREAT EGG HARBOR: WMA 15 (SOURCE: HTTP://WWW.NJ.GOV/DEP/GIS/)

Land Use Type	1986 (in acres)	1995 (in acres)	Net Change (in acres)
Agriculture	22,880	21,113	-1,767
Barren Land	4,799	4,928	129
Forest	156,317	151,413	-4,904
Water	28,284	28,463	179
Urban Land	53,558	60,219	6,662
Wetlands	111,047	110,748	-299

EVALUATION OF BIOLOGICAL RESOURCES

In 2002, New Jersey harvested 84,776,705 pounds of shellfish meat, value at $81,871,542. The shellfish species include hard clams (Mercenaria mercenaria), soft clams (Mya arenaria), mussels, bay scallops (Aequipecten irradians), oysters (Crassostrea virginica), ocean quahogs (Arctica islandica), surf clams (Spisula solidissima), and sea scallops (Placopecten magellanicus), (www.st.nmfs.gov., 2004).

Reeds Bay and Absecon Bay are very shallow, approximately 5-7 feet in depth, which make them very productive in generating hard clams (*Mercenaria mercenaria*). According to a past survey conducted in the SE-2 area by the U.S. Fish and Wildlife Service in cooperation with the Bureau of Shellfisheries, in 1963, it was found that there were an abundance of hard clams in the area, which were commercially valuable. The most recent survey, conducted between 1985 and 1990 by the Bureau of Shellfisheries, found average-to-moderate density of hard clams in Golden Hammock Thorofare, Bonita Tideway, Obes Thorofare, Steelman Bay, and St. George Thorofare.

SE-2 supports a very large seasonal population of waterfowl, wading birds, and shore birds. There are two wildlife refuges found in this area. One is the Edwin B. Forsythe National Wildlife Refuge and the other is the Absecon Wildlife Management Area (see Figure 12). The Edwin B. Forsythe National Wildlife Refuge (see Figure 13) is located ten miles north of Atlantic City. The refuge covers approximately 46,000 acres, which includes portions of the following counties: Atlantic, Burlington, and Ocean. Nearly 80% of the refuge is tidal salt meadow and marshes. The remaining acreage is wooded land that is dominated by pitch pines, oaks, and white cedar.

FIGURE 12: LOCATION OF OBSERVED WILDLIFE HABITAT IN SHELLFISH AREA SE-2

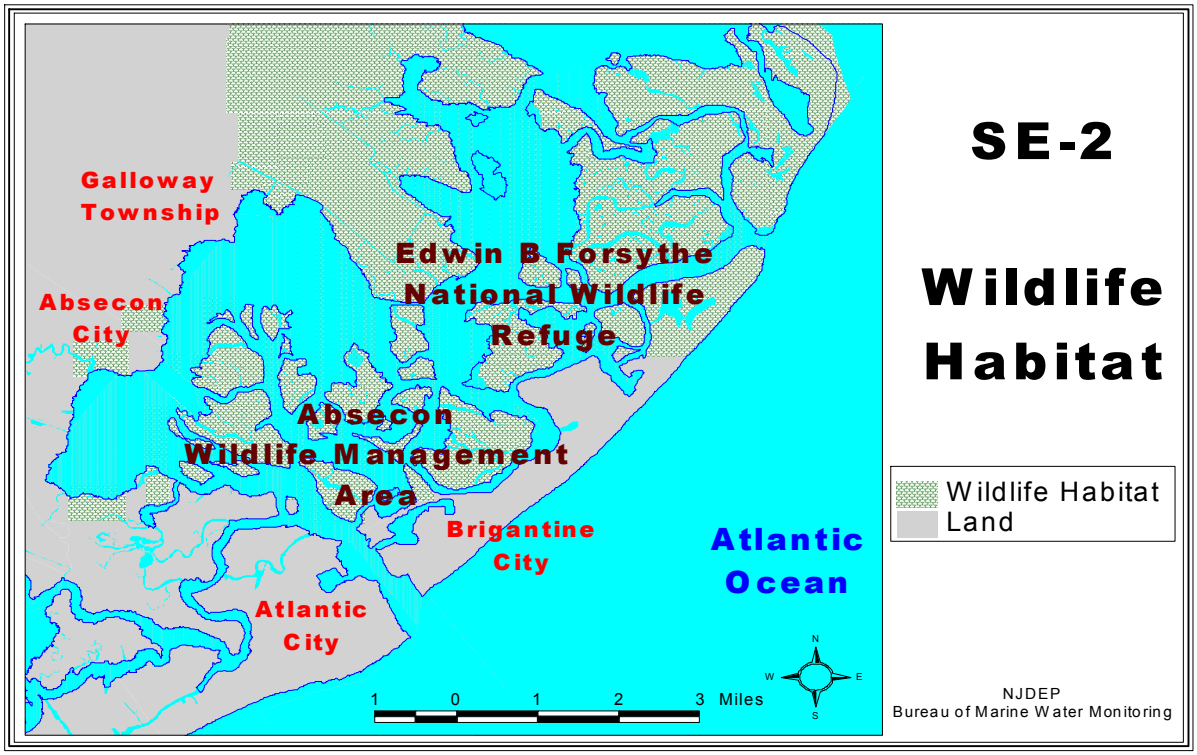


FIGURE 13: EDWIN B. FORSYTHE NATIONAL WILDLIFE REFUGE

IDENTIFICATION AND EVALUATION OF POTENTIAL POLLUTION SOURCES

EFFLUENT DISCHARGES

There are no direct discharges to the SE-2 area. However, there is one wastewater treatment facility located in Atlantic City. The Atlantic County Utilities Authority Wastewater Treatment Plant is located at 1801 Absecon Boulevard (see Figure 14). This facility became operational on September 18, 1978, and provides service to the following communities: Absecon, Atlantic City, Brigantine, Egg Harbor City, Egg Harbor Township, Hamilton Township, Linwood, Longport, Margate, Mays Landing, Northfield, Pleasantville, Somers Point, and Ventnor. This facility discharges its treated effluent to the Atlantic Ocean (see Table 5). The discharge pipe is approximately 1.59 miles off the shore, on Raleigh Avenue in Atlantic City. Since the discharge is directed to the Atlantic Ocean, there is no direct impact onto the SE-2 area (see Figure 15).

FIGURE 14: ATLANTIC COUNTY UTILITIES AUTHORITY

FIGURE 15: ACUA DISCHARGE POINT

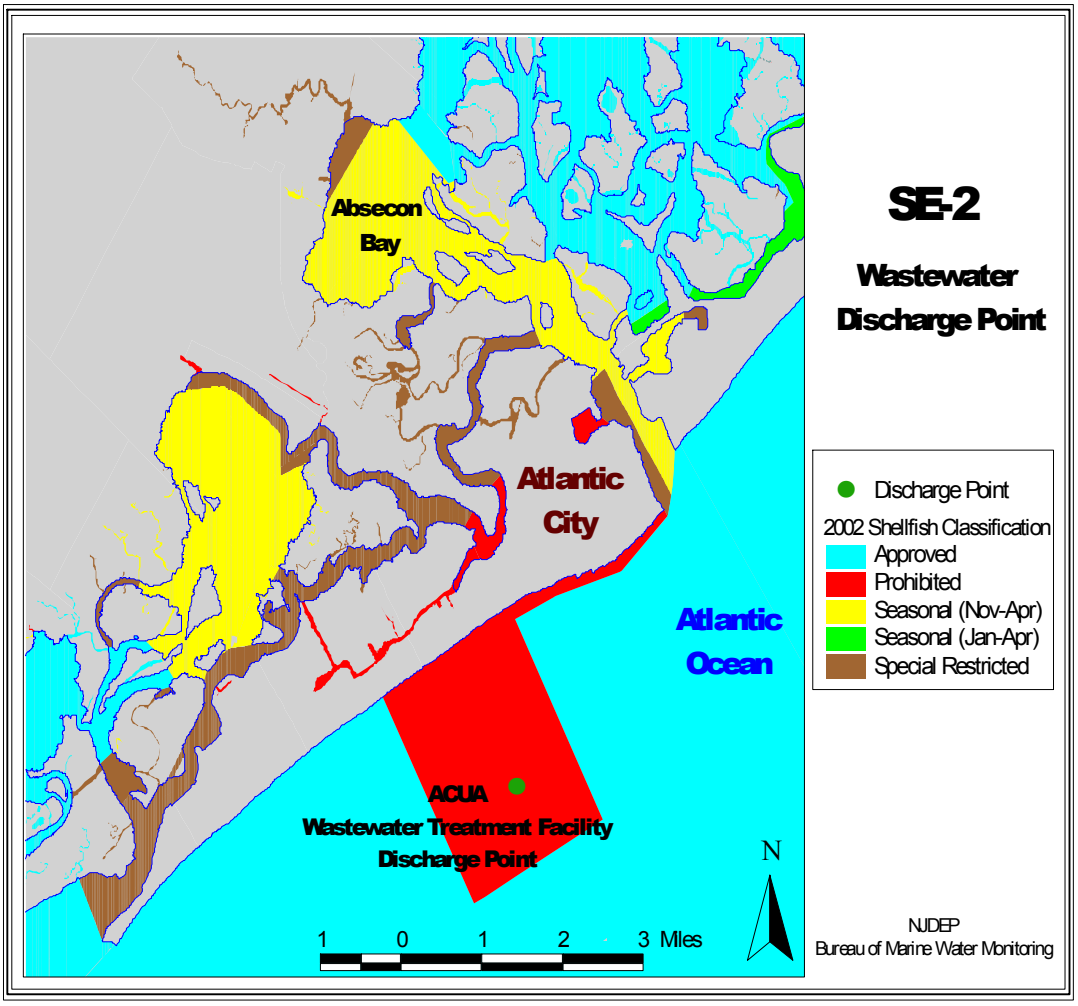


TABLE 5 : DISCHARGES FACILITY IN THE SHELLFISH GROWING AREA SE-2

Discharge Facility	Waste Type	Waste Quantity (MGD)
Atlantic County Utilities Authority	Sanitary	29.5

INDIRECT DISCHARGES

There are several indirect ground water discharges, known contaminated sites, and solid waste landfills located in this shellfish growing area. Since there is a potential for pollutant inputs from these indirect sources into these shellfish growing waters, it is important to continue monitoring the water quality to determine the presence or absence of these indirect sources of pollution

Indirect discharges are defined as sites and properties within the state where contamination of soil or ground water has been identified or where there has been, or there is suspected to have been, a discharge of contamination (NJDEP). There are several ground water contaminated sites found in close proximity to shellfish growing area SE-2 (see Figure 16). Most of these sites have either been closed or are currently going through the Site Remediation Program.

Known contaminated sites are reported throughout the SE-2 area (see Figure 17). Very few of those sites are located in close proximity to the shellfish growing area. The sites that are located near the shoreline are usually service stations that have underground storage tanks, which may have leaked. Any underground discharges are absorbed by the soil surrounding the tank, which leaves very little impact to the surrounding water.

There are four landfill sites found near shellfish growing area SE-2 (see Figure 18). These are the Oak Street Landfill, Ridgewood Landfill, Atlantic City Solid Landfill, and the Superfund site. The only site still operating is the Oak Street Landfill, located in Galloway Township. The Atlantic City Solid Landfill site has been closed for many years and is currently the home of the Borgata Casino Hotel & Spa. Routine monitoring for contamination in this area is important because there is always a possibility of leakage, which may flow into shellfish waters.

FIGURE 16: GROUND WATER CONTAMINATED AREAS

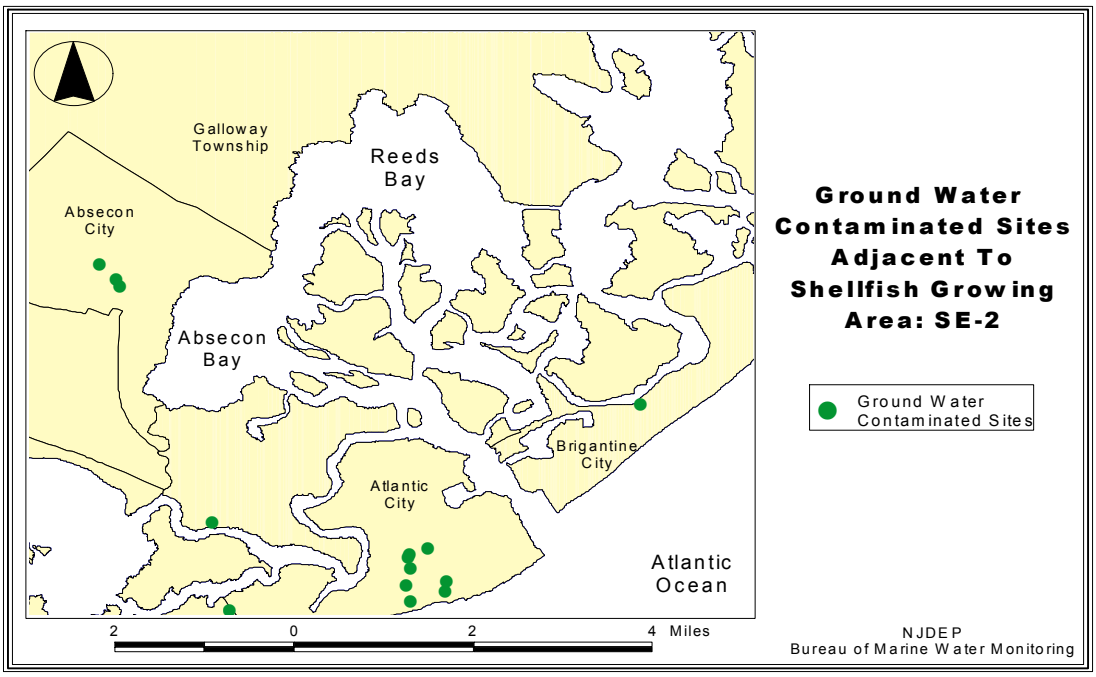


FIGURE 17: KNOWN CONTAMINATED SITES IN SHELLFISH GROWING AREA: SE-2

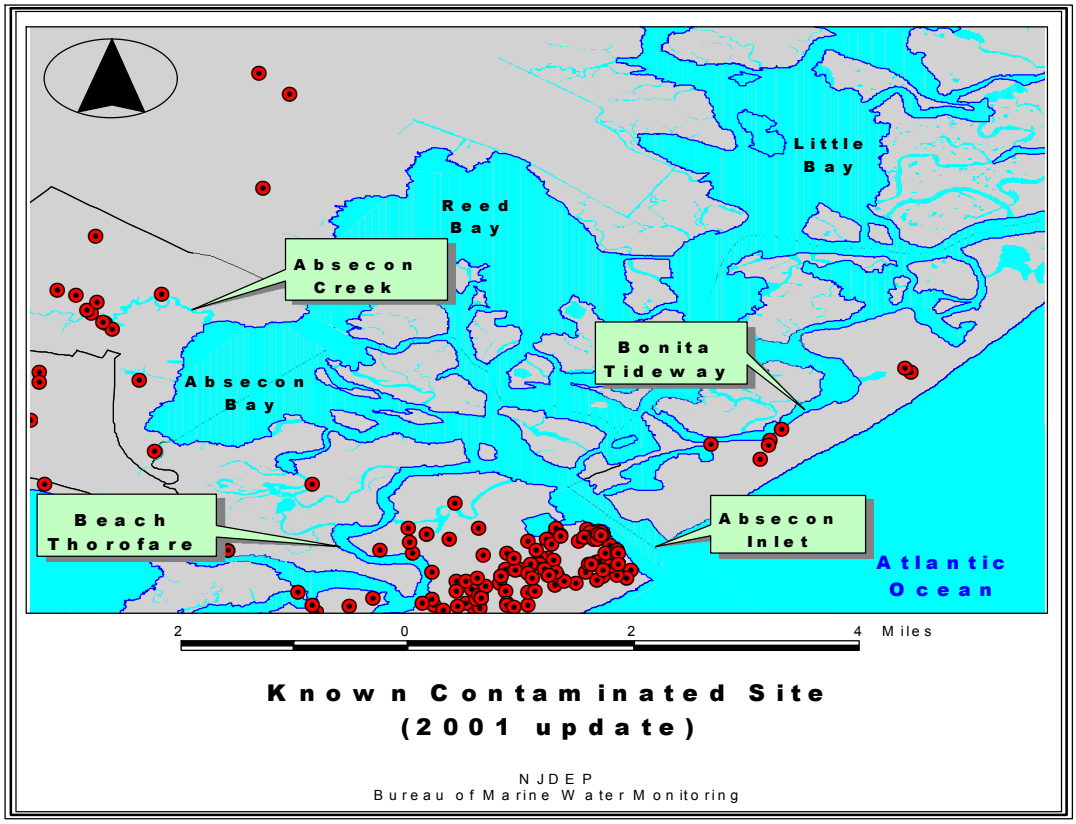
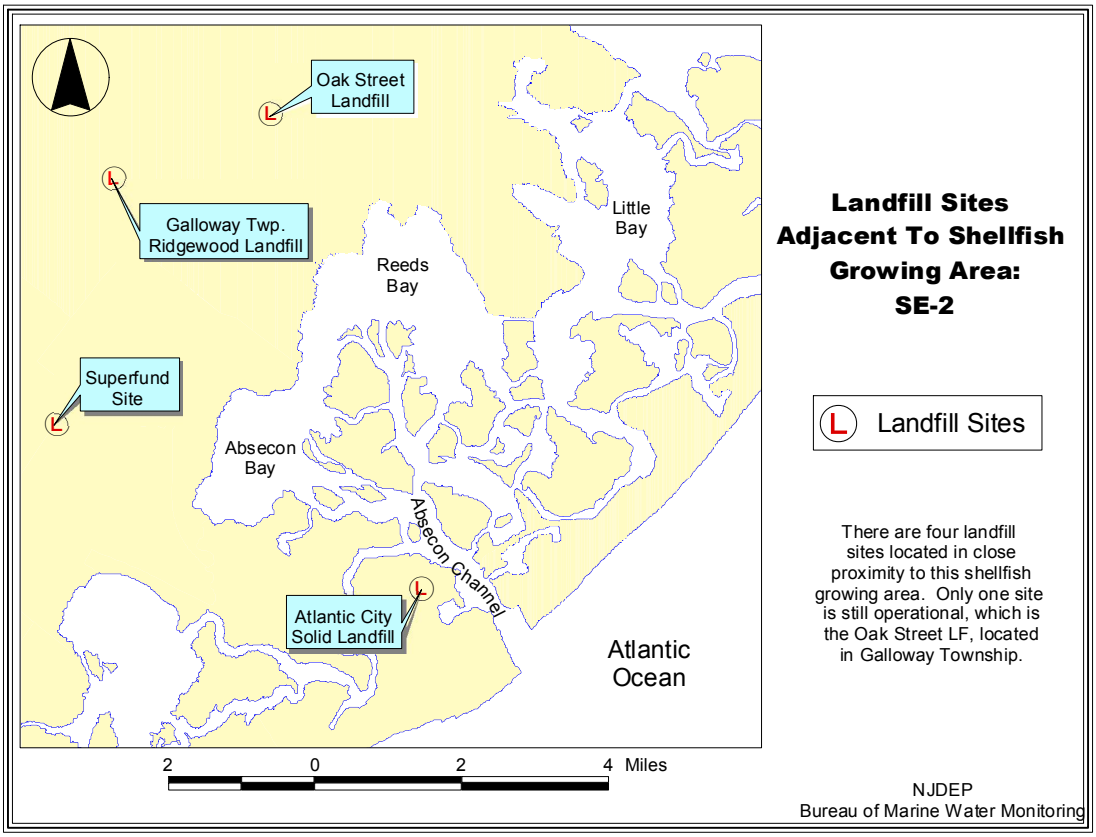


FIGURE 18: LANDFILL SITES ADJACENT TO SHELLFISH GROWING AREA: SE-2



STORM WATER INPUTS

Most of the residential population and urban development are located within the four municipalities that border the SE-2 area. Therefore, there are numerous outfalls surrounding the area (see Figure 19). Major concerns are placed on the storm water outfalls situated in close proximity to shellfish growing waters. These storm water outfalls have the potential to impact water quality. When heavy rainfall occurs, bacteria, feces from domestic animals, and wastes from the streets are deposited into these outfalls, which then flushes out onto the shellfish growing area, thus polluting the surrounding waters. Figure 20, shows the storm water outfalls situated within the vicinity of this shellfish growing area. There are two areas of concern for the SE-2 area, Absecon City and Brigantine City. These areas contain numerous storm water outfalls that have the potential for flushing waste directly onto shellfish waters. The impacted waters include Absecon Bay, Bonita Tideway, and St. George Thorofare. However, historical data indicated that the storm water outfalls in these areas have not caused a major problem to the water quality within the SE-2 area.

FIGURE 19: STORM WATER OUTFALLS IN SHELLFISH GROWING AREA SE-2

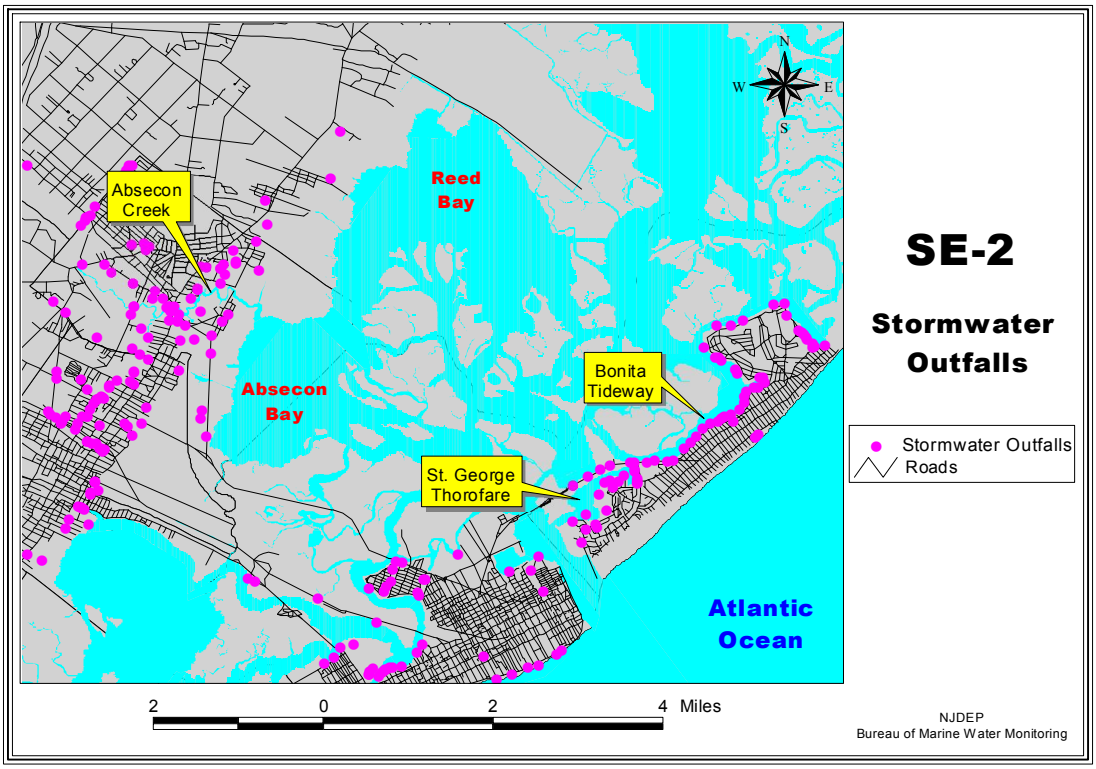


FIGURE 20: STORM WATER OUTFALL AT FARLEY STATE MARINA

MARINAS

Marina facilities have the potential to affect the suitability of shellfish growing areas for the harvest of shellfish. The biological and chemical contamination associated with marina facilities may be of public health significance. 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". The confines of the marina are designated as *Prohibited* for the harvest of shellfish. Adjacent waters are classified using a dilution analysis formula.

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 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 x 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 may be calculated using the formula above, or may be determined using a dilution analysis computer program developed by the State of Virginia and the USFDA. The formula above considers only dilution and occupancy rates. The computer program, which is used for complex configurations where the formula is unlikely to provide the needed accuracy, also considers tidal exchange and bacterial die-off.

There are 21 marinas in the SE-2 area, as shown in Figure 21. There are three marinas located by Absecon Creek, which includes the Absecon Bay Sportmans Center, Up the Creek Marina, and Waynes World Bait & Marina. Seven marinas are located in Atlantic City by Clam Creek. The remaining marinas are scattered throughout Brigantine City by the Bonita Tideway, Steelman Bay, and Broad Thorofare. The biggest marina in this area is the Farley State Marina, which is located by Trump Marina Casino. This marina has approximately 640 slips (see Figure 22). The waters within these marinas 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 *Seasonally Approved* (no harvest during summer months when the marina is active). Marina buffer zones were calculated using the method described above. The size of each buffer zone is shown in Table 6.

FIGURE 21: MARINA FACILITIES IN SHELLFISH GROWING AREA SE-2

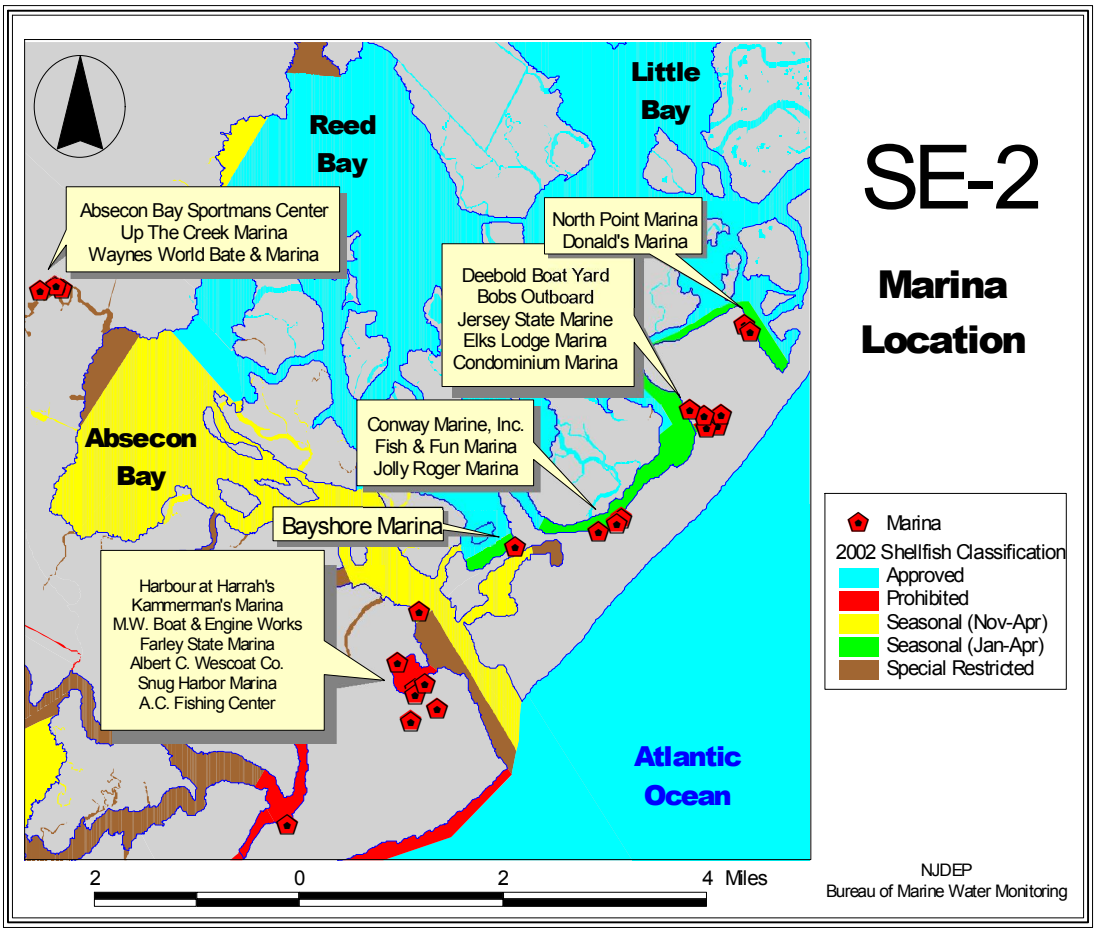


FIGURE 22: FARLEY STATE MARINA

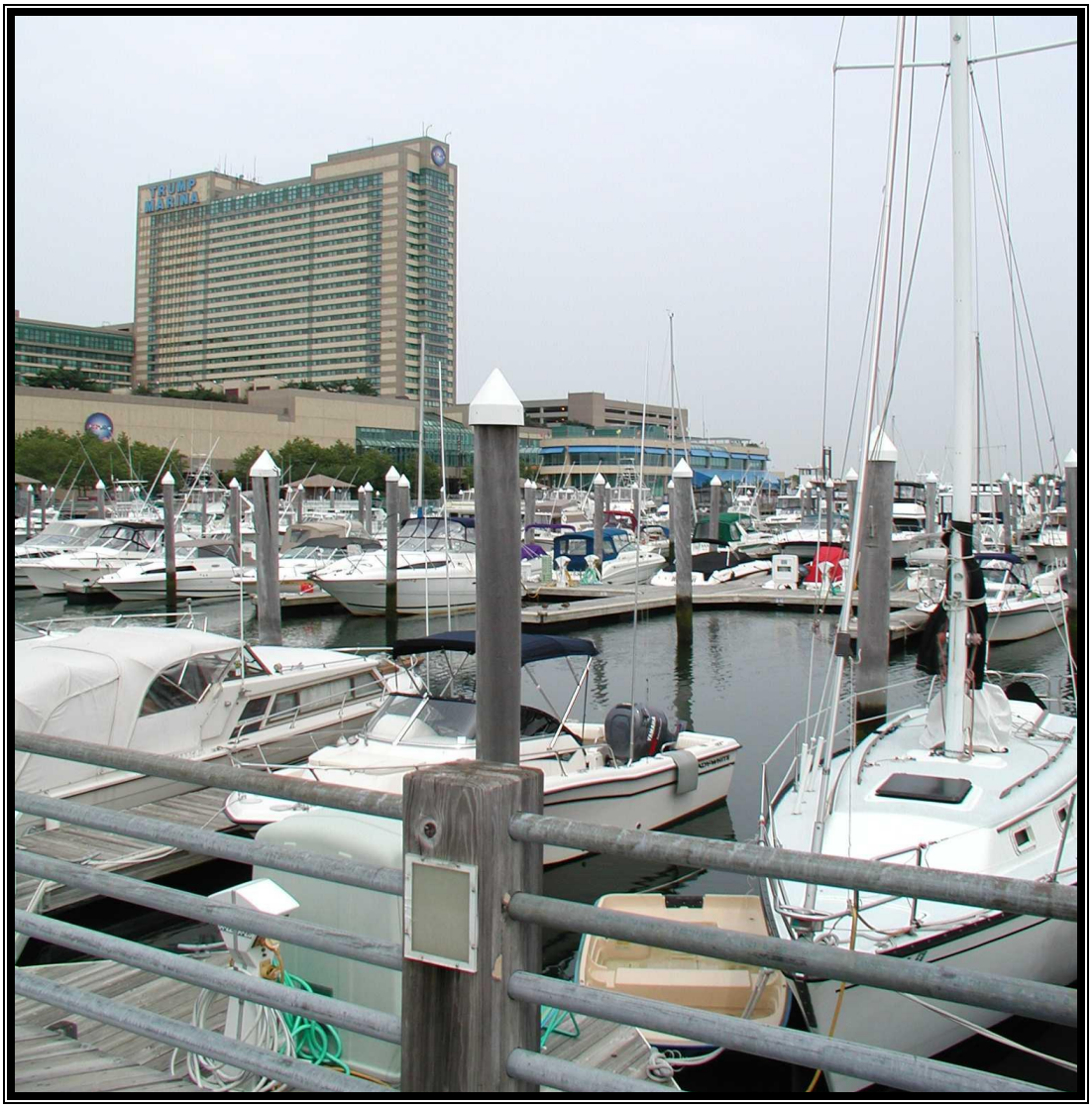


TABLE 6: MARINA FACILITIES LOCATED IN SHELLFISH GROWING AREA SE-2

	Marina Name	Location	Total Slips	# of Slips above 24 ft	Depth (ft)	Size of Buffer Area (radius; feet)
1	Waynes World Bait & Tackle	Absecon	21	21	4	649
2	Up the Creek Marina	Absecon	35	35	4	838
3	Absecon Bay & Sportman Center	Absecon	20	20	4	634
4	Jersey State Marina	Brigantine	38	38	15	451
5	Condominium Marina	Brigantine	38	38	15	451
6	Elks Lodge Marina	Brigantine	50	50	15	517
7	Deebold Boat Yard	Brigantine	21	21	15	335
8	Bobs Outboard	Brigantine	24	24	15	358
9	Donalds Marina	Brigantine	24	24	16	347
10	Jolly Roger Marina	Brigantine	18	18	17	292
11	Fish & Fun Marina	Brigantine	22	22	18	313
12	Conway Marina	Brigantine	25	25	20	317
13	Bayshore Marina	Brigantine	50	50	10	634
14	North Point Marina	Brigantine	30	9	16	269
15	M & W Boat Works	Atlantic City	11	11	12	271
16	Snug Harbor Marina	Atlantic City	7	7	12	216
17	Kammerman's Marina	Atlantic City	8	8	12	231
18	AC Wescoat Co.	Atlantic City	0	0	12	0
19	Farley State Marina	Atlantic City	640	640	6	2926
20	Harrah's Marina	Atlantic City	107	107	12	846
21	AC Fishing Center	Atlantic City	12	12	12	283

SPILLS OR OTHER UNPERMITTED DISCHARGE

There were several spills recorded between October 1999 and September 2003, none resulted in a temporary closure of shellfish waters.

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 can occur during the summer and early fall.

TABLE 7: AVERAGE MID-ATLANTIC STORM EVENT INFORMATION. (SOURCES: USEPA; US DEPARTMENT OF COMMERCE).

Annual Average Number of Storms	60
Average Storm Event Duration	10 hours
Average Storm Event Intensity	0.08 – 0.09 inches/hour
Average Storm Event Volume	0.65 inches

Although the average storm event lasts approximately 10 hours, with an accumulation of 0.65 inches, it is not unusual for an individual storm volume to be 2 – 3 inches. Note the data below that show the 2-year return 6-hour storm event to be between two and three in inches, while the 2-year 24-hour return volume varies between three and four inches (see Table 7). Storm volumes greater than approximately 3.5 – 4.0 inches are much less frequent.

TABLE 8: STORM EVENT VOLUME FOR 2-YEAR STORM EVENT RECURRENCE (SOURCE: USGS**).**

Location	2-Year, 1-Hour Rainfall	2-Year, 6-Hour Rainfall	2-Year, 24-Hour Rainfall
Millville	1.33	2.33	3.02
Cape May	1.33	2.41	3.10
Atlantic City	1.47	2.67	3.65
Long Branch	1.55	3.02	4.15
Newark	1.21	2.34	3.25
Sandy Hook	1.37	2.73	3.68

HYDROGRAPHY

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

The tidal cycle for this shellfish growing area is semidiurnal, with two high tides and two low tides in a 24 hour, 50 minute period. Tidal flushing from the Atlantic Ocean is through the Brigantine and Absecon Inlet, and from Great Bay through the Main Marsh Thorofare.

Precipitation inputs to this area from October 1999 through September 2003 are shown in Table 9. There have been no significant changes in hydrography. The primary weather station for this area is 311, located at the Atlantic City International Airport. The secondary weather station is 325, located at the Atlantic City State Marina. The secondary station data are only used when data from the primary station are incomplete.

TABLE 9: CLIMATOLOGICAL DATA
Rainfall Recorded at NOAA's Station 311

Sampling Date	Precipitation		
	Day of Sampling	***Day of Sampling + Day Before***	***Day of Sampling + 2 Day Before***
10/12/1999	0.00	0.00	0.32
10/15/1999	0.00	0.00	0.00
10/18/1999	0.21	1.33	1.33
10/25/1999	0.00	0.00	0.04
11/9/1999	0.00	0.00	0.00
11/29/1999	0.00	0.00	0.00
12/13/1999	0.40	0.40	0.40
12/14/1999	1.05	1.45	1.45
1/6/2000	0.00	0.03	0.78
1/13/2000	0.11	0.11	0.12
2/22/2000	0.00	0.00	0.00

Sampling Date	Precipitation		
	Day of Sampling	*Day of Sampling + Day Before*	*Day of Sampling + 2 Day Before*
2/29/2000	0.00	0.23	0.24
3/9/2000	0.00	0.00	0.00
3/24/2000	0.00	0.00	1.15
4/6/2000	0.00	0.00	0.20
4/7/2000	0.00	0.00	0.00
4/24/2000	0.00	0.00	0.01
4/26/2000	0.00	0.42	0.42
4/28/2000	0.00	0.01	0.01
5/11/2000	0.00	0.15	0.15
5/17/2000	0.03	0.03	0.03
6/13/2000	0.00	0.27	0.27
6/19/2000	0.00	1.10	1.10
7/6/2000	0.00	0.00	0.23
7/17/2000	0.01	0.02	1.64
7/25/2000	0.10	0.12	0.12
8/17/2000	0.00	0.00	0.01
8/18/2000	0.55	0.55	0.56
9/15/2000	0.19	0.19	0.19
9/20/2000	0.00	0.47	0.47
10/6/2000	0.00	0.00	0.00
10/12/2000	0.00	0.00	0.00
10/17/2000	0.00	0.00	0.00
11/1/2000	0.00	0.00	0.00
12/11/2000	0.21	0.21	0.22
1/11/2001	0.00	0.00	0.28
1/18/2001	0.00	0.00	0.01
2/23/2001	0.00	0.15	0.15

Sampling Date	Precipitation		
	Day of Sampling	***Day of Sampling + Day Before***	***Day of Sampling + 2 Day Before***
3/2/2001	0.00	0.00	0.01
3/9/2001	0.27	0.27	0.27
3/12/2001	0.55	0.55	0.55
3/22/2001	0.09	1.66	1.73
3/23/2001	0.00	0.09	1.66
4/26/2001	0.00	0.00	0.01
5/7/2001	0.00	0.00	0.00
5/14/2001	0.00	0.00	0.00
5/18/2001	0.00	0.00	0.00
6/25/2001	0.00	0.02	0.04
7/2/2001	0.00	0.00	0.00
7/23/2001	0.00	0.00	0.00
8/8/2001	0.00	0.00	0.00
8/17/2001	0.00	0.01	0.01
9/7/2001	0.00	0.00	0.00
9/17/2001	0.00	0.00	0.00
9/18/2001	0.00	0.00	0.00
10/4/2001	0.00	0.00	0.00
10/10/2001	0.00	0.00	0.00
10/16/2001	0.03	0.20	0.28
11/1/2001	0.00	0.00	0.00
12/7/2001	0.00	0.00	0.00
12/14/2001	0.01	0.02	0.04
1/3/2002	0.00	0.00	0.00
1/11/2002	0.36	0.36	0.37
2/1/2002	0.05	0.16	0.17
2/14/2002	0.00	0.00	0.00

Sampling Date	Precipitation		
	Day of Sampling	*Day of Sampling + Day Before*	*Day of Sampling + 2 Day Before*
3/14/2002	0.00	0.29	0.34
3/20/2002	1.59	1.59	2.12
4/18/2002	0.04	0.04	0.04
4/24/2002	0.00	0.00	0.11
4/29/2002	0.00	2.29	2.38
5/10/2002	0.00	0.07	0.07
5/31/2002	0.14	0.14	0.14
6/13/2002	1.42	1.75	1.75
6/18/2002	0.00	0.00	0.00
6/25/2002	0.01	0.06	0.06
7/22/2002	0.00	0.00	0.01
7/24/2002	0.05	0.10	0.10
8/21/2002	0.00	0.00	0.00
9/5/2002	0.00	0.00	0.00
9/11/2002	0.00	0.00	0.01
9/19/2002	0.00	0.00	0.00
10/7/2002	0.00	0.00	0.01
10/22/2002	0.00	0.00	0.01
10/28/2002	0.00	0.00	1.70
11/20/2002	0.00	0.00	0.00
12/6/2002	0.00	0.69	0.69
12/11/2002	1.02	1.02	1.02
1/2/2003	0.04	1.18	1.18
3/31/2003	0.00	0.29	1.40
4/8/2003	0.00	0.59	0.59
4/14/2003	0.00	0.00	0.38
4/21/2003	0.03	0.03	0.03

Sampling Date	Precipitation		
	Day of Sampling	***Day of Sampling + Day Before***	***Day of Sampling + 2 Day Before***
4/29/2003	0.00	0.00	0.00
5/6/2003	0.00	0.05	0.05
6/25/2003	0.00	0.00	0.00
6/26/2003	0.00	0.00	0.00
7/10/2003	0.62	0.68	0.68
7/17/2003	0.00	0.00	0.00
7/29/2003	0.49	0.56	0.56
7/30/2003	0.02	0.51	0.58
8/5/2003	0.03	0.04	0.04
8/19/2003	0.00	0.00	0.03
9/3/2003	0.07	0.10	0.15
9/9/2003	0.00	0.00	0.00
9/25/2003	0.00	0.00	0.54
9/30/2003	0.00	0.00	0.51

WATER QUALITY STUDIES

BACTERIOLOGICAL QUALITY

A total of 4318 samples were collected and analyzed for total coliform (TC) and fecal coliform (FC) from 113 sampling stations listed in Assignment 167, 172, and part of Assignment 197. Both Assignments 167 and 172 were sampled under the Systematic Random strategy (SRS), while Assignment 197 was sampled, preferably at ebb tide, under the Adverse Pollution Condition strategy (APC). There were approximately 34 APC and 79 SRS sampling stations in the SE-2 area (see Figure 23). This report includes data analyzed between October 1999 to September 2003 (see Table 10 and Table 11). The summary of all the raw data is provided in the Appendix. The National Shellfish Sanitation Program (NSSP) criteria can be found on Table 2 and Table 3.

COMPLIANCE WITH NSSP APPROVED AND SEASONAL CRITERIA

Approved Year- Round Classification

There were approximately 56 sampling stations situated in *Approved* waters. No sampling stations in this area were found to exceed the NSSP criteria for Adverse Pollution Condition or Systematic Random Sampling strategy.

Seasonally Approved (November to April) Classification

Absecon Bay, Absecon Channel and its tributaries, and a portion of St. George Thorofare are all classified as *Seasonally Approved (November to April)*. A total of 27 sampling stations are located in the areas described above. Five stations were sampled under the Adverse Pollution Condition strategy (APC) and 22 stations were sampled under the Systematic Random Sampling strategy (SRS). According to the data collected, no station had exceeded the NSSP criteria.

Seasonally Approved (January to April) Classification

The Bonita Tideway, Obes Thorofare, Steelman Bay, and the unnamed waterways located by Little Panama are classified as *Seasonally Approved (January to April)*. There are approximately eight sampling stations and all were sampled under the Adverse Pollution Condition strategy. No stations in these areas detected high level of total coliform bacteria. The results indicated all stations were within NSSP Seasonally Approved criteria for total coliform. Therefore, these waters met their current shellfish classification.

COMPLIANCE WITH NSSP SPECIAL RESTRICTED AND PROHIBITED CRITERIA

Special Restricted Classification

Special Restricted waters can be found in Absecon Bay, Absecon Creek, Newfound Thorofare, Beach Thorofare, Duck Thorofare, Clam Thorofare, St. George Thorofare, Absecon Channel, and Absecon Inlet. There are approximately 21 sampling stations located throughout these areas. Three sampling stations failed to meet the *Approved* (year-round, summer, and winter) classifications, two stations failed to meet the *Approved* (year-round and winter) classifications, and one station failed to meet the *Approved* (summer) classification. While these stations failed to meet the NSSP *Approved* criteria, they were acceptable for the NSSP *Special Restricted* specification. Therefore, these waters met their current shellfish classification (see Figure 24).

Prohibited Classification

Only one station is located in *Prohibited* waters. Station 2216A is located by Baremore Quarter, in Brigantine City. The results were within NSSP criteria; therefore, met the current shellfish classification.

FIGURE 23: SAMPLING STATIONS IN SHELLFISH GROWING AREA SE-2

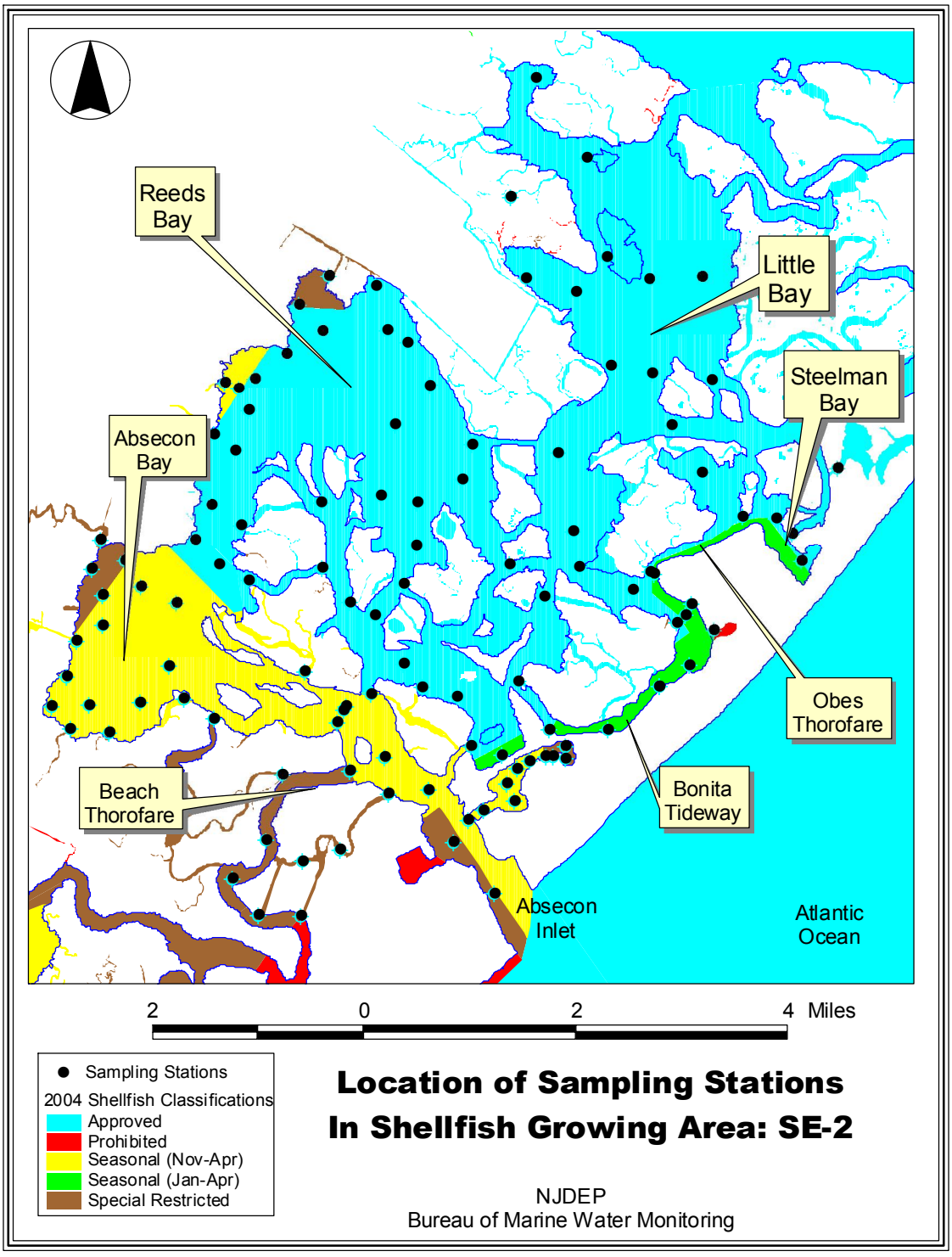


FIGURE 24: APC SAMPLING STATIONS EXCEEDING NSSP APPROVED CRITERIA

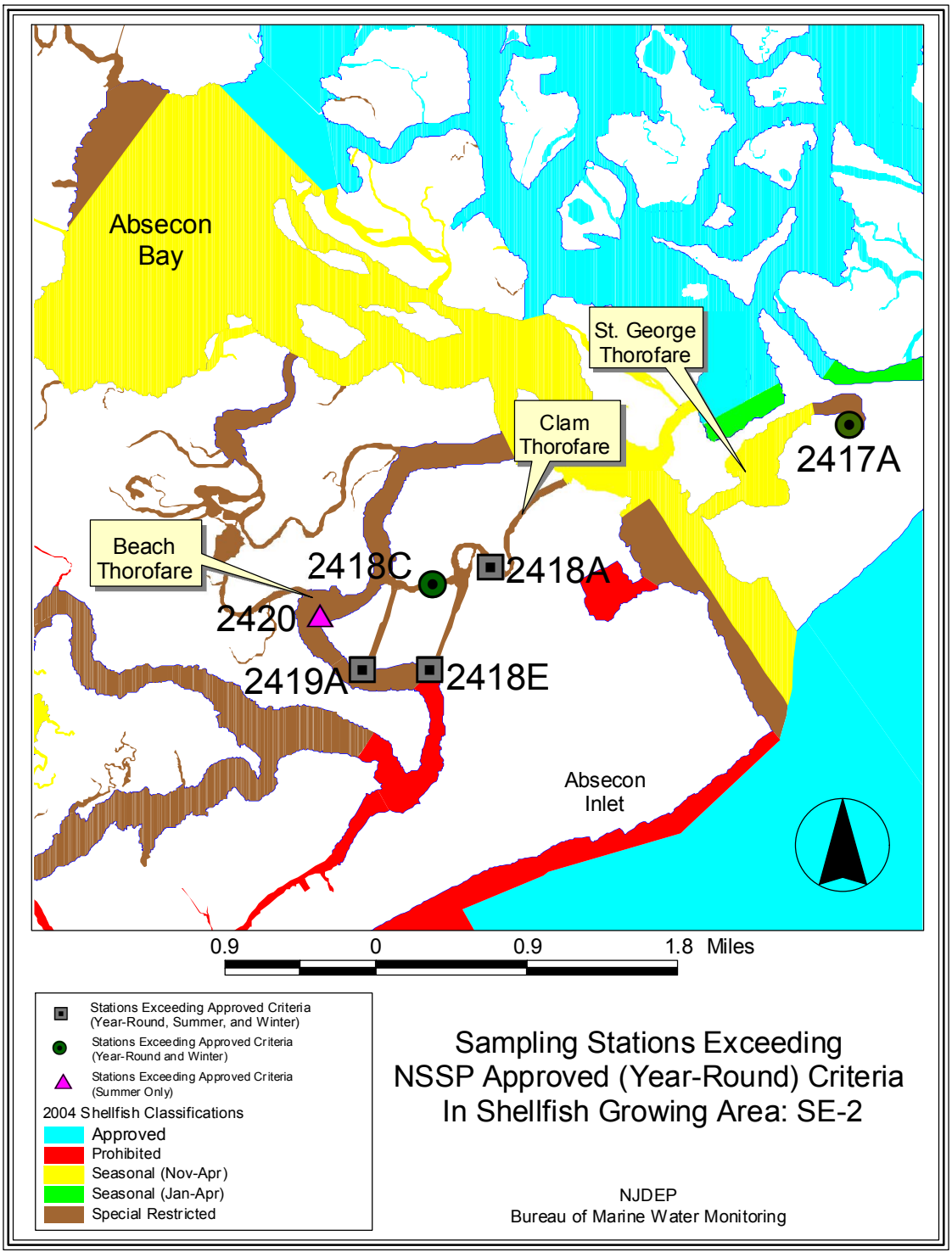


TABLE 10: TOTAL COLIFORM STATISTICAL SUMMARY (APC 1999-2003)

Station	Status	Year Round			Summer			Winter		
		Geometric Mean	%>330	N	Geometric Mean	%>330	N	Geometric Mean	%>330	N
2207A	A	7.44	0.00%	38	6.42	0.00%	23	9.32	0.00%	15
2210C	A	7.34	2.63%	38	8.17	4.35%	23	6.24	0.00%	15
2210F	SJ	7.08	2.63%	38	7.51	4.35%	23	6.46	0.00%	15
2211	SJ	10.12	2.63%	38	9.21	0.00%	23	11.68	6.67%	15
2212A	SJ	9.11	0.00%	38	9.08	0.00%	23	9.16	0.00%	15
2214	SJ	12.14	0.00%	38	12.28	0.00%	23	11.94	0.00%	15
2215A	SJ	10.27	2.63%	38	9.83	4.35%	23	10.97	0.00%	15
2216A	P	9.97	2.63%	38	12.04	4.35%	23	7.46	0.00%	15
2218	SJ	10.70	7.89%	38	14.10	8.70%	23	7.01	6.67%	15
2218A	SJ	6.08	2.63%	38	7.23	4.35%	23	4.65	0.00%	15
2218B	A	6.99	0.00%	38	9.00	0.00%	23	4.74	0.00%	15
2219A	A	5.76	2.63%	38	8.26	4.35%	23	3.31	0.00%	15
2221	SJ	8.12	0.00%	38	9.80	0.00%	23	6.09	0.00%	15
2221A	A	6.96	0.00%	38	9.19	0.00%	23	4.55	0.00%	15
2223B	A	4.19	0.00%	38	4.64	0.00%	23	3.59	0.00%	15
2226A	A	4.63	2.70%	37	4.49	0.00%	22	4.86	6.67%	15
2227	A	5.51	2.70%	37	5.21	4.55%	22	5.98	0.00%	15
2229A	A	6.47	2.78%	36	7.11	4.76%	21	5.68	0.00%	15
2414	SR	9.04	2.63%	38	10.24	4.35%	23	7.45	0.00%	15
2415	SR	13.61	5.26%	38	15.39	8.70%	23	11.28	0.00%	15
2417	SR	7.58	5.26%	38	10.42	8.70%	23	4.66	0.00%	15
2417A	SR	9.78	10.53%	38	10.80	8.70%	23	8.40	13.33%	15
2417B	SR	9.85	5.41%	37	14.13	8.70%	23	5.45	0.00%	14
2417C	SR	17.18	5.26%	38	23.26	8.70%	23	10.79	0.00%	15
2417D	S	5.16	0.00%	38	6.34	0.00%	23	3.77	0.00%	15

Station	Status	Year Round			Summer			Winter		
		Geometric Mean	%>330	N	Geometric Mean	%>330	N	Geometric Mean	%>330	N
2417F	S	5.87	0.00%	38	7.01	0.00%	23	4.47	0.00%	15
2417G	S	7.65	2.63%	38	9.60	4.35%	23	5.41	0.00%	15
2417H	S	6.41	0.00%	38	6.53	0.00%	23	6.24	0.00%	15
2418A	SR	31.37	15.79%	38	33.54	17.39%	23	28.33	13.33%	15
2418C	SR	47.47	13.16%	38	52.94	8.70%	23	40.16	20.00%	15
2418E	SR	99.31	36.84%	38	136.76	43.48%	23	60.79	26.67%	15
2419A	SR	114.55	31.58%	38	153.99	30.43%	23	72.77	33.33%	15
2420	SR	21.49	7.89%	38	20.60	13.04%	23	22.93	0.00%	15

TABLE 11: TOTAL COLIFORM STATISTICAL SUMMARY (SRS 1999-2003)

Station	Status	Year Round			Summer			Winter		
		Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N
2101A	A	5.00	10.56	37	4.57	8.41	19	5.51	13.13	18
2101C	A	4.91	13.68	37	5.72	18.59	19	4.18	9.44	18
2102	A	4.10	9.76	20	3.17	3.55	10	5.31	16.83	10
2102A	A	4.71	12.97	37	4.23	10.12	19	5.27	16.67	18
2102C	A	5.02	19.51	37	6.59	36.36	19	3.77	7.83	18
2103A	A	6.40	21.58	37	6.08	21.74	19	6.75	22.06	18
2103E	A	8.93	57.24	37	12.31	115.68	19	6.36	22.60	18
2104	A	6.13	20.47	37	7.67	29.56	19	4.83	12.91	18
2104B	A	5.20	16.01	37	6.34	24.74	19	4.21	8.95	18
2104E	A	4.43	9.87	37	5.44	13.53	19	3.56	6.29	18
2106A	A	4.16	7.84	37	4.48	8.78	19	3.85	6.96	18
2200A	A	8.05	42.82	37	11.71	81.98	19	5.42	17.52	18
2202B	A	4.86	11.66	37	5.30	12.22	19	4.44	11.18	18
2204B	A	4.88	12.66	37	4.75	11.70	19	5.02	14.07	18
2205A	A	6.39	23.20	37	6.61	32.27	19	6.17	15.55	18
2208D	A	4.52	11.44	37	4.32	8.34	19	4.75	15.24	18
2209D	A	4.87	15.98	37	5.30	23.03	19	4.46	10.14	18
2209G	A	6.02	23.35	37	8.43	37.06	19	4.22	12.29	18
2220	A	6.56	27.95	37	7.29	35.59	19	5.86	21.99	18
2224A	A	4.29	10.25	37	4.28	12.53	19	4.30	7.99	18
2230	A	4.87	11.55	37	5.48	14.87	19	4.29	8.54	18
2300	A	5.10	17.13	37	6.58	23.94	19	3.89	11.10	18
2300B	A	3.67	6.27	37	3.77	6.76	19	3.57	5.84	18
2300C	A	4.35	10.43	37	4.38	10.68	19	4.32	10.44	18
2300D	A	4.17	12.11	37	4.02	8.50	19	4.32	16.64	18
2300E	S	4.06	8.60	41	4.07	8.54	21	4.05	8.82	20

Station	Status	Year Round			Summer			Winter		
		Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N
2301B	SR	6.06	20.67	39	7.72	33.87	19	4.82	11.46	20
2302	A	7.53	39.50	37	13.76	95.61	19	3.98	7.91	18
2303B	A	4.57	11.66	37	4.43	11.95	19	4.71	11.62	18
2303C	A	4.36	9.71	36	4.20	9.66	18	4.52	9.96	18
2304	A	5.12	17.60	39	3.60	6.24	19	7.16	33.33	20
2304C	A	4.55	11.27	37	4.33	9.53	19	4.81	13.52	18
2305C	A	7.82	36.79	35	10.98	56.39	17	5.67	22.60	18
2306	A	5.85	22.83	39	6.13	25.63	19	5.59	21.10	20
2306C	A	6.47	37.40	39	6.76	58.77	19	6.20	23.03	20
2307	S	21.14	164.45	40	34.27	274.59	21	12.40	77.65	19
2307B	A	8.61	61.26	39	9.20	107.24	19	8.08	32.93	20
2308	A	8.68	58.82	39	9.65	86.95	19	7.84	40.70	20
2308A	A	6.43	20.98	39	5.83	16.66	19	7.05	26.21	20
2308B	A	9.41	40.96	39	7.92	33.42	19	11.09	49.97	20
2308C	A	8.79	37.41	39	13.09	67.56	19	6.03	17.49	20
2309A	A	8.20	36.23	37	11.64	68.01	19	5.66	14.74	18
2309C	A	4.21	9.07	37	5.26	13.55	19	3.32	4.65	18
2309D	A	7.49	31.93	37	12.53	64.24	19	4.35	9.61	18
2310B	A	6.07	16.90	37	6.98	18.75	19	5.24	15.03	18
2311B	A	5.15	14.62	36	6.81	24.95	18	3.89	6.63	18
2311D	A	4.92	14.62	37	6.07	22.79	19	3.94	7.96	18
2400	A	6.36	19.23	40	6.38	20.92	21	6.33	17.97	19
2400A	A	5.57	16.00	40	6.09	20.24	21	5.04	12.19	19
2400B	A	7.45	26.02	39	8.48	29.62	19	6.59	23.26	20
2401	SR	18.38	94.93	40	17.19	102.21	21	19.79	89.93	19
2401A	SR	8.89	41.63	40	7.32	26.94	21	11.02	64.56	19
2401C	S	9.11	35.18	40	6.84	21.15	21	12.51	55.27	19

Station	Status	Year Round			Summer			Winter		
		Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N
2402	SR	7.87	37.04	40	7.19	32.82	21	8.69	43.66	19
2402A	SR	6.86	28.22	40	5.35	17.84	21	9.04	43.52	19
2403	S	8.67	34.61	40	4.70	10.03	21	17.06	70.25	19
2403B	S	11.70	72.22	39	11.09	64.50	20	12.39	84.97	19
2404C	S	11.63	51.23	41	11.22	36.28	21	12.08	71.72	20
2405	S	9.29	44.53	40	5.14	16.33	21	17.86	84.97	19
2405C	S	13.91	80.83	40	11.58	48.03	21	17.04	136.34	19
2406	S	7.86	44.17	40	4.62	12.59	21	14.13	109.92	19
2406A	S	16.00	146.02	40	6.69	31.42	21	41.92	381.76	19
2406B	S	17.07	95.81	40	16.52	97.72	21	17.69	98.10	19
2407	S	8.31	33.27	40	8.78	30.53	21	7.81	37.19	19
2407B	S	13.77	83.31	40	13.05	60.96	21	14.62	118.17	19
2409A	SR	8.96	34.65	41	9.39	31.55	21	8.52	38.83	20
2411A	S	9.58	49.99	40	11.38	65.96	21	7.93	36.86	19
2412A	S	4.90	12.29	41	4.79	12.09	21	5.01	12.79	20
2412B	S	5.03	15.75	41	5.95	23.31	21	4.22	9.59	20
2412C	S	7.23	29.63	41	7.25	27.82	21	7.21	32.70	20
2412E	S	5.16	14.38	41	5.15	15.33	21	5.16	13.77	20
2412H	S	4.14	9.04	41	4.34	10.04	21	3.94	8.19	20
2413	SR	5.15	16.21	41	5.38	14.10	21	4.91	18.70	20
2416	S	3.34	4.86	41	3.25	4.44	21	3.45	5.31	20
2416L	SR	4.91	14.67	41	4.62	12.48	21	5.24	17.59	20
2416S	SR	5.87	20.29	41	6.30	22.64	21	5.45	18.54	20
2418	S	9.00	62.63	40	13.11	144.26	20	6.17	20.91	20

TIDAL EFFECTS

The tidal effects or preferences can be either ebb currents, flood currents, or neither of these two types of currents. Ebb and flood currents describe the horizontal motions associated with the fall and rise of the tide in restricted regions along the coast. Tidal currents can affect the water quality of a shellfish growing area, because hydrographic and meteorological characteristics, such as tidal amplitude and type, water circulation patterns, depth, salinity, stratification characteristics, rainfall patterns and intensity, and prevailing winds may affect the distribution of pollutants in a specific area (Ingmanson and Wallace, 1989). This is why an evaluation of pollution sources and hydrographic characteristics are used to evaluate the water quality in a shellfish growing area.

Tidal impacts were evaluated by performing a t-test using the total coliform MPN value. The MPN values from samples collected during ebb tide were compared with those collected during flood tide. In order for a station to have a tidal component, the t-probability must be less than 0.05, but not zero. According to the data analyzed, four stations were found to have a tidal component. These stations are located in Reeds Bay, Middle Thorofare, Beach Thorofare, and Absecon Channel (see Figure 25). Station 2411A and 2416L were affected by ebb tide, while station 2308C and 2414 were affected by flood tide (see Table 12).

Due to the shallowness of the bay and the surrounding salt marshes, this shellfish growing area provides a good habitat for many animals. It was found that the bird populations in this area were extremely large. Therefore, when flood tides occur, animals' feces from nearby marshes can be swept up and carried into the bay, thus contributing to higher level of bacteria counts observed during flood tide.

FIGURE 25: SAMPLING STATIONS AFFECTED BY TIDE

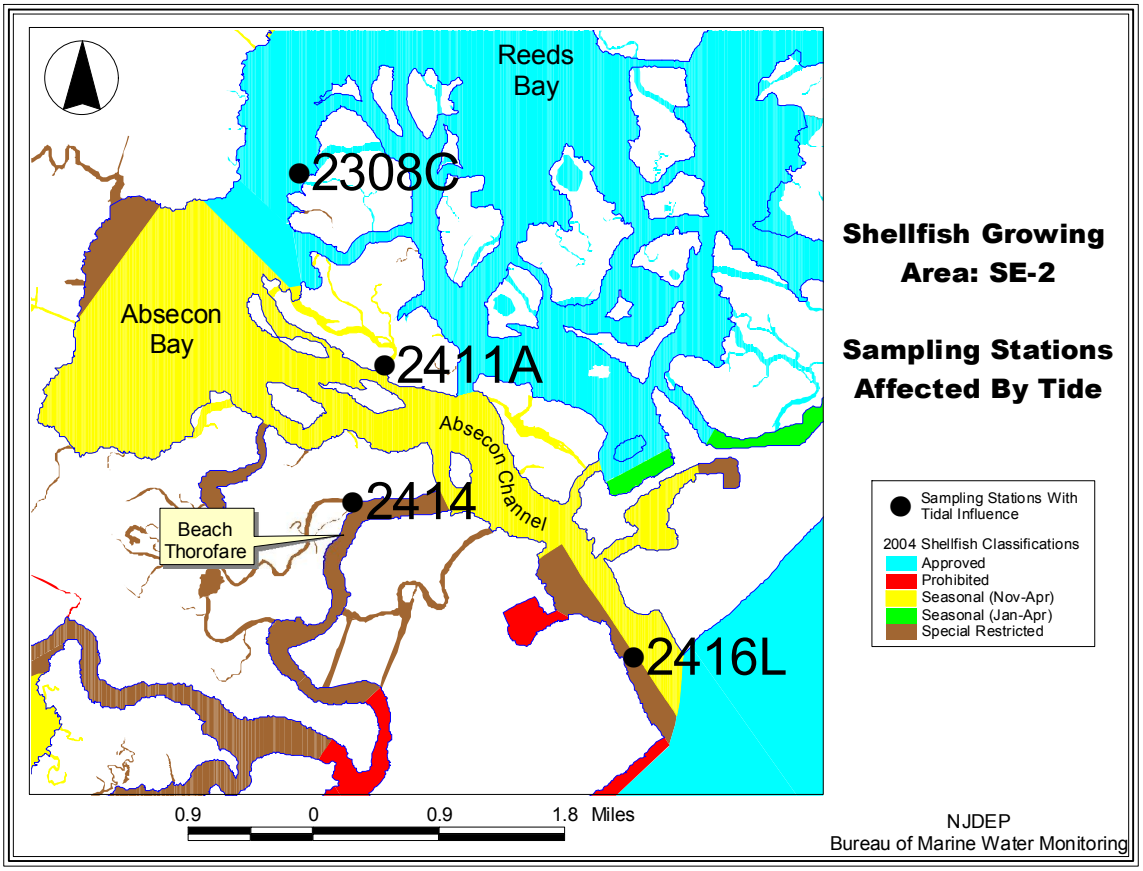


TABLE 12: TIDE STATISTICS

Station	Geometric Mean Total Coliform MPN		Probability>[T]
	Ebb	Flood	
2308C	4.2	10.6	0.039
2411A	18	6.6	0.015
2414	5.6	13.3	0.045
2416L	8.8	3.7	0.002

RAINFALL EFFECTS

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

Historical data comparing the difference between coliform levels measured after rainfall with those during dry periods were compared to generate the map below. The Bureau of Marine Water Monitoring has begun to identify particular storm water outfalls that discharge excessive bacteriological loads during storm events (see Figure 26). 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 are 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).

According to the data set analyzed for this report, two stations were affected by rainfall. Rainfall effect was assessed by using the correlation between the rainfall amount recorded for the day of sampling, day of sampling plus one day before, and the day of sampling plus two days before. Rainfall component is based on the correlation calculated for the "day of sampling plus two days before." To have a rainfall component, the correlation must be greater than 0.6. The two stations with a rainfall component were 2216A and 2417G. The current classifications for these two stations are *Prohibited* and *Seasonally Approved (November to April)*, respectively. Station 2216A is located by Baremore Quarter and Station 2417G is situated in St. George Thorofare (see Figure 27).

FIGURE 26: AREAS IMPACTED BY RAINFALL

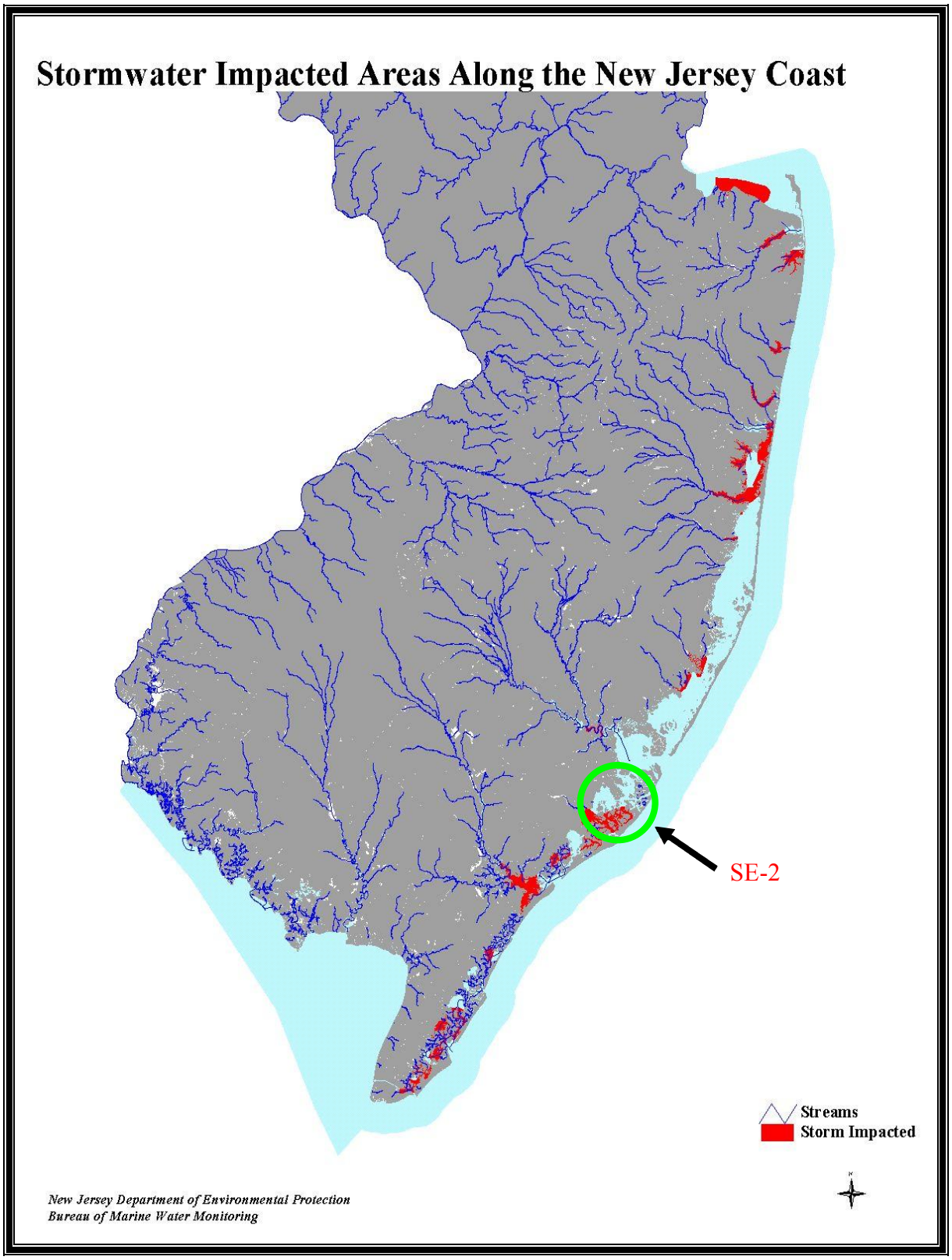
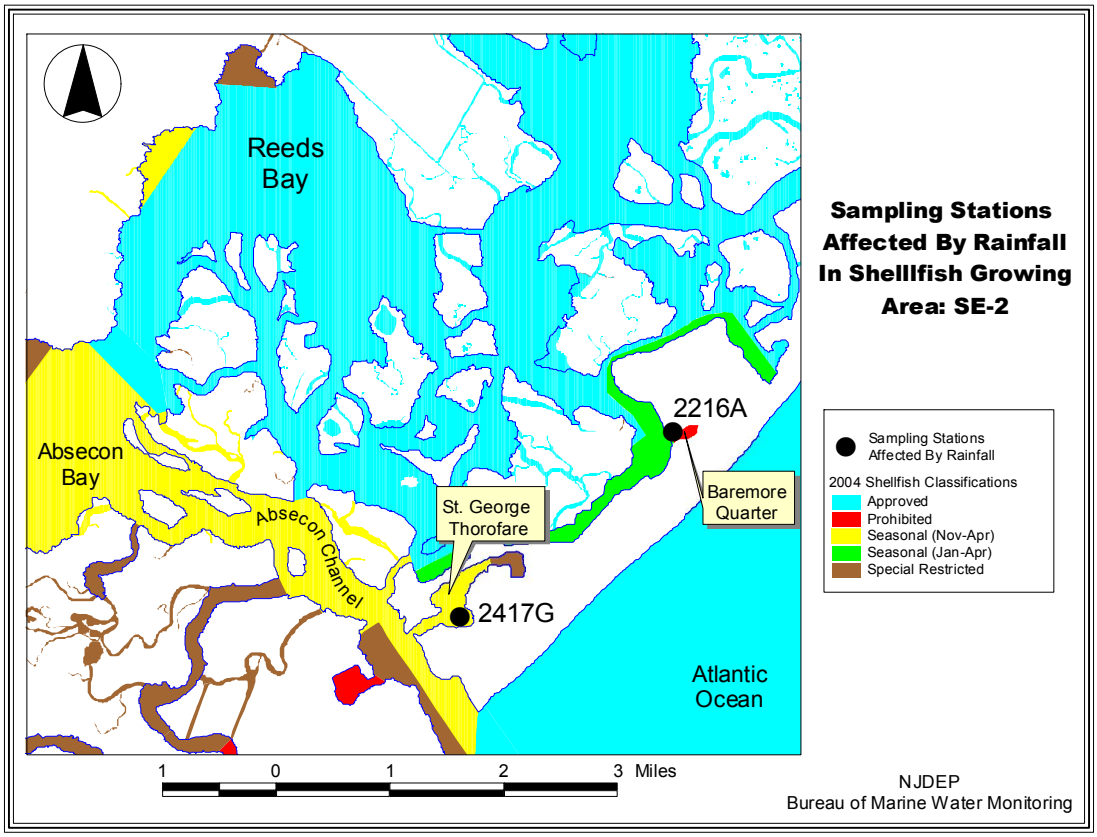


FIGURE 27: SAMPLING STATIONS AFFECTED BY RAINFALL IN SHELLFISH GROWING AREA SE-2



SEASONAL EFFECTS

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

Shellfish are filter-feeding organisms that live in the sand, silt, and mud on the bottom of oceans and bays. They have a range of tolerance to specific environmental conditions, such as temperatures, salinity levels, oxygen levels, quantity and availability of food, and water quality. Seasonal effects on these variables will have an effect on shellfish populations (Ingmanson and Wallace, 1989).

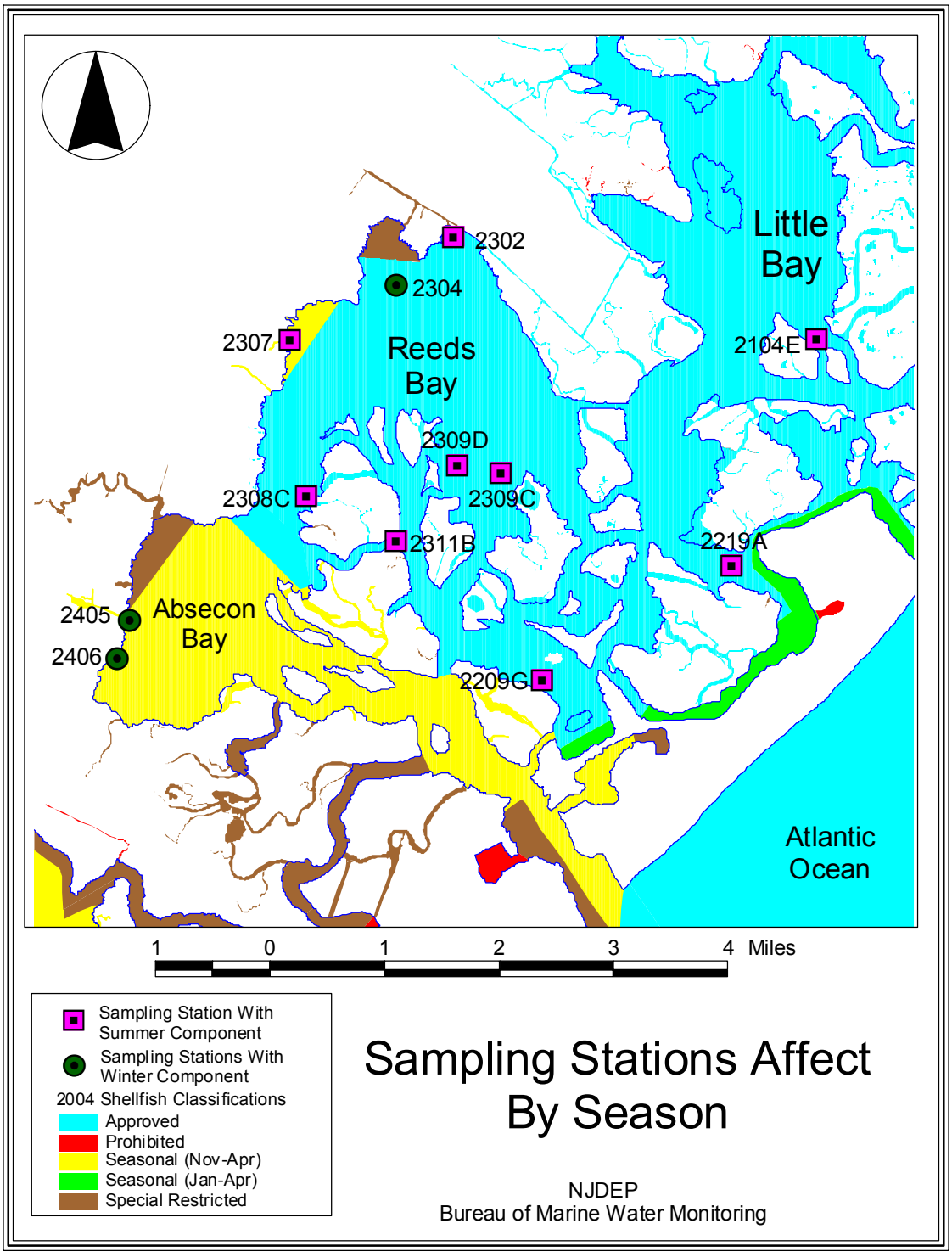
Seasonal variations also affect human activities, with generally more human activity in the warmer months of the year. An increase in human activities in or near the marine environment can have an impact on shellfish populations. Increased pressure from human activities on already stressed failing septic systems and overloaded wastewater treatment facilities can cause sewage to spill into the marine environment, which can negatively impact the water quality of a shellfish growing area by increasing the coliform levels in the water (Ingmanson and Wallace, 1989).

Seasonal effect was assessed using a t-test to compare the total coliform MPN values from samples collected during the summer season versus samples collected during the winter months. To have a seasonal component, t-probability must be less than 0.05, but not zero. Twelve sampling stations in the SE-2 area were found to exhibit a t-probability of less than 0.05. These stations are listed below in Table 13. Three stations were affected by the winter season, while the other nine stations were affected by the summer season. See Figure 28 for the location of these stations.

Table 13: Season Statistics

Station	Total Coliform Geometric Mean		Probability > [T]
	Summer	Winter	
2104E	5.4	3.6	0.038
2209G	8.4	4.2	0.046
2219A	8.3	3.3	0.018
2302	13.8	4.0	0.002
2304	3.6	7.2	0.024
2307	34.3	12.4	0.044
2308C	13.1	6.0	0.030
2309C	5.3	3.3	0.018
2309D	12.5	4.3	0.003
2311B	6.8	3.9	0.038
2405	5.1	17.9	0.001
2406	4.6	14.1	0.007

FIGURE 28: SAMPLING STATIONS AFFECTED BY SEASON



INTERPETATION AND DISCUSSION OF DATA

BACTERIOLOGICAL

The criteria for acceptability of shellfish growing water was based on the bacterial parameters set by the National Shellfish Sanitation Program (NSSP). Each state adopts either the Total Coliform criteria or the Fecal Coliform criteria for determining water quality.

The New Jersey Department of Environmental Protection had always based its water classification on the results generated from the total coliform test. Even though water classification is based on the total coliform criteria, the Bureau of Marine Water Monitoring does take corresponding samples for fecal coliform analysis. These data are, however, utilized as adjunct information and are not used for classification of shellfish growing waters. The NSSP criteria can be found on Table 2 and Table 3.

The bacteriological data collected for this report are listed in the Appendix. These data were collected under both the Adverse Pollution Condition and Systematic Random Sampling strategies.

According to the data set analyzed for this report, three APC stations failed to meet the *Approved (year-round, summer, and winter)* classifications. They were stations 2418C, 2418E, and 2419A. Two APC stations failed to meet the *Approved (year-round and winter)* classifications and they were Stations 2417A and 2418C. One station failed to meet the *Approved (summer)* classification. This was Station 2420. The criteria for *Approved* classification for Adverse Pollution Condition sampling strategy are: the geometric mean can not exceed 70 MPN/100 mL and no more than 10 percent of the samples set can exceed 330 MPN/100 mL. Areas classified, as *Special Restricted* must meet the criteria of 700 MPN/100 mL and no more than 10 percent of the samples can exceed 3300 MPN/100 mL. All six stations are located in *Special Restricted* waters. Therefore, they were assessed under the NSSP Special Restricted criteria. The results from these six stations indicated that they had failed to meet the *Approved* criteria, but were within the *Special Restricted* specification.

There were twelve sampling stations with a seasonal component and four sampling stations with a tidal component. The bacteriological levels for these sampling stations were very minimal. Even though, these stations failed to meet the t-probability of less than 0.05, the statistical data indicated that the geometric mean or MPN value for each of the sampling stations was far less than the criterion set by the NSSP. In this case, seasonal and tidal components had no major impact on this shellfish growing area.

Two sampling stations were affected by rainfall. Station 2417G is situated within St. George Thorofare. The current classification for this area is *Seasonal Approved (November to April)*. Station 2216A is in *Prohibited* waters, located by Baremore Quarter. Both stations are located in Brigantine City. Rainfall impacts were assessed by

correlating total coliform MPN values with cumulative rainfall on the day of sampling, 24 hours prior to the day of sampling, and 48 hours prior to the day of sampling. A relationship between rainfall amounts and total coliform levels is suggested if rainfall correlation coefficient is greater than 0.6. Historical data analyzed by the Bureau of Marine Water Monitoring indicated this area was impacted by rainfall, especially in Atlantic City and Brigantine City (see Figure 26).

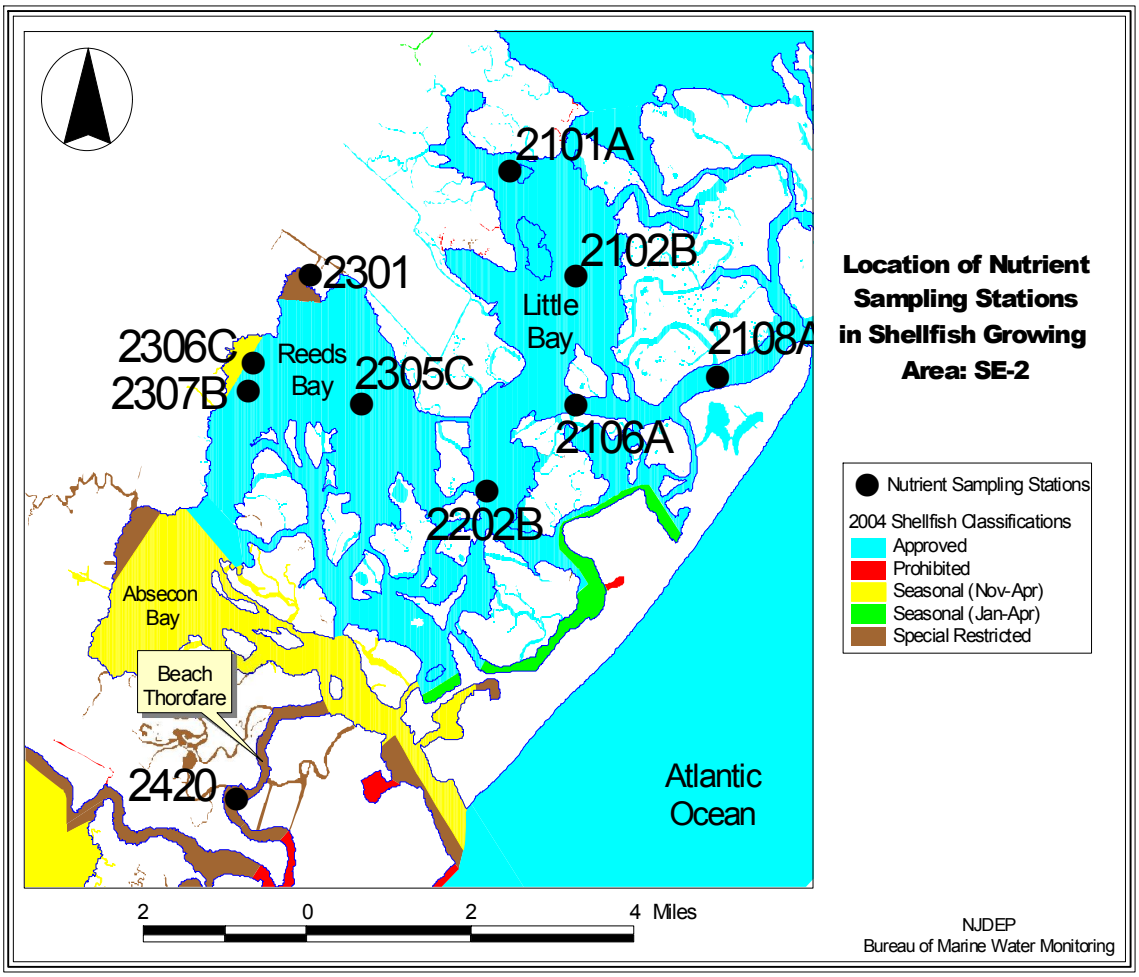
As shown in Figure 19 (Storm Water Outfalls in Shellfish Growing Area SE-2), there are numerous storm water outfalls situated along the shoreline in Brigantine City. When heavy rains occur, debris from the street can be swept into nearby storm drains and then flushed out into shellfish growing waters. Things that can enter into storm drain systems include human feces from clogged sewage drains, feces from domestic animals, trash, and motor oil. All these factors can contribute to higher bacteria counts.

Both stations are located adjacent to several storm water outfalls. They are also situated in an area where there is very minimal flushing, which means that when contaminants enter these bodies of water, they do not quickly dissipate. According to the rainfall data, higher levels of bacteria counts were observed when rainfall amount was above 0.5 inches, 48 hours prior to sampling. This indicated that flushing within these areas is very poor. Even though these stations were affected by rainfall, they still met the NSSP total coliform criteria.

NUTRIENTS

There are ten stations in this shellfish growing area that were sampled under the estuarine monitoring program for chemical parameters including nutrients. These ten nutrient stations are 2101A, 2102B, 2106A, 2108A, 2202B, 2301, 2305C, 2306C, 2307B, and 2420. The location of these sampling stations can be found on Figure 29. More detailed information concerning dissolved oxygen and nutrient levels can be found in the Estuarine Monitoring Reports published by the NJDEP. The latest report (New Jersey Ambient Monitoring Program: Report on Marine and Coastal Water Quality - 2000) is available from the Bureau of Marine Water Monitoring, www.state.nj.us/dep/wms/bmw.

FIGURE 29: LOCATION OF NUTRIENT SAMPLING STATIONS



CONCLUSIONS

BACTERIOLOGICAL EVALUATION

Based on the water quality data obtained between October 1999 and September 2003, the results for all of the sampling stations were within NSSP *Approved* or *Special Restricted* criteria. There were no indications that indirect discharges, spills, storm water outfalls, tidal component, rainfall component, and seasonal effects had caused a significant impact to the water quality of this shellfish growing area.

RECOMMENDATIONS

The water quality for this area in recent years has been exceptionally good. At this time, it is recommended that a portion of Absecon Bay and Absecon Channel, all of Will Thorofare and Low Water Thorofare be upgraded from *Seasonal Approved (November – April)* to *Approved* year-round. The proposed areas will be equivalent to approximately 1,916 acres (see Figure 30). The best landmark that can be use to delineate between the *Approved* and *Seasonal Approved* waters in Absecon Channel is the Justice Vincent's Haneman Bridge. There are no landmarks in the Absecon Bay area that can be use as a marker. Therefore, two Department maintained markers would be placed in appropriate area of the bay to delineate between *Approved* and *Seasonal Approved* waters. One marker will be placed approximately 0.960 miles west of Absecon Creek (latitude North 39 degrees 24 minutes 29.38 seconds and longitude West 74 degrees 29 minutes 10.83 seconds). The other marker will be located at latitude North 39 degrees 23 minutes 40.81 seconds and longitude West 74 degrees 28 minutes 48.83 seconds.

LEGAL DESCRIPTION FOR RECOMMENDED CHANGES

New Jersey Administrative Code

Old Text N.J.A.C. 7:12-4.1 (a) 6

6. [Absecon Bay-Absecon Channel Reed Bay area: Seasonal-Special Restricted May 1 through October 31 yearly. Approved November 1 through April 30 yearly:]

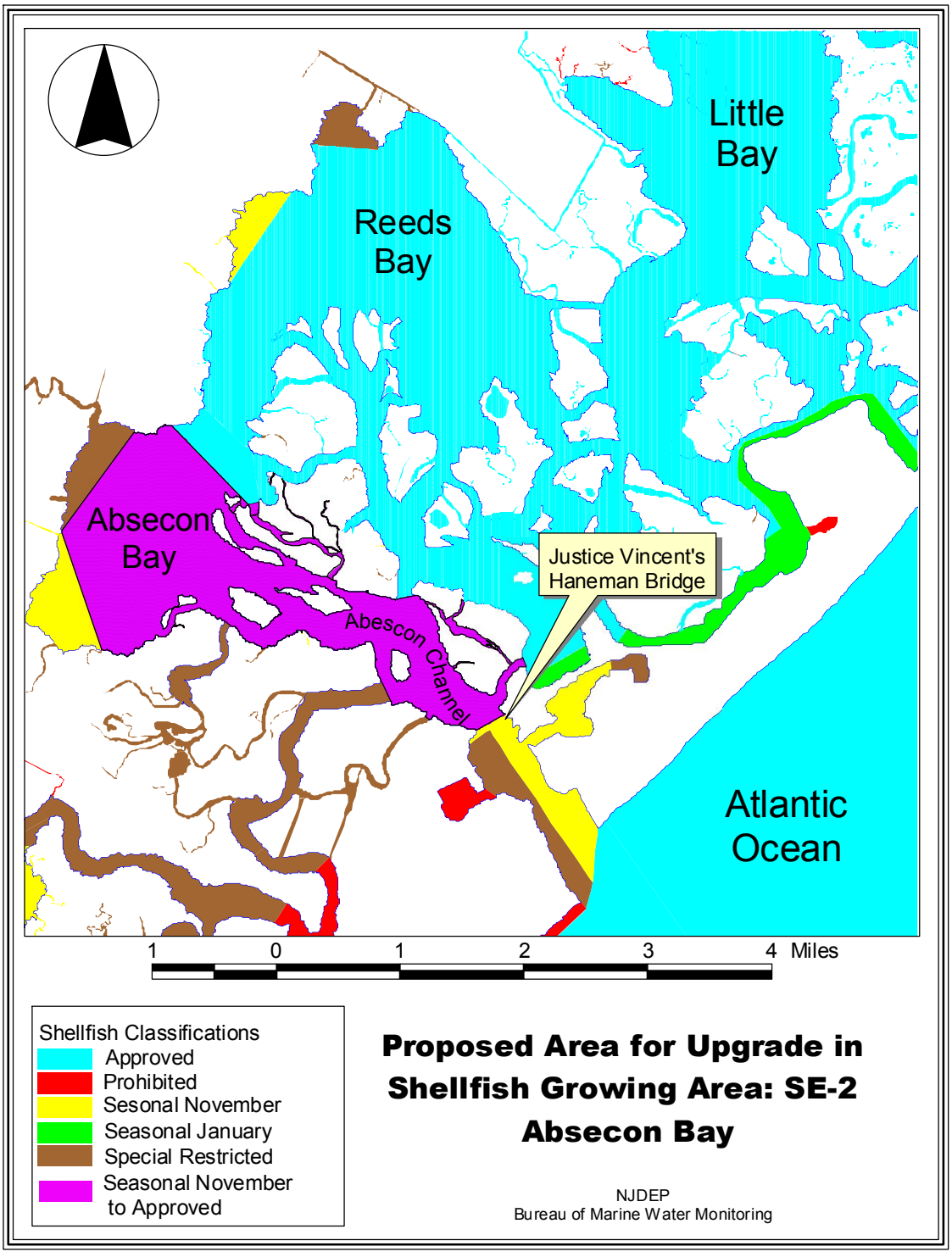
i. [All of Middle Thorofare, Wills Thorofare, Absecon Channel, Absecon Inlet, Little Panama, Low Water Thorofare and Absecon Bay contained within a line beginning at the point of land on the western shore at the mouth of Point Bar Thorofare, then along that shoreline across the mouth of Newfound Thorofare, then along that shoreline and across the mouth of Jonathan Thorofare, then along that shoreline to the Department maintained marker located at the mouth of the first major man-made cut or lagoon (not including mosquito ditches) and bearing approximately 036 degrees T to another Department maintained marker on the opposite bank and continuing along that shoreline in a northeast direction to the Department maintained marker, than bearing approximately 134 degrees T to the Department maintained marker at the mouth on the west shore of Wills Thorofare, then bearing approximately 075 degrees T across Wills Thorofare and Absecon Channel, then across the mouth of Middle Thorofare and along the eastern shoreline of two unnamed islands, including Low Water Thorofare and an unnamed thorofare, and the mouth of Little Panama and along the shoreline in a southerly direction to Absecon Channel, then in a seaward direction across the mouth of St. George's Thorofare and along that shoreline to the seaward end of the jetty, than channelward to a line from R "2" (FI R 2.5s) and bearing approximately 328 degrees T to the midspan of the Rte. 87 bridge, then along the bridge in a westerly direction to the base of the bridge, then along the shoreline in a northerly direction across the mouth of Clam Thorofare and Beach Thorofare and along that shoreline to the point of origin at the point of land at Point Bar Thorofare.]

New Text N.J.A.C. 7:12-4.1 (a) 6

6. Absecon Bay, Absecon Channel and Absecon Inlet area: Seasonal-Special Restricted May 1 through October 31 yearly. Approved November 1 through April 30 yearly:

i. Absecon Bay starting from the Department maintained marker, located approximately 0.960 miles west from the mouth of Absecon Creek (Latitude North 39 degrees 24 minutes 29.38 seconds and Longitude West 74 degrees 29 minutes 10.83 seconds) continuing southwest along the shoreline, then crossing over the mouth of Jonathan Thorofare and continuing south eastward along the shoreline toward another Department maintained marker located at the mouth of an unnamed thorofare (Latitude North 39 degrees 23 minutes 40.81 seconds and Longitude West 74 degrees 28 minutes 48.83 seconds), then bearing approximately 342 degrees T to the point of origin; Absecon Channel and all waters contained within a line from the base of the Justice Vincent's Haneman Bridge (Rt. 87) starting on the Atlantic City side and extending northeast toward Brigantine City and continuing along the shoreline to Rum Point, then crossing over the mouth of St. George's Thorofare and continuing to the seaward end of the jetty on the eastern shore, at the mouth of Absecon Inlet, then channelward to a line from RN"2"(FIR2.5s) and bearing approximately 174 degrees T to the midspan of the Justice Vincent's Haneman Bridge, then running northwest along the line to the Rt. 87 bridge, then westward along the bridge to the point of origin at the base of the bridge, note section of the channel is classified as Special Restricted, see 7:12-3-2 (a) 23 *i*;

FIGURE 30: AREA RECOMMENDED FOR UPGRADE



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NOAA. National Climatic Data Center website located at www.erh.noaa.gov/er/box/dailystns.shtml.

U.S. Census Bureau. www.census.gov/

U.S. Environmental Protection Agency. www.epa.gov/owow/

USGS. www.usgs.gov/

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APPENDICES

A. Statistical Summaries

   Year-round

   Winter Only

   Summer Only

B. Seasonal Evaluation

C. Precipitation

   Rainfall Correlation

   Cumulative Rainfall

   Wet Weather Statistical Summary

   Dry Weather Statistical Summary

D. Tidal Evaluation

E. Data Listing - 1998 through 2002

Ambient Monitoring Program

Partial Sanitary Survey Report

Shellfish Growing Area: SE-2

Absecon Bay, Reeds Bay,

Little Bay and Beach Thorofare

January 2008

Department of Environmental Protection

Lisa P. Jackson, Commissioner

State of New Jersey

Jon S. Corzine, Governor