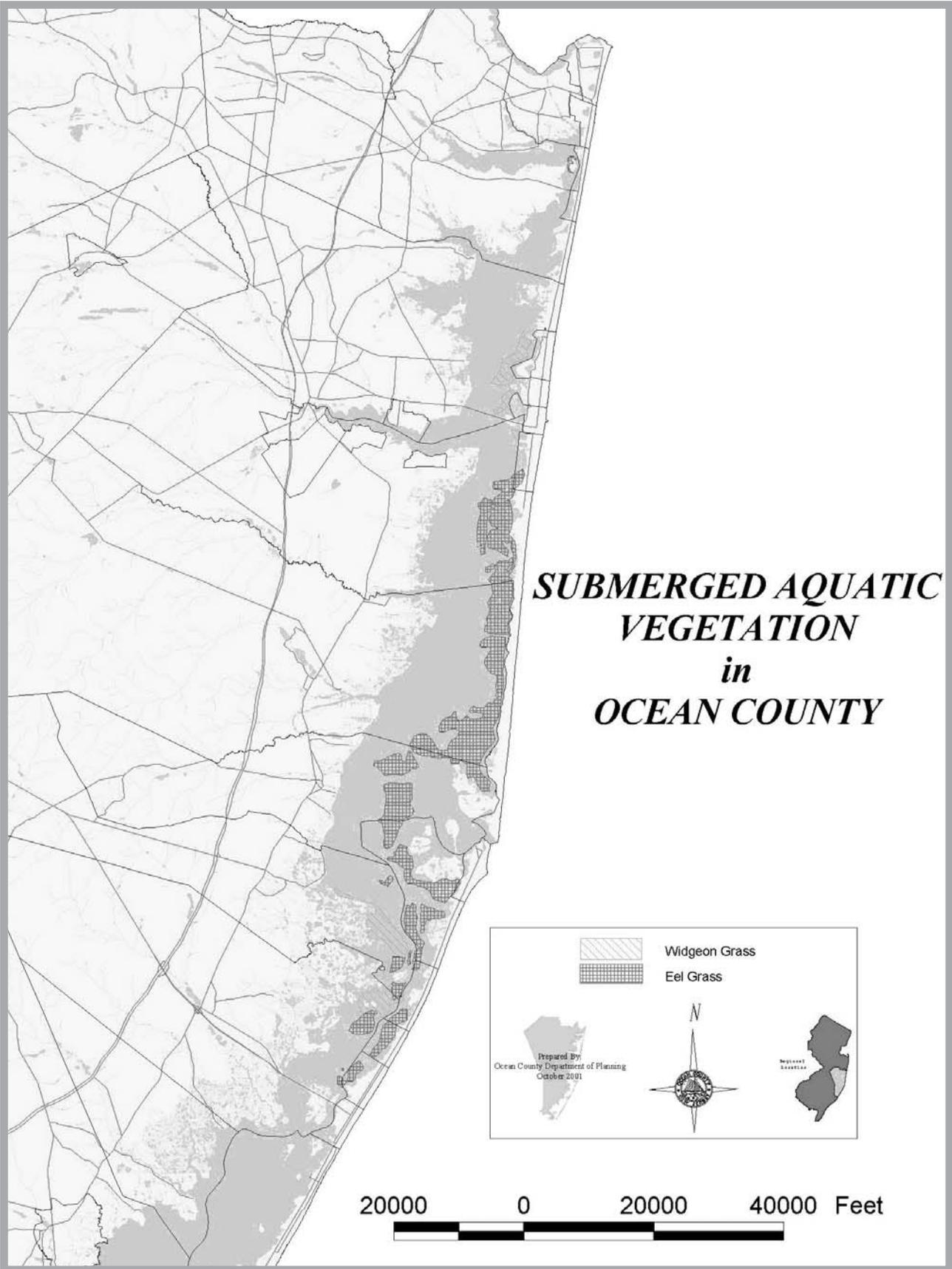


CHAPTER 9

Monitoring Program

Plan

Rutgers Institute of Marine and Coastal Science, Little Egg Harbor. PHOTO BY C.MINERS



9.1 Introduction

An effective monitoring program is an integral component of the CCMP. Monitoring is necessary to assess the status and trends in the health and abundance of the Barnegat Bay watershed's water quality, water supply, habitat and living resources, and opportunities for human enjoyment. Monitoring provides the scientific evidence of changes taking place within the Bay and watershed, either on a temporal or spatial scale. The results of such monitoring can validate the effectiveness of current and planned management strategies, leading to the achievement of goals, or can suggest where more concentrated attention should be placed.

This Monitoring Program Plan describes the existing and future monitoring efforts that will be taken within the bay and watershed. Monitoring is conducted by a variety of Program participants, from federal, state, and county agencies, to academic and research institutions and citizen volunteers. The Action Items contained within this Monitoring Program Plan both complement and support the Action Plans in Chapters 5 to 8 of this CCMP. For example, workshops called for in

the Monitoring Program Plan will help flesh out the monitoring component of Action Items in the Water Quality and Water Supply Action Plan, and ensure that progress in implementing those actions is measurable. The Monitoring Program Plan also helps to ensure that Action Items are implemented effectively and adjusted when necessary. By measuring environmental changes in association with Action Item implementation, the BBNEP will be able to evaluate the results of these actions and whether the goals and objectives of the Program are being met. The integration of the Monitoring Program Plan and Action Plan Action Items is indicated in Table 9-1.

Monitoring can be effective at different stages of the implementation process. Output monitoring measures programmatic progress and addresses CCMP implementation issues such as number of actions implemented within a given period of time. Outcome monitoring focuses on the results of actions, such as the changes in ambient environmental conditions, ecological functions, and biological populations and communities. Both kinds of monitoring are addressed by this Monitoring Program Plan.



PHOTO: C. MINERS

MONITORING PROGRAM PLAN

TABLE 9-1. Linkages between the Environmental Action Plans (Chapters 5 and 6) and the Monitoring Program Plan.

Water Quality/Water Supply & Habitat and Living Resources Action Plans: Action Items	Monitoring Needs of Action Items	Corresponding Monitoring Program Plan Actions	Description of Linkage
<p>Action Items 5.1, 5.3, 5.4, 6.11-6.14</p>	<ol style="list-style-type: none"> 1) Implementation monitoring. 2) Database to track progress in stormwater management basin inventory, BMP basin retrofits, and municipality compliance with Phase II Municipal Stormwater rules. 3) GIS to reveal Barnegat Bay coastal zone boundary, impaired sub-watersheds, state lands, etc. 4) Hydrologic monitoring to evaluate basin BMP retrofit performance. 5) TMDL development and monitoring. 6) Information tracking and dissemination. 	<p>9.1—Conduct workshops on monitoring, modeling, and research needs.</p> <p>9.2—Develop and implement long-term data management strategy.</p> <p>9.3-9.4—Monitor CCMP objectives.</p>	<p>Workshops will refine scope of the Action Items and identify specific data elements needed to satisfy monitoring needs.</p> <p>BBEP will seek commitments from Management Conference members to implement TMDL development and monitoring. These members will implement this part of the EMP.</p> <p>Implementation of the long-term data management strategy will facilitate the evaluation of data generated through the Action Items so that their effectiveness in reducing nonpoint source contamination can be assessed.</p> <p>The long-term data management strategy will include provisions for results of the monitoring that would be needed for the development of TMDLs and for results of monitoring that would be required to evaluate the effectiveness of TMDLs.</p> <p>BBEP will conduct implementation monitoring to track Action Item implementation (Action Item 9.4), effectiveness monitoring to track resource values and concerns (Action 9.3), and disseminate information.</p>

TABLE 9-1. (continued)

Water Quality/Water Supply & Habitat and Living Resources Action Plans: Action Items	Monitoring Needs of Action Items	Corresponding Monitoring Program Plan Actions	Description of Linkage
<p>Action Items 5.5-5.13, 6.1-6.6, 6.8-6.10</p>	<ol style="list-style-type: none"> 1) Database to track information on developments, households, farms, golf courses, and municipalities participating in Action programs. 2) Database to track Canada Geese nuisance complaints. 3) GIS database to track the amount of barren land and forest cover. 4) GIS database to track populations of rare, threatened, and endangered wildlife. 5) Short-term sampling to identify sources of pesticide/fertilizer residues. 6) Information tracking and dissemination. 	<p>9.1—Conduct workshops on monitoring, modeling, and research needs.</p> <p>9.2—Develop and implement long-term data management strategy.</p> <p>9.3-9.4—Monitor CCMP objectives.</p>	<p>Workshops will refine scope of the Action Items and identify specific data elements needed to satisfy monitoring needs.</p> <p>BBEP will seek commitments from Management Conference members to conduct sampling.</p> <p>Implementation of the long-term data management strategy will facilitate the evaluation of data generated through the Action Items so that their effectiveness as source-control strategies can be assessed.</p> <p>BBEP will conduct implementation monitoring to track Action Item implementation (Action 9.4), effectiveness monitoring to track resource values and concerns (Action 9.3), and disseminate information.</p>
<p>Action Items 5.14, 5.15</p>	<p>No new monitoring needs other than implementation monitoring and information tracking/dissemination. Monitoring of point sources is coordinated under existing regulatory programs.</p>	<p>N/A</p>	<p>N/A</p>

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TABLE 9-1. (continued)

Water Quality/Water Supply & Habitat and Living Resources Action Plans: Action Items	Monitoring Needs of Action Items	Corresponding Monitoring Program Plan Actions	Description of Linkage
Action Items 5.16-5.19	<ol style="list-style-type: none"> 1) Database to track the number of sewage pumpout facilities installed, distribution of promotional materials, and results of usage surveys. 2) Database to track information on marinas and other boating facilities participating in "Clean Marinas" program. 3) Information tracking and dissemination. 	<p>9.1—Conduct workshops on monitoring, modeling, and research needs.</p> <p>9.2—Develop and implement long-term data management strategy.</p> <p>9.5—Monitor CCMP objectives.</p>	<p>Workshops will refine scope of the Action Items and identify specific data elements needed to satisfy monitoring needs.</p> <p>Implementation of the long-term data management strategy will facilitate the evaluation of data generated through the Action Items so that their effectiveness as source-control strategies can be assessed.</p> <p>BBEP will conduct implementation monitoring to track Action Item implementation and disseminate information.</p>
Action Items 5.20-5.24, 6.7	<ol style="list-style-type: none"> 1) Expand existing stream-gauging and saltwater monitoring networks. 2) Database to track information on users of weather station data, status of wastewater reuse demonstration project. 3) Data collection through shellfish resource survey. 4) Information tracking and dissemination. 	<p>9.1—Conduct workshops on monitoring, modeling, and research needs.</p> <p>9.4—Develop and implement long-term data management strategy.</p> <p>9.4—Monitoring CCMP objectives.</p>	<p>Workshops will refine scope of the Action Items and identify specific data elements needed to satisfy monitoring needs.</p> <p>BBEP will seek commitments from Management Conference members to implement expansion of monitoring network.</p> <p>Implementation of the long-term data management strategy will facilitate the evaluation of data generated through the Action Items so that their effectiveness in meeting goals can be assessed.</p> <p>BBEP will conduct implementation monitoring to track Action Item implementation and disseminate information.</p>

TABLE 9-1. (continued)

Water Quality/Water Supply & Habitat and Living Resources Action Plans: Action Items	Monitoring Needs of Action Items	Corresponding Monitoring Program Plan Actions	Description of Linkage
Action Items 5.2, 5.25	<ol style="list-style-type: none"> 1) Data collection required for completion of the Natural Resource Inventory (NRI). 2) Sanitary Survey and Intensive (land-based) Survey to support NJDEP Shellfish Waters and Bathing Beaches protection strategies. 3) Information tracking and dissemination. 	<p>9.2—Conduct workshops on monitoring, modeling, and research needs.</p>	<p>Workshops will refine scope of the Action Items and identify specific data elements needed to satisfy monitoring needs.</p>
		<p>9.4—Develop and Implement Long-Term Data Management Strategy.</p>	<p>BBEP will seek commitments from Management Conference members to implement NRI, Sanitary Survey, and Intensive (land-based) Survey.</p>
		<p>9.5—Monitor CCMP objectives.</p>	<p>Implementation of the long-term data management strategy will facilitate the evaluation of data generated through the Action Items so that their effectiveness in providing baseline information required for other Action Items can be assessed.</p>
			<p>BBEP will conduct implementation monitoring to track Action Item implementation and disseminate information.</p>

MONITORING PROGRAM PLAN

9.2 EXISTING MONITORING PROGRAMS IN THE BARNEGAT BAY WATERSHED

9.2.1 WATERSHED-BASED MONITORING PROGRAMS

A number of ongoing monitoring programs have facilitated the development of the CCMP, and will continue to be useful during CCMP implementation. These monitoring activities also serve as the basis for the development of the Monitoring Program Plan. Summaries of these existing monitoring programs are presented below.

NATIONAL SHELLFISH SANITATION PROGRAM (NSSP)

This program was established by the U.S. Surgeon General in 1929 and is active in all coastal states involved in interstate shellfish harvest and sale. Its purpose is to regulate the harvest and sale of shellfish to safeguard the public health from the consumption of contaminated shellfish. The elements of this program that address nonpoint source (NPS) pollution concerns are the shellfish growing water classification requirements, which require shellfish producing states to classify their coastal waters according to their suitability for safe shellfish harvest. Classifications are based on three types of assessments: pollution source surveys, water quality monitoring, and hydrologic surveys. Barnegat Bay and its tributaries are divided into six Shellfish Growing Areas for monitoring of total coliform and fecal coliform bacteria. Sampling occurs at several hundred monitoring stations at least six times per year. This monitoring is conducted at a cost of \$154,000 per year.

FUNDING AGENCY: State appropriations.

MONITORING PARAMETERS: Total coliforms, fecal coliform, (temperature and salinity sampled in a subset of these stations).

STATIONS: 2500 stations statewide; Barnegat Bay is divided into 6 Shellfish Growing Areas.

FREQUENCY: Sampled between 5 and 12 times per year.

SAMPLE COLLECTION: Per methods described in the New Jersey Field Sampling Procedures Manual - 1992, as amended and supplemented.

DATA MANAGEMENT: MS Access, STORET (2001 or later), data prior to 1996-Legacy STORET.

ESTUARINE MONITORING PROGRAM

The NSSP is designed to monitor water quality for public health reasons. In the early 1980s, the "green tide" problems along the New Jersey coast highlighted the need to monitor parameters besides coliform bacteria that would provide information on the ecological health of the coastal waters as well. In response to this need, in 1989 the NJDEP Bureau of Marine Water Monitoring started the Estuarine Monitoring Program. It monitors parameters such as oxygen, salinity, nitrogen, phosphorus, secchi depth (turbidity), temperature, chlorophyll, and suspended solids. Samples are collected quarterly. There are approximately 200 estuarine monitoring stations in the Barnegat Bay watershed.

The monitoring data from this program are used to identify nitrate-impacted waters. Areas such as the upper end of Barnegat Bay show elevated nitrate levels relative to other estuarine waters of New Jersey. The apparent cause is NPS pollution.

FUNDING AGENCY: State appropriations.

MONITORING PARAMETERS: Oxygen, salinity, nitrogen, phosphorus, turbidity (Secchi depth), temperature, chlorophyll, suspended solids.

STATIONS: 260 stations statewide; ~ 40 stations in Barnegat Bay.

FREQUENCY: Quarterly.

SAMPLE COLLECTION: Per methods described in the New Jersey Field Sampling Procedures Manual - 1992, as amended and supplemented.

DATA MANAGEMENT: MS Access, STORET (2001 or later).

TOMS RIVER NONPOINT SOURCE STUDY

The Toms River Nonpoint Source Study is a cooperative effort between the NJDEP and the USGS with Section 319h funding from the USEPA. Its purpose is to establish the pollutant loads associated with land use. Four sites have been selected in sub-tributaries of the Toms River, each of which has a different predominant land use (commercial/high-density residential; moderate-density residential; undeveloped land; and mixed land use). This study is budgeted at \$75,000 per year.

Baseline conditions were characterized when the data were collected in 1994, the first year of the study. Nitrate and organic nitrogen were the predominant nitrogen species at the most highly developed site. Loads of nitrate and ammonia were greatest during storms (3 lbs. nitrate nitrogen per day per square mile and ammonia nitrogen per day per square mile) at this location. At the site with moderate development, nitrate was the predominant nitrogen species. This was especially true during base flow when loads ranged from 2.5 to 7 lbs. nitrate nitrogen per day per square mile. Organic nitrogen was the predominant nitrogen species at the site where there was little development. Fecal coliform loads were greatest at the highly developed and moderately developed land-use sites. Median values for fecal coliform loads ranged from 37 x 10¹² to 63 x 10¹² fecal coliforms per square mile.

A synoptic study was completed recently to characterize the geographic variability of water quality throughout the watershed. The participating agencies will build on this program to improve their understanding of NPS pollution. As originally planned, additional replicates of the land use factors (high-density commercial/residential, moderate-density residential, and undeveloped) are to be established, possibly in the adjacent Metedeconk River watershed and on the barrier island.

The next phase of the study will be to begin best management plan implementation in cooperation with local governments. Monitoring by the NJDEP throughout the best management plan (BMP) implementation phase will take place over the next few years to measure the effectiveness of those BMPs installed.

FUNDING AGENCY: State Corporate Business Tax (CBT) and state appropriations.

MONITORING PARAMETERS: Temperature, dissolved oxygen, pH, specific conductance, ammonia, suspended solids, nitrate/nitrite, total nitrogen, total phosphorus, orthophosphate, turbidity, E-coli.

STATIONS: Four stations along tributaries of the Toms River.

FREQUENCY: Sampling occurs during storm events.

SAMPLE COLLECTION: Per methods described in the New Jersey Field Sampling Procedures Manual - 1992, as amended and supplemented.

DATA MANAGEMENT: MS Access and submitted to USGS (not WATSTORE).

COOPERATIVE COASTAL MONITORING NETWORK

This network is operated to monitor the safety of New Jersey's coastal waters for bathing. Stations are located immediately adjacent to the shores where bathing occurs, and due to the purpose of the program, sampling is limited to the summer months. The OCHD is responsible for sample collection and the Ocean County Utilities Authority (OCUA) is responsible for sample analysis. Results are reported to the NJDEP and the New Jersey Department of Health. Samples are analyzed for fecal coliform and enterococcus bacteria. Other conditions noted at these locations include floatables and the presence of algae.

This network identifies areas with water quality concerns, initiating pollution source investigations that result in corrections to sewage and stormwater collection systems, such as those addressed in the Sewage Infrastructure Improvement Act.

FUNDING AGENCY: Coastal Protection Trust Fund.

MONITORING PARAMETERS: Fecal coliform and enterococcus.

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STATIONS: 328 stations statewide; 184 ocean stations and 144 bay stations.

FREQUENCY: Sampled once per week from mid-May to mid-September (resamples taken daily until bacteria levels are within standards); samples also collected after storm events.

SAMPLE COLLECTION: Per methods described in the New Jersey Field Sampling Procedures Manual - May 1992 as amended and supplemented, and Chapter 9 of the State Sanitary Code for dip method.

DATA MANAGEMENT: MS Excel, STORET (2001 or later).

AMBIENT SURFACE WATER MONITORING NETWORK

This network was established with seven specific objectives on a statewide basis. Those objectives most relevant to the BBNEP are to determine status and trends of ambient surface waters, to work synergistically with the NJDEP Ambient Biomonitoring Network and atmospheric, groundwater, and coastal water-quality networks, and to measure non-point source contributions from major land-use areas, atmospheric deposition, and groundwater. There are five stations in the Barnegat Bay watershed, with a sampling frequency of four times per year. A wide variety of conventional parameters, such as field characteristics, nutrients, major ions, biochemical oxygen demand, organic pesticides, trace elements, VOCs and bed sediment contaminants, are monitored in this program. Metals, pesticides/VOCs and sediments are monitored on a reduced sampling frequency.

Network data are available from the following sources: the USGS computerized data system, WATSTORE; USEPA's computerized data system, STORET; and USGS's annual Water Resources Data - New Jersey reports. A major objective of this network is to coordinate water chemistry and biological databases. Completing that task supports priority initiatives, such as the National Environmental Performance Partnership System (NEPPS), in which biological databases are of increas-

ing importance. The increased monitoring at reference or background stations will support water quality standards development, a central component to water resources management, which is also covered by the NEPPS Agreement. Monitoring costs amount to \$45,000 per year.

FUNDING AGENCY: S106 Grant.

MONITORING PARAMETERS: Metals, pesticides/VOCs, sediments, chlorophyll, bacteria (during primary contact season).

STATIONS: 115 stations statewide; 4 stations in Barnegat Bay watershed.

FREQUENCY: Four times per year.

SAMPLE COLLECTION: Per methods described in the New Jersey Field Sampling Procedures Manual - 1992, as amended and supplemented.

DATA MANAGEMENT: WATSTORE, STORET, Water Resources Data-New Jersey reports.

AMBIENT GROUNDWATER QUALITY MONITORING NETWORK

The Ambient Groundwater Quality Monitoring Network is a cooperative program under the direction of the NJDEP and the USGS. The objective is to characterize groundwater quality. In the Barnegat Bay watershed, approximately eight stations are sampled once every five years during the month of August. Samples from the wells are analyzed for physical characteristics, major ions, nutrients, trace elements, organic constituents, and gross alpha and beta radioactivity. The Barnegat Bay watershed area was last sampled in the water year 2000.

Since the NJDEP initiated its watershed approach to water resources management, this monitoring network has focused its activities in watershed management areas under intensive review by the NJDEP. Meeting the groundwater subgoals/objectives of the NEPPS agreement requires data on groundwater concentrations of nitrates, metals, and VOCs, which are available from this program's database. Network data are available from the following

sources: the USGS computerized data system, WATSTORE; USEPA's computerized data system, STORET; and USGS's annual Water Resources Data - New Jersey reports.

FUNDING AGENCY: S106 Grant.

MONITORING PARAMETERS: Dissolved nutrients, dissolved elements (including metals), VOCs.

STATIONS: 150 stations statewide; 8 stations in the Barnegat Bay watershed area.

FREQUENCY: Annually on a statewide basis, each watershed area is sampled once every five years (Barnegat Bay watershed last sampled in August 2000).

Sample Collection: Per methods described in the New Jersey Field Sampling Procedures Manual - 1992, as amended and supplemented.

DATA MANAGEMENT: WATSTORE, STORET, Water Resources Data-New Jersey reports.

AMBIENT BIOMONITORING NETWORK

The NJDEP's Bureau of Freshwater and Biological Monitoring's Ambient Biomonitoring Network (AMNET) consists of sampling sites in the Barnegat Bay watershed. The program established sampling stations in every sub-watershed, where the health of in-stream benthic macroinvertebrate communities are evaluated using a USEPA-developed statistical methodology referred to as a Rapid Bioassessment Protocol (RBP). Under the program, drainage basins are sampled for benthic macroinvertebrates on a rotational schedule once every five years. The results of the program have been incorporated into the NEPPS as a primary environmental indicator of water quality impairment. AMNET reports of results are published annually by the Bureau. This program is budgeted at \$3,600 for a two-year period.

FUNDING AGENCY: S106 grant.

MONITORING PARAMETERS: Benthic macro invertebrates.

STATIONS: Over 800 stations statewide.

FREQUENCY: Once every five years.

SAMPLE COLLECTION: Per methods described in the New Jersey Field Sampling Procedures Manual - 1992, as amended and supplemented.

DATA MANAGEMENT: STORET, GIS.

ECOREGION REFERENCE

STATION PROGRAM

The Ecoregion Reference Station Program (ERS) is used to support surface water quality and biological monitoring network activities of the Bureau of Freshwater and Biological Monitoring by providing a network of biologically nonimpaired reference stations. There are seven stations in the Barnegat Bay watershed. Originally introduced by the USEPA in the 1980s, the Ecological (Eco) Region concept operates under the premise that water bodies reflect the character of the land they drain, and that where sites are physically comparable, chemical and biological conditions should also be comparable. As such, reference sites within a given ecoregion can serve as benchmarks, or yardsticks, for all other stations within the same ecoregion. The reference stations are, therefore, powerful tools in assessing the results from both biological and chemical monitoring stations in the other networks conducted by the Bureau. Programs such as the 305(b) Watershed Initiative, and NEPPS are all supported by this network. Reference site selection is based upon a number of factors, including, but not limited to: good water quality, presence of pollution-intolerant benthic macroinvertebrate species, stable stream banks and channels, the absence of excessive suspended solids/siltation, and the absence of upstream point and non-point sources of pollution.

FUNDING AGENCY: State appropriations.

MONITORING PARAMETERS: Water quality, stable stream banks and channels, absence of excessive suspended solids/siltation, absence of upstream point and nonpoint sources of pollution, presence of pollution (intolerant benthic microorganisms).

STATIONS: 73 biological reference stations since 1989; 7 stations in Barnegat Bay watershed.

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FREQUENCY: Not applicable.

SAMPLE COLLECTION: Per methods described in the New Jersey Field Sampling Procedures Manual - 1992, as amended and supplemented.

DATA MANAGEMENT: STORET, GIS.

COASTAL PHYTOPLANKTON MONITORING

Every summer, from May to September, the Bureau of Freshwater and Biological Monitoring, in collaboration with the USEPA Region II, monitors phytoplankton populations in the waters along the 120 miles of New Jersey coastline and in major estuaries, including six stations in the Barnegat Bay watershed. Large-scale blooms of these organisms can produce unsightly and unhealthy water quality, conditions often referred to as red, green, or brown tides depending on the dominant varieties. When these algae die off, their decay uses significant amounts of dissolved oxygen in the water, sometimes reducing the bottom oxygen levels below the minimum necessary to sustain larger organisms, such as fish and shellfish. Some of the species that create algal blooms are known to have potentially harmful effects on humans, either through direct contact, or through ingestion of shellfish that have become contaminated with the microorganisms. Fortunately, New Jersey's harmful algal blooms have not been of the acutely toxic varieties.

The Bureau maintains a network of phytoplankton monitoring stations, sampled biweekly or as needed, in accord with the USEPA helicopter monitoring scheme. The monitoring results are used both to indicate potential blooms, and if they do occur, to provide an estimation of the extent and human health threat of the bloom. The historical data also contribute to our understanding of those species that chronically bloom, and the areas in which they bloom. This monitoring program incurs an expenditure of \$74,000 per year.

FUNDING AGENCY: State appropriations.

MONITORING PARAMETERS: Phytoplankton abundance (harmful algae species only).

STATIONS: 22 stations statewide; 6 stations in Barnegat Bay watershed.

FREQUENCY: Once every two weeks from the end of May to September.

SAMPLE COLLECTION: Per methods described in the New Jersey Field Sampling Procedures Manual - 1992, as amended and supplemented.

DATA MANAGEMENT: MS Access.

ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM (EMAP)

This is a nationwide program administered by the USEPA to assess the health of the country's estuaries. Measurements include basic water chemistry, inorganic and organic toxicants, sediment texture, and biodiversity. There are several EMAP sampling locations in the Barnegat Bay region. Sampling locations are not fixed, but instead vary from year to year to accommodate the stochastic sampling design. As of 2001, USEPA Region II is implementing a two-year R-EMAP, or Regional EMAP, study focused specifically on Barnegat Bay. This R-EMAP study will attempt to characterize the ambient conditions of Barnegat Bay using the same parameters as those used in the EMAP protocol.

COASTAL 2000 MONITORING

The Coastal 2000 project is an attempt to assess the condition of the Nation's estuarine waters through a rigorous and statistically valid sampling design. The USEPA is partnering with 24 coastal states, including New Jersey, to examine core indicators of coastal ecosystem health: fish and benthic community structure, sediment and water quality, sediment toxicity, concentrations of contaminants in fish and shellfish, and fish pathology. The New Jersey Marine Sciences Consortium (NJMSC) has been designated as New Jersey's participating agency in this multi-million dollar national coastal assessment project.

In cooperation with the NJDEP, Division of Fish and Wildlife, NJMSC scientists will assess the condition of all of New Jersey's coastal waters, including Barnegat Bay and its tributaries. Collecting the data on the core indicators will provide a valuable picture of the condi-

tion of coastal waters in Barnegat Bay and will provide additional tools to use in ecosystem condition monitoring work, which is aimed at managing and preserving the resources of Barnegat Bay and its watershed.

FUNDING AGENCY: EPA funds.

MONITORING PARAMETERS: Basic water quality (oxygen, salinity, etc.), sediment toxins (inorganic and organic), fish tissue analysis, fish pathology, species diversity (benthic organisms, fish), sediment texture.

STATIONS: 50 stations statewide; ~12 stations in Barnegat Bay (including Little Egg Harbor and excluding Great Bay).

FREQUENCY: First samples taken in August 2000 with a follow-up regimen in the summer of 2001.

SAMPLE COLLECTION: Per methods described in the New Jersey Field Sampling Procedures Manual - 1992, as amended and supplemented.

DATA MANAGEMENT: STORET.

NJDEP LAND USE MAPPING PROGRAM

This program was established by the NJDEP to map land use statewide. The state defines land use as how humans are using the land, including residential land, industrial land, commercial and service use, etc. The NJDEP has either contracted out or partnered with the USGS to have color-infrared aerial photography taken in statewide coverage on an approximately five to ten-year time cycle. This aerial photography has been further processed to produce digital ortho-photography. Based on this aerial photographic data, the NJDEP has contracted out the detailed mapping of land use.

The first land use mapping for the Barnegat Bay watershed is for 1986. This data set has been recently updated with 1995 photography. In addition to mapping land use type, the 1995 data include estimates of impervious surface cover. These two land use maps are

available in digital GIS form from the NJDEP on CD-ROM or directly downloadable through the Internet. The NJDEP has plans to update this data set in 2002-2003. The data set has several applications, including identification of trends in land use and impervious surface cover and identification of watersheds that have the highest potential for NPS pollution inputs to Barnegat Bay.

CRSSA LAND COVER MAPPING PROGRAM

The Rutgers University Center for Remote Sensing & Spatial Analysis (CRSSA) has an ongoing land cover mapping and monitoring program for the Barnegat Bay watershed and adjacent Jacques Cousteau National Estuarine Research Reserve (JCNERR). Land cover represents the biophysical material or features covering the land surface and includes such categories as high intensity development, grassland, and forestland. Greater detail as to the vegetation community or habitat type is also mapped (for example, pitch pine lowland).

Based on satellite imagery, CRSSA has mapped land cover at varying levels of detail for the Barnegat Bay watershed for the years of 1972, 1984 and 1995. CRSSA has plans to update the land cover for the Barnegat Bay watershed in 2001-2002. This data set has several applications, including: identification of trends in land use and impervious surface cover; identification of watersheds that have the highest potential for NPS pollution inputs to Barnegat Bay, and monitoring of habitat loss, alteration and fragmentation.



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9.2.2 OTHER MONITORING PROGRAMS

The following monitoring programs will also provide additional data and/or information for measuring the effectiveness of the action items and for evaluating how well the objectives portrayed in each Chapter of the CCMP are being achieved.

STREAMFLOW MONITORING PROGRAM

As part of its statewide network, the USGS operates a number of sites in the Barnegat Bay watershed where streamflows are measured. These sites include three streamflow-gauging stations and two low-flow partial-record stations. At each of these sites, measurements are made at different intervals and for different purposes. In addition, historical streamflow data are available for three discontinued streamflow-gauging stations and a number of other miscellaneous sites in the watershed.

At streamflow-gauging stations, streamflow is measured continuously (every 15 minutes). Data for one of these sites is transmitted via satellite and is available in real time on the Internet.

Low-flow stations are established to periodically measure flow during conditions that are presumed to represent baseflow.

TIDE MONITORING PROGRAM

As part of its statewide coastal network, the USGS operates a number of sites where tides are measured in the Barnegat Bay watershed. These sites include four tidal crest-stage stations and four tide-gauging stations. At tide-gauging stations, the height of tides is measured on a continuous basis. Tidal crest-stage gauges are located in stream reaches that are affected by the tides and are established to measure the highest stage occurring between site visits.

The tide gauges are linked to the New Jersey Tide Telemetry System operated by the USGS, which con-

sists of tide gauges, tidal-crest-stage gauges, weather sensors, and computer base stations. The system was established to help minimize the extensive damage that can result from flooding in New Jersey's coastal regions and back bays. Also, as the populations of the coastal regions increase, large storms threaten developed areas and timely evacuation of residents is crucial. The telemetry system (electronic equipment that transmits measurements to a base station) that is connected to these gauges transmits measurements of tide levels, air and water temperature, rainfall, wind speed and direction, and barometric pressure directly to the National Weather Service, New Jersey State Police, New Jersey Department of Transportation, and county emergency management agencies. Tide levels are available in real time on the Internet.

GROUNDWATER LEVEL MONITORING

The USGS maintains a network of observation wells in New Jersey for the purpose of monitoring groundwater levels throughout the state. Twenty of these wells are located within the Barnegat Bay watershed. Changes in water levels reflect the general response of the groundwater system to natural climate changes, changes in recharge patterns, and groundwater withdrawals. Automatic water-level recorders are used on 8 of these 20 wells to obtain the continuous, long-term record that is needed to evaluate the effects of climate changes on the groundwater system, to develop a data base that can be used to measure the effects of development, to facilitate the prediction of future groundwater supplies, and to provide data for groundwater-resource management. Water-level extremes recorders are used on five of the wells to determine the highest and lowest water levels occurring between site visits. Periodic manual measurements are made at seven other wells in the watershed.

NEW JERSEY COASTAL PLAIN SYNOPTIC AND CHLORIDE NETWORK

In addition to monitoring short-term water level changes in these wells, the USGS has also documented

the spatial distribution of water levels in the confined aquifers of the New Jersey Coastal Plain on a regular basis since 1978. Every five years USGS personnel measure water levels in approximately 1,000 wells throughout the Coastal Plain over a four- to five-month period in late fall to assess the status of the water supply. Typically about 100 of these wells are located within the Barnegat Bay watershed. The USGS also obtains chloride concentrations from monitoring wells as well as public supply wells to use in mapping and monitoring the aquifer for status of and changes in the chloride concentration. Typically the contours of the 250 mg/l and half seawater concentrations are mapped and documented in the report as well as concentration changes over time at specific wells. Results of these studies have been used by the NJDEP to develop withdrawal regulations and to establish Water-Supply Critical Areas.

TMDL AND EXISTING WATER QUALITY MONITORING NETWORK

The existing USEPA regulations for administering the Total Maximum Daily Load (TMDL) provisions of the Clean Water Act require the state to develop "pollution budgets" or TMDLs for all waters impaired by nonpoint and point sources of pollution. Pollution reductions called for by a TMDL budget are designed to meet certain safe levels of pollutants that allow beneficial uses such as swimming or fishing as established in existing water quality standards. In the Barnegat Bay watershed the time line for the development of TMDLs is to establish these by June 30, 2006.

The water quality monitoring network will be used to supplement the TMDL program. This statewide network will monitor water quality at selected sites for each sub-basin (HUC-11 Areas) within a watershed. There are 15 such HUC-11 areas in the Barnegat Bay watershed. Quarterly sampling will be performed over a two-year period beginning in October 2002 and will run through September 2004. All freshwater and estuarine sites in the watershed will be sampled for specific conductance, pH, temperature, D.O., ammonia and TSS. Freshwater sites will also be monitored for flow and test for sulfate, chloride, TDS, total phosphorus, nitrite and nitrate and total kjeldahl nitrogen. The data will supplement the NJDEP/USGS stream

monitoring network data from approximately 100 sites statewide and aid in determining the parameters for developing TMDLs.

TMDLs for the 15 HUC-11 areas within the Barnegat Bay watershed will be developed through collaborative efforts using staff from the NJDEP and in conjunction with the watershed planning process, which will include input from existing Public Advisory Committees and Technical Advisory Committees.

COLONIAL NESTING WATERBIRD MONITORING

Barnegat Bay supports large and diverse breeding colonies of birds. Twenty species of colonial waterbirds nest within Barnegat Bay-Little Egg Harbor estuarine habitats, including ten species of long-legged wading birds, six species of terns, three species of gulls, and black skimmers. These avifauna are valuable bioindicators of environmental quality, notably the concentrations of chemical contaminants, levels of human disturbance, resource abundance, and habitat health in the system. They feed near the top of the food chain on numerous species of fish and invertebrates.

The New Jersey Department of Environmental Protection, Division of Fish and Wildlife has monitored nesting populations of colonial waterbirds through a combination of ground and aerial surveys for the past two decades. In addition, Dr. Joanna Burger of Rutgers University has conducted comprehensive investigations of colonial waterbird abundance over the same period of time. Regular censusing of shorebirds and seabirds has revealed important long-term changes in population abundance, as well as recent changes associated with the degradation of critical habitat areas. Declines in population abundance of some species during the past two decades have been attributed to the loss of habitat, increased human disturbance, and predation effects (e.g., from herring gulls and red foxes). In addition, the NJDEP regularly monitors other bird populations such as the osprey and the beach-nesting piping plover.

MONITORING PROGRAM PLAN

9.3 DEVELOPMENT OF THE MONITORING PROGRAM PLAN

The Monitoring Plan for the BBNEP will establish a framework to achieve the following objectives:

- Assess the current environmental health and future trends within the Barnegat Bay estuary and watershed project area;
- Assess the effectiveness of CCMP implementation; and
- Allow for re-evaluation of the program's priorities and actions (discussed further in Chapter 12, Implementation).

The Monitoring Plan includes actions to support these monitoring objectives and will determine appropriate environmental indicators and quantitative measures of effectiveness to accurately paint a picture of overall implementation progress. A final monitoring plan will be completed on the basis of monitoring workshops, which are described as an Action Item in this chapter. This and the other Action Items that follow form the underpinnings of a monitoring program in support of the BBNEP's CCMP.

ACTION 9.1

Prepare for and conduct workshops on monitoring, modeling, and research needs.

SIGNIFICANCE OF ACTION: Section 9.2 summarizes ongoing monitoring, modeling and research efforts and needs in New Jersey. These ongoing activities will assist in early implementation of the Environmental Monitoring Plan (EMP). The EMP will target a comprehensive set of environmental measurements (indicators), which the BBNEP would use to evaluate the success of CCMP action implementation:

- Identify any new areas of concern;
- Determine whether implementation has resulted in actual environmental improvements; and

- Provide information to help redirect and refocus the CCMP during implementation.

STATUS: Partial Commitment.

WHO: BBNEP STAC (Lead), NJDEP, USEPA, OCPD.

HOW: The first step in developing a monitoring program is to conduct a needs assessment with the end-users. The BBNEP, working through the STAC, will hold monitoring workshops involving appropriate scientists and managers to formulate a monitoring, modeling and research plan (i.e., the EMP) to address identified needs. At the first workshop, agencies that have responsibility for various environmental monitoring programs in the Barnegat Bay area will share information on their programs, as well as continuing unmet monitoring needs.

Following this first workshop and completion of a needs assessment, another workshop will be held to identify monitoring efforts and evaluate whether they can be part of an integrated monitoring program designed to meet the needs of the BBNEP. Discrete sampling and subsequent chemical analysis in the laboratory are the traditional mainstays of monitoring natural waters. However, a wide variety of monitoring efforts exist for Barnegat Bay that are conducted by myriad federal, state, and local agencies and institutions. These entities use different protocols, monitor for different parameters, and analyze and store their data using different methods and media. Thus, one of the objectives in capitalizing on existing monitoring efforts is to seek agreement on uniform procedures for data collection, analysis, and storage. Finally sampling design, technology and data management requirements must be developed to meet the needs of the user communities. Consequently, the monitoring program must be integrated with the Data Management Plan outlined in Chapter 10.

WHEN: Work on this action is underway and will be completed in spring 2002.

COST ESTIMATE: Approximately \$50,000 for the initial series of workshops.

FUNDING SOURCES: NEP funding, others to be developed.

In addition, the NJDEP has committed to expanding the existing water quality monitoring system to include monitoring stations within each area sub-watershed and to enhance the monitoring to include additional biological and chemical parameters.

ACTION 9.2

Develop and implement a long-term data management strategy.

SIGNIFICANCE OF ACTION: Data management is an important component of a monitoring strategy and plan. The BBNEP will hire a Data Management Coordinator. The BBNEP is seeking commitments from agencies and institutions to help implement the EMP, including data management and hiring of the Coordinator.

A central authority is needed to take charge of data management and oversee input, storage and updating of data from various sources. (See Chapter 10 of the CCMP for details about the Data Management Goals.) This action is intended to identify the entity that will archive key data sets in a manner to facilitate future use.

The data management system should provide:

- Rigorous documentation of data set contents and quality assurance/quality control (QA/QC) procedures. Standardized sampling, analytical methods, and QA/QC protocols should be adopted to ensure that monitoring information collected by the various partners in this effort are of high quality and are directly comparable.
- Easy downloading of data.

A Data Management Coordinator is needed to complete data entry, prepare a report documenting the data sets entered, including a description of the data sets, costs to enter the data sets, and an evaluation of additional data sets to be considered for entry in the chosen system, including costs.

STATUS: Recommendation.

WHO: BBNEP STAC (Lead), NJDEP, USEPA, OCPD.

HOW: The STAC will hold a data management workshop to evaluate data management options that the BBNEP can use to implement a long-term data management strategy. One key part of the data management options evaluation will be a conceptual model of long-term data management, describing how various options relate and how they could be implemented in a step-wise fashion (See Chapter 10).

The BBNEP has begun to identify the long-term data management needs. *These include:*

- Support reporting on the program of CCMP implementation.
- Provide for storage, retrieval, editing, and QA/QC of relevant environmental data, including physical, chemical, and biological data.
- Provide access to all data to the USEPA, NJDEP, other agencies and investigators.
- Provide appropriate tools to users, including a data entry package, statistical package, GIS interface, and STORET (USEPA's data system) interface.
- Provide a full description of data sets, including QA/QC information.
- Provide collections of relevant reference materials at accessible locations (i.e., existing libraries and other locations to be identified).
- Conduct all activities at low cost and with adequate degree of user friendliness.

WHEN: Work on this action will commence upon final approval of the CCMP, or upon commitment by a sponsoring entity, and will be completed within one year.

COST ESTIMATE: Approximately \$20,000 for the workshop.

MONITORING PROGRAM PLAN

ACTION 9.3

Monitor CCMP implementation.

FUNDING SOURCES: Not yet identified.

SIGNIFICANCE OF ACTION: The Clean Water Act (CWA) Section 320(b)(6) specifies that each National Estuary Program (NEP) Management Conference shall "... monitor the effectiveness of actions taken pursuant to the plan," with the following two primary goals:

- Measure the effectiveness of the management actions and programs implemented under the CCMP.
- Provide essential information that can be used to redirect and refocus the CCMP during implementation.

The first primary goal is environmental in nature, and focuses on changes in ambient conditions, ecological functions, and biological populations and communities. The second primary goal is programmatic in nature and addresses CCMP implementation issues. To effectively evaluate the success of the CCMP, it will be necessary to track both the extent to which the actions laid out in the CCMP are being implemented and the environmental effects, or lack thereof, of those implemented actions. This Action Item addresses the environmental monitoring component. Action Item 9.4 will address the programmatic element.

STATUS: Commitment.

WHO: NJDEP (Lead), OCPD, and other technical participants in the Management Conference.

HOW: Participants will monitor the effectiveness of implementation based on achieving the goals, targets, or measures of success defined in the CCMP.

Effectiveness monitoring answers broader ecological questions:

- Is the ecological integrity of the bay and watershed changing?
- Is water quality improving or getting worse, and by

how much?

- Are there any emerging issues not anticipated by the CCMP?
- Are there any new areas of concern (threats) that need to be tracked?

Effectiveness monitoring lends itself more toward an assessment of success in attaining CCMP goals and objectives than to the implementation of specific actions. This type of monitoring requires a statistically sound analysis of environmental data of known quality and confidence.

The environmental monitoring component of the CCMP is designed to utilize monitoring data collected and assessed by participating agencies, so that this information can be directly compared to quantifiable objectives. It builds upon recently conducted characterization studies and existing monitoring efforts. It seeks to promote cooperation among agencies and stakeholders by incorporating and coordinating efforts into an integrated monitoring plan, increasing the scope and resolution of existing efforts, improving the timeliness of data analysis, and making the results available to a diverse group of agencies and stakeholders in a timely manner.

The fully developed monitoring plan will incorporate existing and planned monitoring efforts, or elements from those programs; identify critical information gaps; and attempt to standardize and coordinate future monitoring efforts. This will minimize duplication of effort among agencies, reduce the cost of monitoring, and provide integrated results to the scientific, regulatory, and stakeholder communities in an efficient and timely manner.

PROCESS FOR MONITORING EFFECTIVENESS:

1. Identify use impairments related to water quality and NPS pollution. This can be done using monitoring to document the magnitude of an environmental problem.

2. Trace a water quality problem back to its source. This is accomplished with monitoring on a more localized, targeted, and intensive manner.
3. Correct the problem at its source and monitor effectiveness. Use evaluation monitoring to measure pollution control.
4. Using the monitoring systems described in 1, 2, and 3 above, trace the water quality improvement back to the removal of the use impairment.

This process has already been used with success at certain locations in New Jersey (Navesink River and numerous bathing beaches). Once pollution sources have been identified (for example, through the Natural Resources Inventory (NRI)), there must be the ability to monitor the management measures taken. The NJDEP is preparing an inventory of NPS pollution management measures being implemented throughout the state. This is an important tool that will enhance coordination among the planning, monitoring, and watershed characterization functions in the BBNEP. The type of monitoring program used will depend on the type of management measure.

STRATEGY FOR MONITORING IN BARNEGAT BAY WATERSHED:

1. The NJDEP prepares a listing of impairments (303(d) list) as candidates for NPS monitoring. These are ranked according to severity of impairment.
2. The NJDEP and BBNEP investigate and identify sources and decide on NPS management strategies to address the impairments.
3. The NJDEP's Water Monitoring Management staff reviews the list to determine the type of monitoring that will be necessary to measure effectiveness and the potential cost of monitoring.
4. If the necessary level of monitoring exceeds the existing monitoring programs, funding sources are identified for the new monitoring needs.

5. BMPs are implemented with continued monitoring. Monitoring program results are reviewed annually.

WHEN: Ongoing. Modifications to existing monitoring programs will be initiated following development of an approved monitoring plan and final approval of the CCMP.

COST ESTIMATE: Funding will come from existing program budgets. Modifications to existing programs will be scoped out as necessary.

FUNDING SOURCES: State and federal agency monitoring budgets.

ACTION 9.4

Track CCMP Action Item Implementation.

SIGNIFICANCE OF ACTION: Programmatic implementation monitoring (i.e., tracking progress of Action Items) is the second component of comprehensive BBNEP monitoring, and will help to keep managers informed regarding the implementation status of various programs and the degree to which programs are or are not achieving their intended outcomes. With this information, managers can make needed modifications to the CCMP or to the actions taken to achieve the desired outcomes outlined in the Plan. Where appropriate, resources can be redirected to ensure that desired outcomes are achieved.

Implementation, or programmatic, monitoring is designed to answer such questions as:

- Is the CCMP being implemented at the level of commitment specified in the CCMP goals, targets, and measures of success?
- Was the action taken?
- What were the specific results?
- Was the action able to be implemented?
- Are the actions in the Plan having the desired effects?
- Does the Plan need to be changed?

MONITORING PROGRAM PLAN

Many actions in the CCMP lend themselves to this type of administrative monitoring. Implementation monitoring establishes accountability on the part of the designated lead organizations for specific actions outlined in the CCMP. It can also be used to verify whether an educational outreach program has reached its target audience.

STATUS: Commitment.

WHO: The BBNEP Program Office (Lead), OCPD.

HOW: The CCMP Tracking System is intended to track action items scheduled for implementation. The tracking will occur by priority issue, specifically: (1) Water Quality/Water Supply; (2) Habitat and Living Resources; (3) Human Activities and Competing Uses; and (4) Public Outreach and Education. Users of the system will be involved in providing reports to the Barnegat Bay Program Office. The reports will provide the basis for annual and triennial reporting by the Program Office.

General capabilities:

- Priority Action Item tracking
- Dates
- Deliverables
- Payment schedule
- Budget tracking
- Program budget
- Other sources of funding
- Link to BBNEP Web site and partner Web sites

WHEN: Work on this action will commence upon final approval of the CCMP.

COST ESTIMATE: \$20,000 is budgeted for initiation of work.

FUNDING SOURCES: NEP program funding.

A more detailed and updated addendum to the *Monitoring Program Plan* (2003) can be found at our website, www.bbep.org or by calling the Barnegat Bay National Estuary Program office.

