COASTAL
NONPOINT SOURCE CONTROL
DEMONSTRATION PROJECT

DRAFT
NONPOINT SOURCE MANAGEMENT PLAN
FOR THE WATERSHED OF
PHINNEYS HARBOR
BOURNE, MASSACHUSETTS

Prepared for the

Massachusetts Department of Environmental Protection

Division of Water Pollution Control

by

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CHAPTER 1
INTRODUCTION

Nonpoint Source Pollution

Nonpoint source pollution has become recognized as a primary obstacle to the achievement of water quality standards and is now becoming a major focus of pollution control efforts. Nonpoint source pollution is defined as pollution derived from diffuse or widespread sources as opposed to point sources such as discharges from municipal wastewater treatment plants which usually flow from the end of a pipe. Typical nonpoint pollutants and sources include:

- **Bacteria** from stormwater, on-site wastewater disposal systems, feedlot runoff, domestic and wild animals, and boat discharges
- **Nutrients** from cultivated areas, on-site wastewater disposal systems, fertilizer application, and decaying grass clippings and vegetation
- **Sediment** from stormwater runoff, land cultivation, construction sites, cleared land, and stream bank erosion
- **Oil and Grease** from parking lot runoff, road surfaces, and illegal disposal of waste oil
- **Heavy Metals** from parking lots, road runoff, and industrial areas

Legislative Background

From the 1970's to the present, water pollution control regulations have been directed primarily at point source control. With most point discharges addressed under the National Pollutant Discharge Elimination System (NPDES), the U.S. Environmental Protection Agency (EPA) and state regulatory agencies such as the Massachusetts Department of Environmental Protection (DEP), Division of Water Pollution Control (DWPC) have begun to focus on controlling nonpoint sources of pollution. Unlike point sources, however, there are no well established institutional or regulatory frameworks to deal with nonpoint sources.

As a first step in developing this framework, with Section 319 of the 1987 amendments to the Clean Water Act, Congress provided local, state and federal agencies with a new mandate to restore the beneficial uses of streams, lakes, wetlands and estuaries impaired by nonpoint source pollution. The states are currently in the process of developing nonpoint source control strategies through the preparation of Nonpoint Source Assessment Reports and Nonpoint Source Management Plans. Through these plans, the states are identifying nonpoint source pollution impaired water bodies, developing nonpoint source management plans to address the most impaired water bodies, and applying for federal nonpoint source control funds.

Project Objectives and Approach

In order to develop approaches and effective means for the assessment and control of nonpoint source pollution problems for use by municipal officials in Massachusetts coastal areas, especially in areas where nonpoint sources have resulted in shellfish closures, the Division of Water Pollution Control selected two test case or demonstration areas for study. These areas included the watershed of Phinneys Harbor and Back River in Bourne, and part of the watershed of the East Branch of the Westport River (EBWR) in Westport. Both of these areas are experiencing shellfish closures due to bacterial contamination. There are, however, no significant point source discharges in either area, indicating that the loss of resources is occurring as a result of nonpoint source pollution.

In order to demonstrate both technical and organizational means to control nonpoint sources, nonpoint source management plans were developed for both study areas. This report contains a nonpoint source management plan for the watershed of Phinneys Harbor and Back River, Bourne, Massachusetts. The objective of the development and implementation of the nonpoint source management plan is to achieve a visible, measurable improvement in water quality in an area where nonpoint sources were having detrimental effects. In the case of the Bourne demonstration area, established goals include:

- Achievement of Massachusetts water quality standards

- Reduction of nonpoint pollutant loadings
- Restoration of the recreational and economic value of shellfish beds in Phinneys Harbor and Back River.

The major tasks conducted and outlined in this report include:

1. Review of past studies and sanitary surveys, shellfish closure records, previous efforts at pollution control, and existing environmental quality data including data on land use, geology and soils, hydrography, water quality, sediment quality, and biological resources (Chapter 2).
2. Identification and ranking of nonpoint pollution sources within the demonstration area (Chapter 3).
3. Identification, evaluation, and screening of best management practices (BMPs) for each category or particular source of pollution identified. Screening criteria include technical feasibility, economics, public support, demonstration value and anticipated water quality improvements (Chapter 4).
4. Development of a nonpoint source management plan for the demonstration area including recommended BMPs, cost estimates, funding sources, implementation responsibilities, regulatory requirements, scheduling, a water quality monitoring plan, and a description of anticipated water quality benefits (Chapter 5).

As there is no existing institutional/regulatory framework for nonpoint source control, much of the effort must come from state and local governments and civic groups. There is a critical need for networking, coalition building, and sharing of responsibilities among federal, state, regional, municipal and local groups. Further, enthusiastic individuals from such groups must be identified, educated and supported by the state's lead nonpoint source agency.

In order to assist state and local municipal officials in developing local strategies to control nonpoint sources, procedures used in the development of nonpoint source management plans for the demonstration areas in Westport and Bourne are outlined in a concurrently prepared report entitled: Nonpoint Source Control: A Guidance Document for Local Officials, 1989. This document, available from the Division of Water Pollution Control, guides users, step-by-step, through a basic approach to nonpoint source control as outlined in Figure 1-1 and will be disseminated in an educational/technical assistance format to municipal officials from communities experiencing persistent water quality problems derived from nonpoint sources.

Project Participants

This technical report has been prepared by Metcalf & Eddy, Inc. under contract to the Massachusetts Department of Environmental Protection. The conduct of the study was facilitated by a large number of other participants. Continuous guidance and technical review was provided by the Massachusetts Division of Water Pollution Control. In order to obtain input from groups involved in nonpoint source control, a project advisory group (PAG) was formed. This group consisted of 27 primary members from federal, state and local government; local environmental groups; local agricultural and fisheries groups; and the academic community. The PAG met for two working sessions during the development of the management plans and guidance document. The role of the group was to:

- Identify pertinent environmental assessment information and pollution sources
- Provide input form various perspectives during project development
- Review the draft nonpoint source management plans and guidance document
- Provide a communication link to larger groups and auxiliary project advisory group members
- Develop consensus and support within the represented organizations.

Each PAG member contributed by providing pertinent data and reports, assisting with field investigations, and sharing site-specific knowledge and organizational information. A list of PAG members is provided in Appendix A.

Numerous individuals from local communities and agencies, as well as state and federal agencies, provided input and assistance. This assistance is noted in

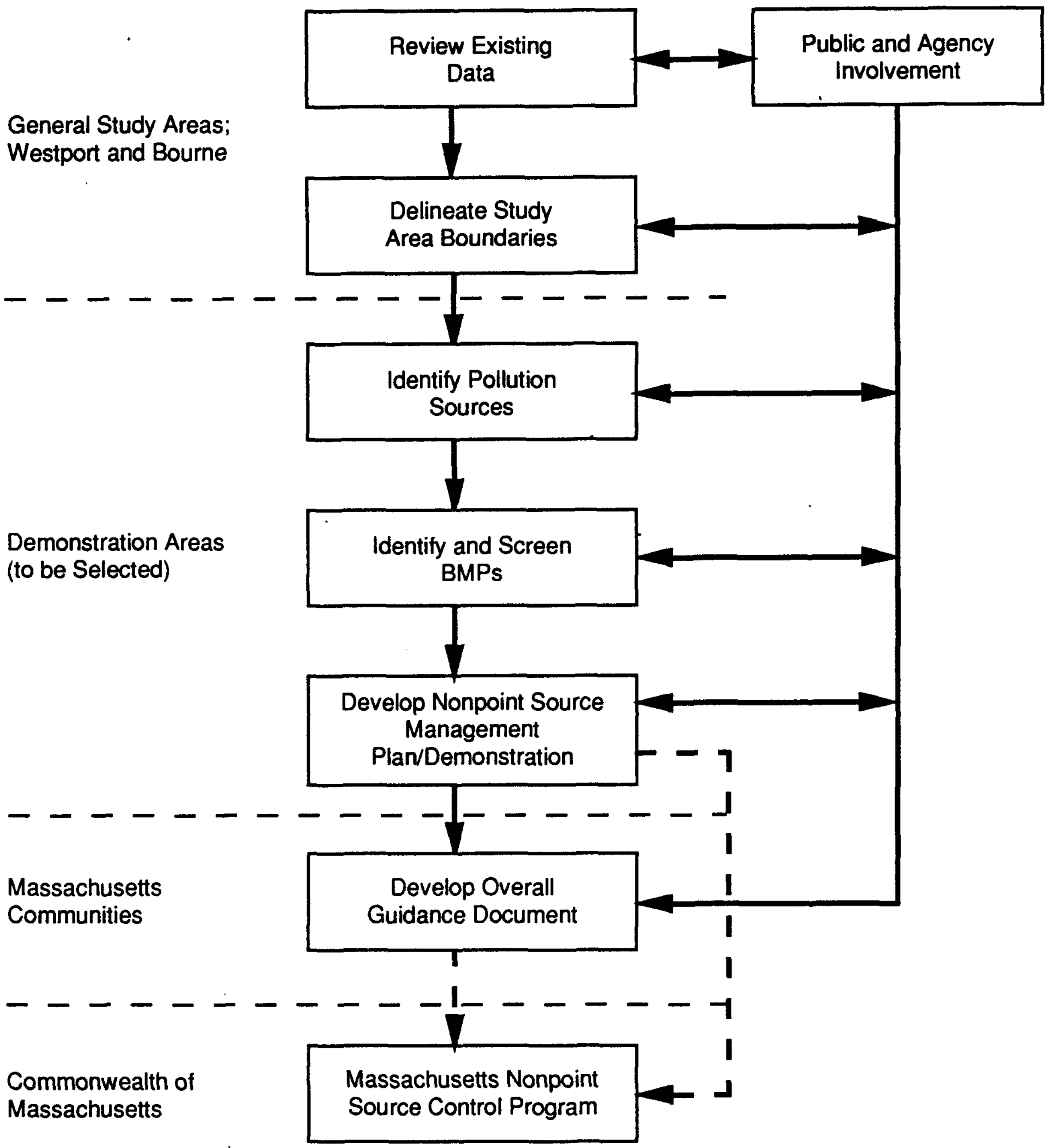

FIGURE 1-1. NONPOINT SOURCE DEMONSTRATION PROJECT TECHNICAL APPROACH

the report where applicable. A public participation program consisting of two public meetings in each demonstration area was also held to obtain further local input to the project.

CHAPTER 2
STUDY AREA BACKGROUND AND EXISTING ENVIRONMENT

This chapter provides a discussion of the project study area - Phinneys Harbor and Back River in Bourne, Massachusetts. Initially, the history of nonpoint source pollution impacts and control efforts is provided and applicable water quality and shellfishing standards and criteria are outlined. Finally, an environmental baseline description including land use, geology and soils, hydrography, water and sediment quality and biological resources is provided.

Phinneys Harbor (Figure 2-1) is a coastal embayment in Bourne, Massachusetts situated just south of the Cape Cod Canal next to the Monument Beach area. The harbor is connected to Back River and Eel Pond, an estuarine system with extensive tidal flats. A total drainage area of 1,788 acres, all in the town of Bourne, feeds this system.

Nonpoint Source Pollution Impacts

Nonpoint source pollution in Phinneys Harbor and Back River is symptomatic of widespread pollution problems in the Buzzards Bay system of which it is a part. According to the Massachusetts Nonpoint Source Assessment Report (MDEQE, 1988a) nonpoint source pollution is pervasive in Buzzards Bay and includes pollution from such sources as surface runoff, boat discharges, storm sewers, septic systems, waterfowl, feedlot runoff and pasture runoff. Bacteria, nutrients and solids contamination from these sources has resulted in shellfishing bans, eutrophication and depressed dissolved oxygen levels in various areas of the bay. In response, organizations ranging from the U.S. Environmental Protection Agency to local environmental groups are participating in the EPA-sponsored Buzzards Bay project. This project involves a comprehensive multidisciplinary study of the bay, its watershed, and potential solutions to widespread pollution problems caused by both point sources and nonpoint sources. In turn, the DEP Division of Water Pollution Control has identified Buzzards Bay as an area that has been significantly degraded by nonpoint source pollution and has incorporated a management plan for Buzzards Bay into its Nonpoint Source Management Plan (MDEQE, 1988b).

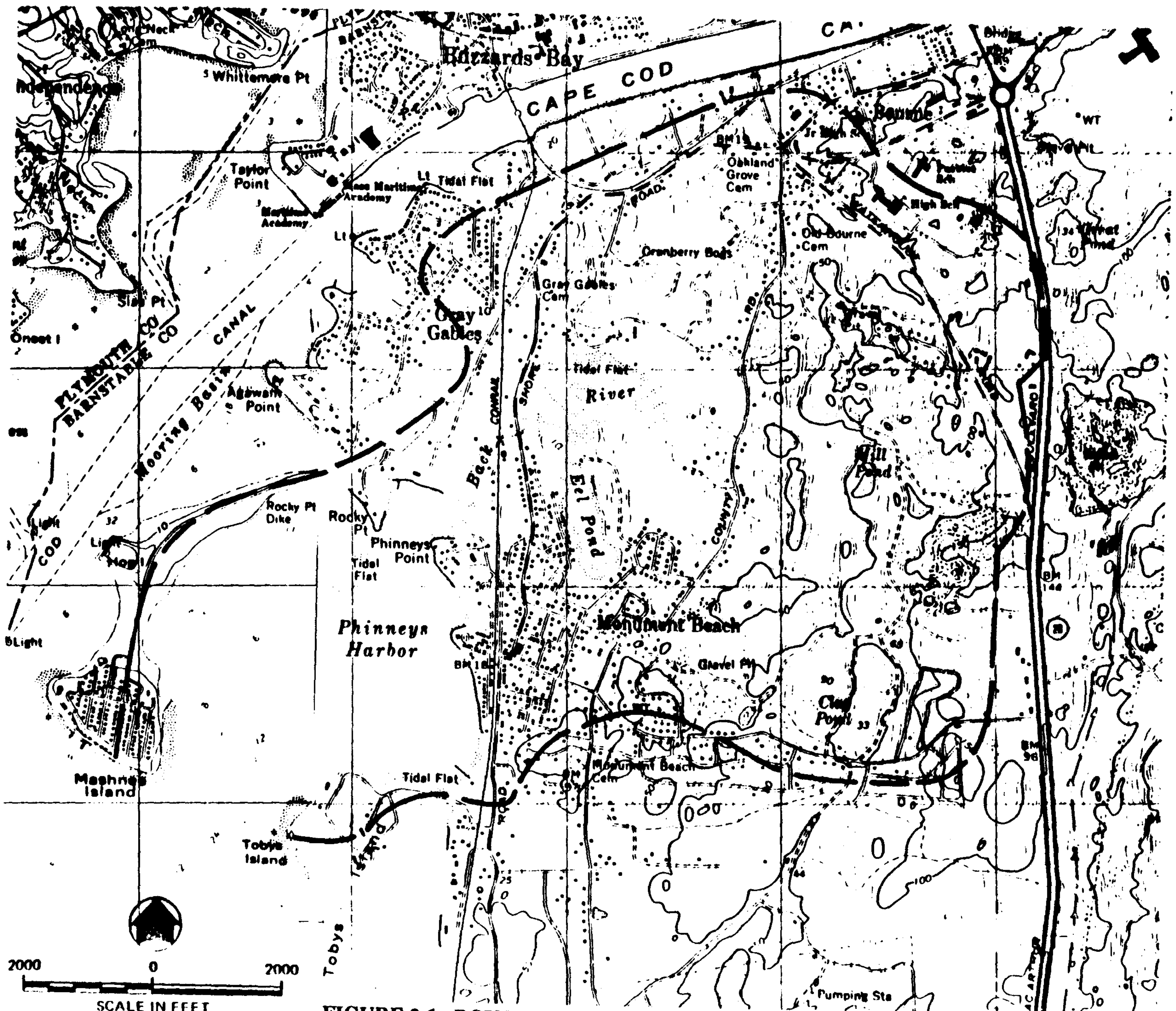

FIGURE 2-1. BOURNE PROJECT AREA LOCATION

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The impacts of nonpoint sources of bacteria on Buzzards Bay have been significant. The bay contains approximately 20,000 acres of shellfish beds where thousands of bushels of hardshell clams, bay scallops, and oysters are harvested annually by commercial and recreational fishermen, accounting for more than $10 million in annual commercial landings. Yet, the number of shellfish beds closed to harvesting as result of coliform contamination has increased dramatically during the past decade such that as of January of 1989, 11,600 of productive shellfish beds were closed. According to the Environmental Protection Agency (EPA, 1989a), the increase in acreage of closed shellfish beds is closely correlated with the increase in the number of building permits issued throughout the watershed.

The impact of nonpoint sources on Phinneys Harbor and Back River has resulted in closures of shellfish beds. According to records obtained from the Massachusetts Division of Marine Fisheries, closures of 111.5 acres of shellfish beds in Back River began to occur in 1984. Over four years, the area was closed intermittently until July 7, 1988, when in a letter to the Bourne Board of Selectmen, the Division of Marine Fisheries (1988) determined that shellfish growing areas in Eel Pond and Back River north of a line drawn east from Rocky Point to the foot of Maryland Avenue did not meet the criterion of an approved harvesting area. The area was thus reclassified as prohibited to the direct harvest of shellfish for human consumption under the provisions of MGL, Chapter 130, Section 74A. Figure 2-2 depicts the location and status of shellfish growing areas in the study area.

Local Pollution Control Measures

In developing a nonpoint source management plan, it is critical to be aware of past and current local efforts to control nonpoint sources. This section describes recent nonpoint source control efforts in Bourne conducted by EPA as part of Buzzards Bay program, as well as by the town and by the U.S. Department of Agriculture.

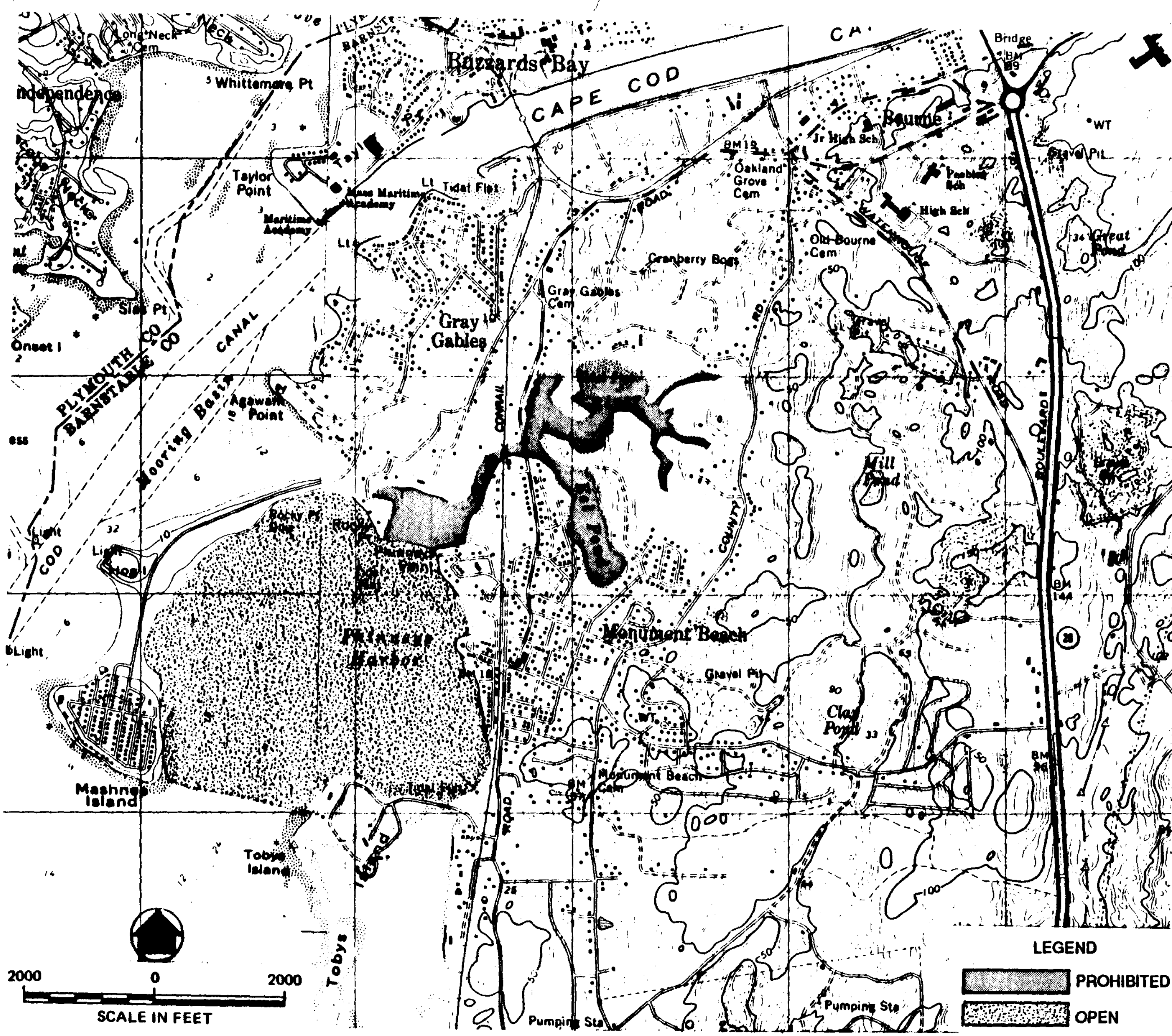

FIGURE 2-2. STATUS OF SHELLFISH GROWING AREAS IN THE PHINNEYS HARBOR WATERSHED

The Town of Bourne has been aggressive in dealing with nonpoint source pollution through use of zoning bylaws and regulations related to controlling septic tank pollution. In addition, the town established a water quality sampling program. In March 1986, the Water Quality Subcommittee of the Bourne Selectmen's Task Force on Local Pollution developed a work plan to survey and identify sources of contamination to the surface and groundwaters in the Town of Bourne. The scope of the monitoring program was to 1) verify DEQE shellfish monitoring program bacteria sampling results, 2) work in cooperation with the EPA Buzzards Bay project, 3) locate sources of fecal coliform contamination, 4) map existing stormdrain discharges, 5) establish a water quality database, and 6) correlate rainfall data and bacteria sampling results. Eighty-one sites were selected as sampling stations based on mapping of suspected bacteria sources. A database was established for 1985, 1986, and 1987 and plots were generated to illustrate the percentage of samples that violated swimming and shellfishing standards, as well as plots of total and fecal coliform counts over time for each station. Several conclusions formulated by the town included that surface water bodies with low flushing such as Back River tend to have higher bacteria levels, and that levels of contamination are directly correlated to and increase with rainfall. Recommendations of the Subcommittee included continued sampling, drainage improvements, and establishment of conditional closures of shellfish beds based on recent rainfall. Through the Board of Health, extensive sampling of shellfish resource areas as well as suspected nonpoint sources has been accomplished. The data from this sampling program are analyzed later in this chapter.

As part of the Buzzards Bay program, a project to control nonpoint source bacteria pollution from stormwater runoff was recently constructed at Electric Avenue Beach in another area of town. This project was funded by the Environmental Protection Agency, Region I, and the design was performed by their contractor (Metcalf & Eddy, 1989). The project involved construction of a system of leaching chambers and leaching galleys, along with revised stormwater drainage piping, to allow infiltration of stormwater into the groundwater. This eliminated a major direct discharge of bacteria which had been identified during the aforementioned town sampling program.

An interesting aspect of the Electric Avenue Beach project is that it was constructed by the town itself using Department of Public Works personnel. This resulted in a substantial savings over use of a private contractor. It also provided the town with expertise in constructing stormwater control facilities. This expertise can be utilized in other areas of town, such as Phinneys Harbor, where stormwater runoff maybe a contamination problem. The Electric Avenue Beach project is being monitored by the Barnstable County Health Department to assess its effectiveness. Preliminary unpublished results have indicated that the facilities are effective in removing bacteria (Heufelder, 1989).

The Town of Bourne has been addressing implementation of stormwater controls in other areas of town. A recent project funded by the town (Gale Associates, Inc., 1989) developed recommended stormwater control BMPs for the Hen Cove, Barlow's Landing and Pocasset River watersheds. Recommendations made consisted mainly of replacing existing catch basins with leaching type catch basins, and replacing concrete-lined drainage ditches with grassed swales. The town has applied for grant assistance through the EPA Buzzard's Bay Project Minigrants program to fund stormwater rehabilitation projects. The application was accepted and the minigrant will be used to assist in constructing the stormwater facilities recommended for the Hen's Cove, Barlow's Landing and Pocasset River watersheds.

Additional methods of nonpoint source pollution control which have been implemented by the town include enactment of bylaws and performance of maintenance activities. For example, the town enacted regulations aimed at septic tank control and dog waste reduction. The town also has a program of regular street sweeping, catch basin cleaning and beach wrack line removal. These programs have not eliminated bacterial contamination of shellfishing areas, but in combination with control of direct stormwater discharges, they are expected to reduce the problem substantially.

The USDA Soil Conservation Service has also played a role in controlling nonpoint source pollution in Bourne and in the watershed of Phinneys Harbor. As a result of various educational efforts by the Soil Conservation Service, a number of cranberry bog owners, including Mr. John Alden who operates a bog adjacent to Back River, have requested assistance from the Soil Conservation Service to develop and implement conservation measures. The Soil Conservation Service provides technical assistance including design of detention ponds, dikes and other conservation measures, as well as cost sharing. More details of the plan being developed for the Alden cranberry bog are provided later in this report.

Applicable Standards and Criteria

Objectives of this demonstration project include improvement of water quality in the study area through the control of nonpoint sources, and achieving an improvement in water quality in shellfish beds which are permanently or intermittently closed due to bacteria violations. This section outlines the water quality standards, criteria and regulations that apply to the Back River and Phinneys Harbor area. These standards and criteria are used later in the report in an assessment of existing water quality and to define water quality objectives for this project.

As required by the Federal Clean Water Act, the Commonwealth of Massachusetts has set water quality standards for Phinneys Harbor and its tributaries. Table 2-1 lists the minimum water quality criteria that must be met by all waters of the Commonwealth, except when the criteria specified for individual classes are more stringent. According to the Massachusetts Surface Water Quality Standards (314 CMR 4.03), Phinneys Harbor, Back River and Eel Pond are classified SA. The water quality criteria for class A waters are presented in Table 2-2. Waters assigned to this class are designated for the uses of protection and propagation of fish, other aquatic life and wildlife; for primary and secondary contact recreation; and for shellfish harvesting without depuration in approved areas. According to the Massachusetts Water Quality Standards, any fresh water tributaries would be classified B. The water quality criteria for Class B waters are presented in Table 2-3. Waters assigned to this class are designated for the uses of protection and propagation of fish, other aquatic life and wildlife; and for primary and secondary contact recreation. In addition, in order to further protect the

TABLE 2-1. MASSACHUSETTS MINIMUM WATER QUALITY CRITERIA FOR ALL WATERS OF THE COMMONWEALTH

Parameter	Criteria
1. Aesthetics	All waters shall be free from pollutants in concentrations or combinations that: a) Settle to form objectionable deposits; b) Float as debris, scum or other matter to form nuisances; c) Produce objectionable odor, color, taste or turbidity; or d) Result in the dominance of nuisance species.
2. Radioactive Substances	Shall not exceed the recommended limits of the United States Environmental Protection Agency's National Drinking Water Regulations.
3. Tainting Substances	Shall not be in concentrations or combinations that produce undesirable flavors in the edible portions of aquatic organisms.
4. Color, Turbidity, Total Suspended Solids	Shall not be in concentrations or combinations that would exceed the recommended limits on the most sensitive receiving water use.
5. Oil and Grease	The water surface shall be free from floating oils, grease and petrochemicals and any concentrations or combinations in the water column or sediments that are aesthetically objectionable or deleterious to the biota are prohibited. For oil and grease of petroleum origin the maximum allowable discharge concentration is 15 mg/l.
6. Nutrients	Shall not exceed the site-specific limits necessary to control accelerated or cultural eutrophication.
7. Other Constituents	Waters shall be free from pollutants in concentrations or combinations that: a) Exceed the recommended limits on the most sensitive receiving water use; b) Injure, are toxic to, or produce adverse physiological or behavioral responses in humans or aquatic life; or c) Exceed site-specific safe exposure levels determined by bioassay using sensitive resident species

TABLE 2-2. WATER QUALITY CRITERIA FOR CLASS SA WATERS

Parameter	Criteria
1. Dissolved Oxygen	Shall be a minimum of 85 percent of SATURATION.
2. Temperature	None except where the increase will not exceed the recommended limits on the most sensitive water use.
3. pH	Shall be in the range of 6.5-8.5 standard units and not more than 0.2 units outside of the naturally occurring range.
4. Total Coliform Bacteria	Shall not exceed a median value of 70 MPN per 100 ml and not more than 10 percent of the samples shall exceed 230 MPN per 100 ml in any monthly sampling period.

TABLE 2-3. WATER QUALITY CRITERIA FOR CLASS B WATERS

Parameter	Criteria
1. Dissolved Oxygen	Shall be a minimum of 5.0 mg/l in warm water fisheries and a minimum of 6.0 mg/l in cold water fisheries.
2. Temperature	Shall not exceed 83°F (28.3°C) in warm water fisheries or 68°F (20°C) in cold water fisheries, nor shall the rise resulting from artificial origin exceed 4.0°F (2.2°C).
3. pH	Shall be in the range of 6.5-8.0 standard units and not more than 0.2 units outside of the naturally occurring range.
4. Fecal Coliform Bacteria	Shall not exceed a log mean for a set of samples of 200 per 100 ml, nor shall more than 10 percent of the total samples exceed 400 per 100 ml during any monthly sampling period, except as provided in 310 CMR 4.02(1).

public from health risks related to the ingestion of contaminated seafood, Massachusetts has adopted the guidelines established by the U.S. Department of Public Health, Shellfish Sanitation Branch, as set forth in the National Shellfish Sanitation Program Manual (U.S. Department of Health and Human Services, 1986). Compliance requirements from the National Shellfish Sanitation Program Manual are listed in Table 2-4, and Table 2-5 describes the state-mandated criteria on which shellfish beds are classified.

Environmental Description

In order to understand the extent and nature of water quality violations in Phinneys Harbor, it is important to understand the characteristics of the contributing watershed. Accordingly, this section contains an environmental description of the Phinneys Harbor area. This description includes a review of existing environmental assessment information on land use, geology and soils, hydrography, water and sediment quality, and biological resources. This baseline is used in this report to identify water quality problems and pollution sources and to evaluate potential best management practices.

Land Use

The watershed of the Back River estuary covers an area of 1,788 acres and is predominantly residential, with some commercial and agricultural development. Recent land use data for the watershed of Phinneys Harbor were developed by EPA (1989b) and are shown in Figure 2-3. There is dense residential development in the Monument Beach area and north and west of Back River. There are approximately 60 acres of inland wetlands consisting of cranberry bogs, wooded swamp, Mill Pond and Mill Brook which discharge into the Back River estuary. Back River is characterized by 73 acres of saltmarsh. Approximately 1,020 acres of the watershed east of Back River is forested.

TABLE 2-4. SATISFACTORY COMPLIANCE CRITERIA FOR GROWING AREAS APPROVED FOR SHELLFISHING WITHOUT DEPURATION (U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, 1986)

A. The area is not contaminated with fecal material, pathogenic organisms, poisonous or deleterious substances, or marine biotoxins.

B. The bacteriological quality of every sampling station in those portions of the area exposed to fecal contamination shall met one of the following standards:

i. The total coliform median or geometric mean MPN of the water does not exceed 70 per 100 ml and not more than 10 percent of the samples exceed an MPN of 230 per 100 ml for a 5-tube decimal dilution test (or an MPN of 330 per 100 ml for a 3-tube decimal dilution test).

The total coliform standard need not be applied if it can be shown by detailed study verified by laboratory findings that the coliforms are not of direct fecal origin and do not indicate a public health hazard. In addition, the standard may not be applicable in a situation where an abnormally large number of pathogens might be present. Consideration must be given to the possible presence of industrial or agricultural wastes containing a typical coliform to pathogen ratio. The standard in (b)(i) is based upon typical coliform to pathogen ratios associated with discharge of domestic sewage after some dilution and die-off in coastal waters.

ii. The fecal coliform median or geometric mean MPN of the water does not exceed 14 per 100 ml and not more than 10 percent of the samples exceed an MPN of 43 for a 5-tube dilution test (or an MPN of 49 per 100 ml for a 3-tube decimal dilution test).

C. The determination that the approved area classification standards are met shall be based upon a minimum of fifteen (15) samples collected from each station in the approved area. These stations shall be located adjacent to actual or potential sources of pollution. Sample collection shall be timed to represent the worst pollution conditions.

TABLE 2-5. SHELLFISH BED CLASSIFICATIONS

APPROVED AREA: any shellfish growing area that does not contain pathogenic bacteria, fecal material or poisonous substances in dangerous concentrations and was approved by state authorities for growing or harvesting shellfish for direct marketing.

CONDITIONALLY APPROVED AREA: any shellfish growing area that is subject to intermittent microbiological pollution and was determined by state authorities to meet approved area criteria for a predictable period. The period is conditional upon established performance standards specified in a management plan.

RESTRICTED AREA: any shellfish growing area that is subject to a limited degree of pollution and was classified by state authorities as an area from which shellfish may be harvested only by licensed diggers and subjected to a suitable and effective purification process.

CLOSED AREA: any shellfish growing area where the harvesting of shellfish is temporarily or permanently not permitted.

PROHIBITED AREA: any shellfish growing area that is closed to the harvesting of shellfish at all times.

Geology and Soils

The watershed is composed mostly of outwash plain deposits which are primarily sandy and gravelly deposits on the order of 80 feet thickness. The location of soil types within the watershed are illustrated in Figure 2-4 and are listed in Table 2-6. Major soils in the area include the Barnstable-Plymouth soil complex. These soils can be stony or bouldery in a matrix of sand. They are well to excessively drained and the water table in these areas is typically greater than 6 feet from the surface. Permeability in both the soils and substrata is rapid to very rapid. Carver and Merrimac soils, also found in the area, have similar characteristics, but tend to be less stony.

These highly permeable soils and abundant vegetation insure that most of the precipitation that falls will recharge to the groundwater rather than form surface runoff. There is generally a low flood frequency associated with

TABLE 2-6. PHINNEYS HARBOR WATERSHED SOIL TYPES

Symbol	Description	Slope	Septic Tank Suitability
BbB	Barnstable Sandy loam, very stony	3-8	Severe: poor filter
BbC	Barnstable Sandy loam, very stony	8-15	Severe: poor filter
BbD	Barnstable Sandy loam, very stony	15-25	Severe: poor filter, slope
BmA	Berryland Mucky loamy coarse sand	0-2	Severe: wetness, flooding
CcB	Carver loamy coarse sand	3-8	Severe: poor filter
CcC	Carver loamy coarse sand	8-15	Severe: poor filter
CcD	Carver loamy coarse sand	15-35	Severe: poor filter, slope
DeA	Deerfield loamy fine sand	0-5	Severe: wetness, poor filter
EaA	Eastchop loamy fine sand	0-3	Severe: poor filter
EaB	Eastchop loamy fine sand	3-8	Severe: poor filter
EnB	Enfield silt loam	3-8	Severe: poor filter
Fm	Freetown mucky peat, ponded	0-1	Severe: ponding
Fs	Freetown and Swansea	0-1	Severe: wetness
Ft	Freetown coarse sand	0-1	Severe: wetness, poor filter
HeB	Hinkley sand loam	3-8	Severe: poor filter
ImA	Ipswich, Pawtucket and Matunuck peats	0-1	Severe: flooding, ponding
MeA	Merrimac sand loam	0-3	Severe: poor filter
MeB	Merrimac sand loam	3-8	Severe: poor filter
MeC	Merrimac sand loam	8-15	Severe: poor filter
PeA	Pipestone loamy coarse sane	0-3	Severe: wetness, poor filter
Pg	Pits, sand and gravel		
PmA	Plymouth loamy coarse sand	0-3	Severe: poor filter
PmB	Plymouth loamy coarse sand	3-8	Severe: poor filter
PmC	Plymouth loamy coarse sand	8-15	Severe: poor filter
PmD	Plymouth loamy coarse sand	15-35	Severe: poor filter, slope
Ps	Plymouth loamy coarse sand		Severe: poor filter
PsB	Plumouth loamy coarse sand	3-8	Severe: poor filter
PsC	Plymouth loamy coarse sand	8-15	Severe: poor filter
PsD	Plymouth loamy coarse sand	15-35	Severe: poor filter, slope
Ud	Udipsamments, smoothed		
W	Water		

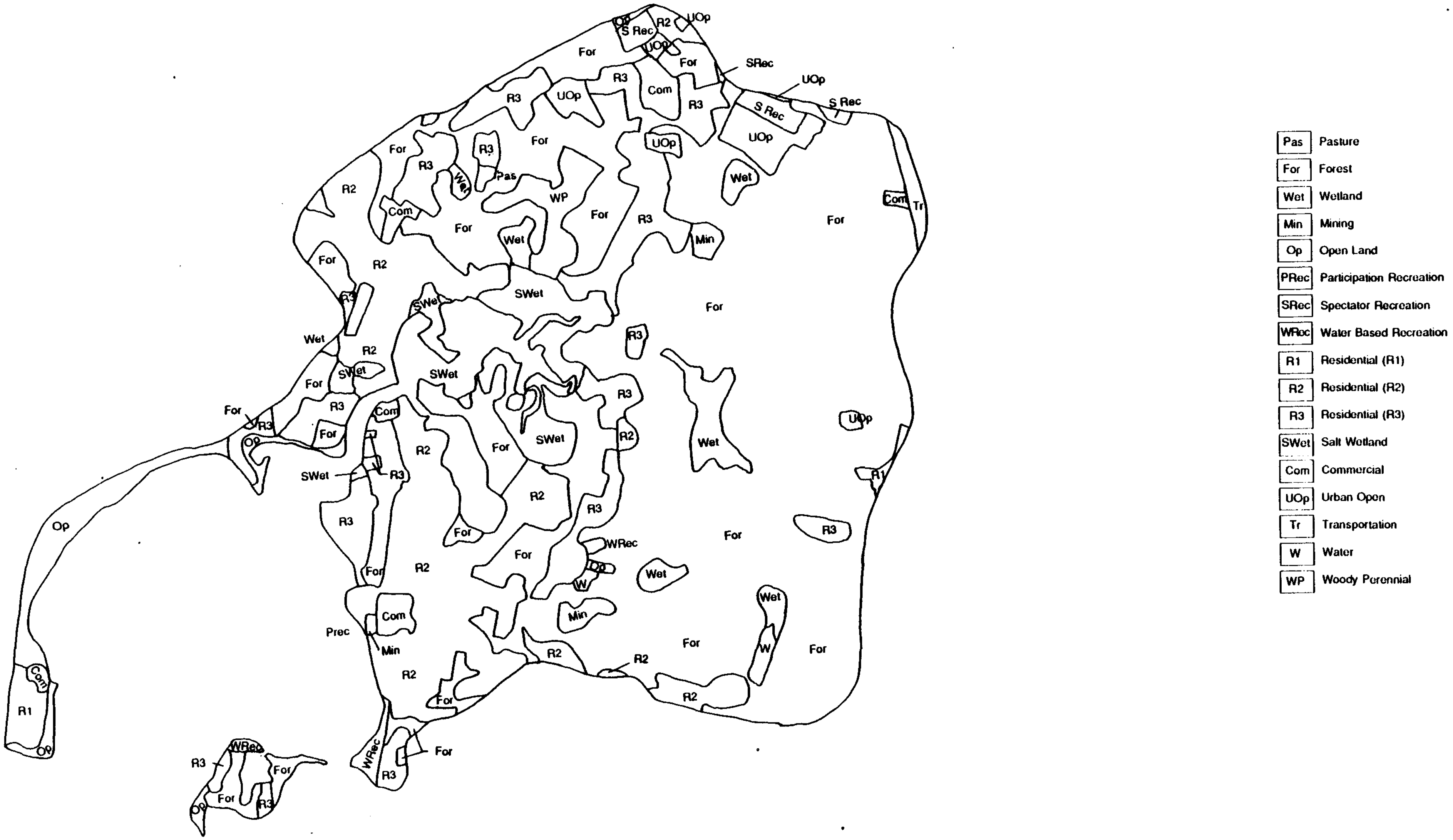

FIGURE 2-3. LAND USE IN THE PHINNEYS HARBOR WATERSHED

FIGURE 2-4. SOILS MAP OF PHINNEYS HARBOR WATERSHED

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these soils. In some areas, they may provide severe conditions for septic tanks in that they are a poor filter.

Soils in low-lying, nearly level areas frequently consist of Freetown and Swansea mucks. These areas form wetlands with water tables near the surface. They are composed of organic material, and are poorly drained. Permeability is moderate, and severe conditions may exist for septic systems due to ponding and wetness. Saltmarsh areas are classified as Ipswich peats, which are poorly drained and frequently flooded (SCS, 1987).

Hydrography

Phinney's Harbor is a 300 acre coastal embayment in northeast Buzzards Bay bordered by Mashnee Island, the Gray Gables and Monument Beach sections of Bourne, and Tobys Island. Water depths range from six to twelve feet over most of the harbor to twenty-four feet in the outer harbor. Water quality may be enhanced in this area by a rapid flushing rate caused by flow around the Tobys Island causeway.

The Back River estuary is a 95-acre, shallow waterbody that is the primary tidal channel flowing into Phinneys Harbor. Two bridges located at Shore Road divide the system into an inner and outer portion. The inner portion branches into several different arms, including Eel Pond. Extensive tidal flats, salt marshes, and bordering vegetated wetlands characterize this area with water depths generally less than five feet. The outer portion of the estuary consists of a narrow channel which widens as it approaches Phinneys Harbor. The bordering tidal flats and salt marshes in the outer portion are less extensive, and the channel is deeper (4 to 12 ft). The mean tidal range is four feet, and flushing is estimated at two to six days (Brookside, 1989). Surface water enters the Back River/Phinneys Harbor system through two tributaries. The northern tributary passes through a number of swamps, marshes, cranberry bogs, and salt marshes. The eastern tributary passes through several cranberry bogs, a small pond (Mill Pond), and a salt marsh. Several intermittent streams also discharge freshwater from two wooded swamps located to the southeast of the estuary.

Water Quality

A number of organizations have collected water quality and other environmental quality data in Phinneys Harbor including the Massachusetts Division of Water Pollution Control, the Massachusetts Division of Marine Fisheries and the Bourne Board of Health. A summary of these sampling programs is presented in this section and in Table 2-7. The locations of sampling stations from these programs are shown in Figure 2-5. The discussion includes both the waters of Phinneys Harbor, and sources of flow to Phinneys Harbor which include Back River and a number of storm drains. This evaluation is further segregated into discussions of dry weather or routinely collected data and wet weather data.

In order to assist in assessing water quality, a database was established by extracting, from existing studies, data collected at several stations in Phinneys Harbor and Back River. Selected stations included: the Railroad Bridge at the mouth of Back River, a storm drain at Monument Beach, St. John Chester Park, and Chester Park, Worcester Avenue. The data were coded and entered in a Lotus spreadsheet, thus allowing sorting and plotting of the data from individual data collection programs or of aggregate data. The database established is included in Appendix B. The data were sorted by station and parameter and were then sorted chronologically to enable preparation of plots of concentration over time.

In the database, the sample number and station number assigned by the collector was recorded. In order to provide a chronological reference and evaluate the time elapsed between rainfall events and sample collection, the sampling date was recorded with the time (if available) as well as rainfall amounts on the day of sampling and the previous day. Parameter analyzed, measured concentration, measured flow, sponsoring agency, year published, and reference number were assigned individual fields in the data file. Units of concentration are colonies (millipore filter) per 100 milliliters. Definitions of the file contents and associated codes and abbreviations are presented in Appendix B. The data file assembled contains over 100 fecal coliform data points from the selected stations.

TABLE 2-7. EXISTING WATER QUALITY DATA SOURCES
BACK RIVER AND PHINNEYS HARBOR

Agency	Report Title	No. of Stations in Study Area	Dates and Frequency of Sampling	Parameters	Scope
Mass. DEQE Division of Water Pollution Control (DWPC, 1987)	Buzzards Bay 1986 Water Quality Survey Data	7-Back River and Phinneys Harbor	8/27-28/85 two per day	Nutrients, solids, bacteria, metals	General water quality survey of Buzzards Bay.
Mass. Division of Marine Fisheries	Shellfish compliance monitoring, ongoing	11-Back River and Phinneys Harbor	several times per year	Bacteria	Shellfish compliance monitoring
Town of Bourne	Town of Bourne Water Quality Monitoring Program (1988)	12-Back River and Phinneys Harbor	several times per year 1985-1987	Bacteria	Shellfish compliance and nonpoint source impact data
Brookside Development				Bacteria, nutrients	Environmental impact study of development

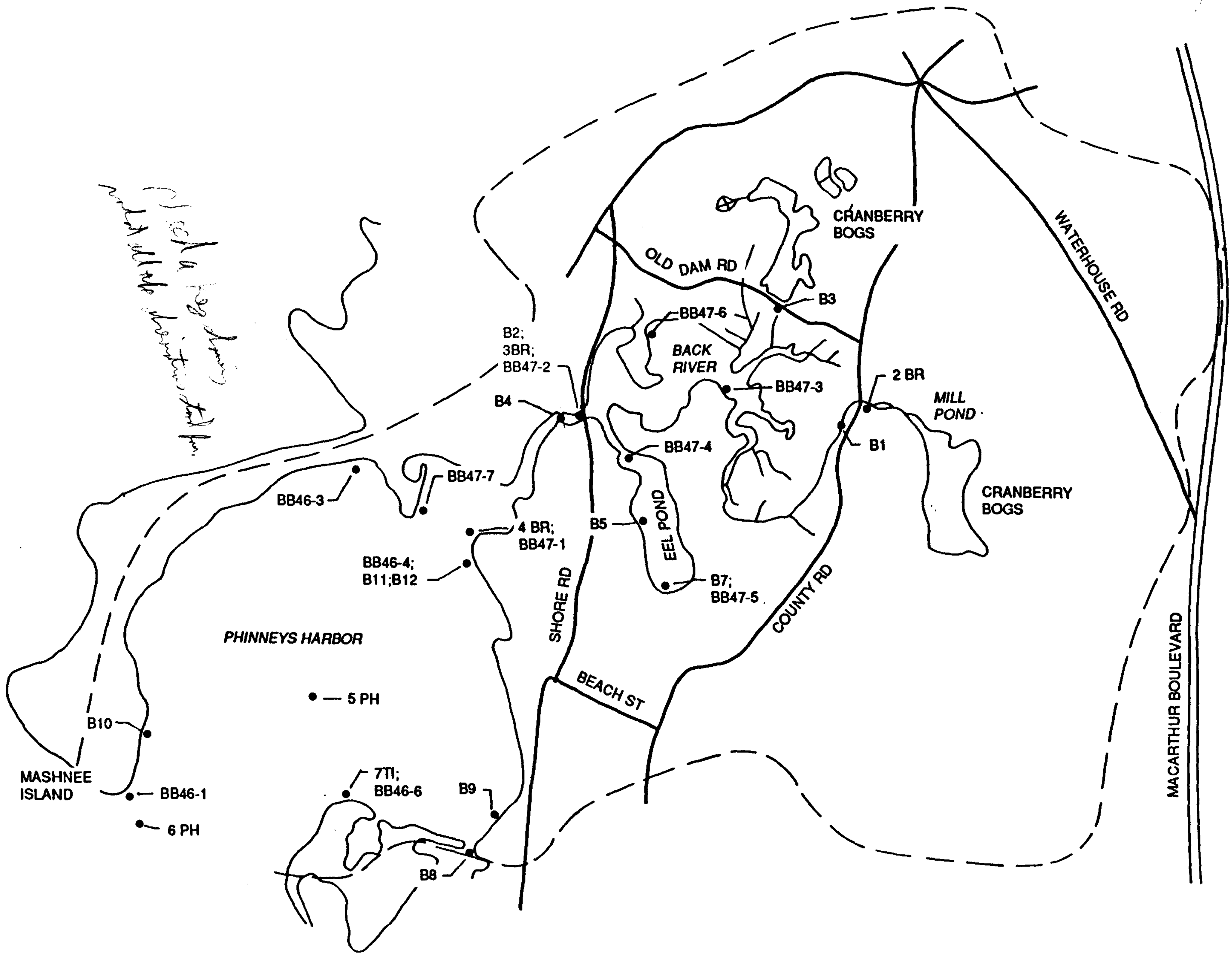

FIGURE 2-5. FIELD SAMPLING STATIONS, PHINNEYS HARBOR WATERSHED

Bacteria. Using the database, plots of fecal coliform bacteria levels were generated covering the period 1983 to 1987. Figure 2-6 shows log fecal coliform values (dry and wet weather combined) at the railroad bridge in Back River between 1985 and 1987. This station provides a good representation of water quality in shellfish growing areas in Back River and northeast portions of Phinneys Harbor. As shown in Figure 2-6, fecal coliform levels during this period frequently exceeded class SA standards (14/100 ml).

During a water quality survey of the Phinneys Harbor area in 1985, the Massachusetts Division of Water Pollution Control (DWPC, 1985) collected water quality data under wet weather conditions at stations in Back River and Phinneys Harbor. These data were collected on August 27-28, 1985 following a large rainfall of 4.19 inches on August 26, 1985 and during 0.38 inches of rainfall on August 27, 1985. This rainfall was preceded by an extended dry period of 18 days in which only 0.37 inches of rain fell. Total and fecal coliform data were collected at Mill Pond (Station 2), Back River (Station 3), and from four stations in the open waters of Phinneys Harbor. These data clearly show the impact of wet weather surface runoff on the bacteriological water quality in the river and the inner harbor. Figure 2-7 shows the concentrations of total and fecal coliform at Stations 2, 3, and 7. Although most of the precipitation associated with this storm occurred on August 26, and these data do not show the effect of the first flush of this storm, the data show elevated fecal coliform bacteria levels (900-2600 colonies/100 ml) following the storm, with levels declining to near baseline conditions approximately two days after the rainfall. Fecal coliform concentrations in the inner harbor at Stations 4, 5 and 6 ranged from 300 to 350 colonies/100 ml within 24 hours of the heavy precipitation on August 26. Fecal coliforms at Station 7 averaged 3 colonies/100 ml, showing that even large inputs of bacteria do not influence the outer areas of Phinneys Harbor. Although this data collection program was not oriented about this precipitation event, the sampling results clearly show an increase in coliform bacteria in response to surface runoff and a subsequent decrease following flushing by tidal action and bacterial die-off.

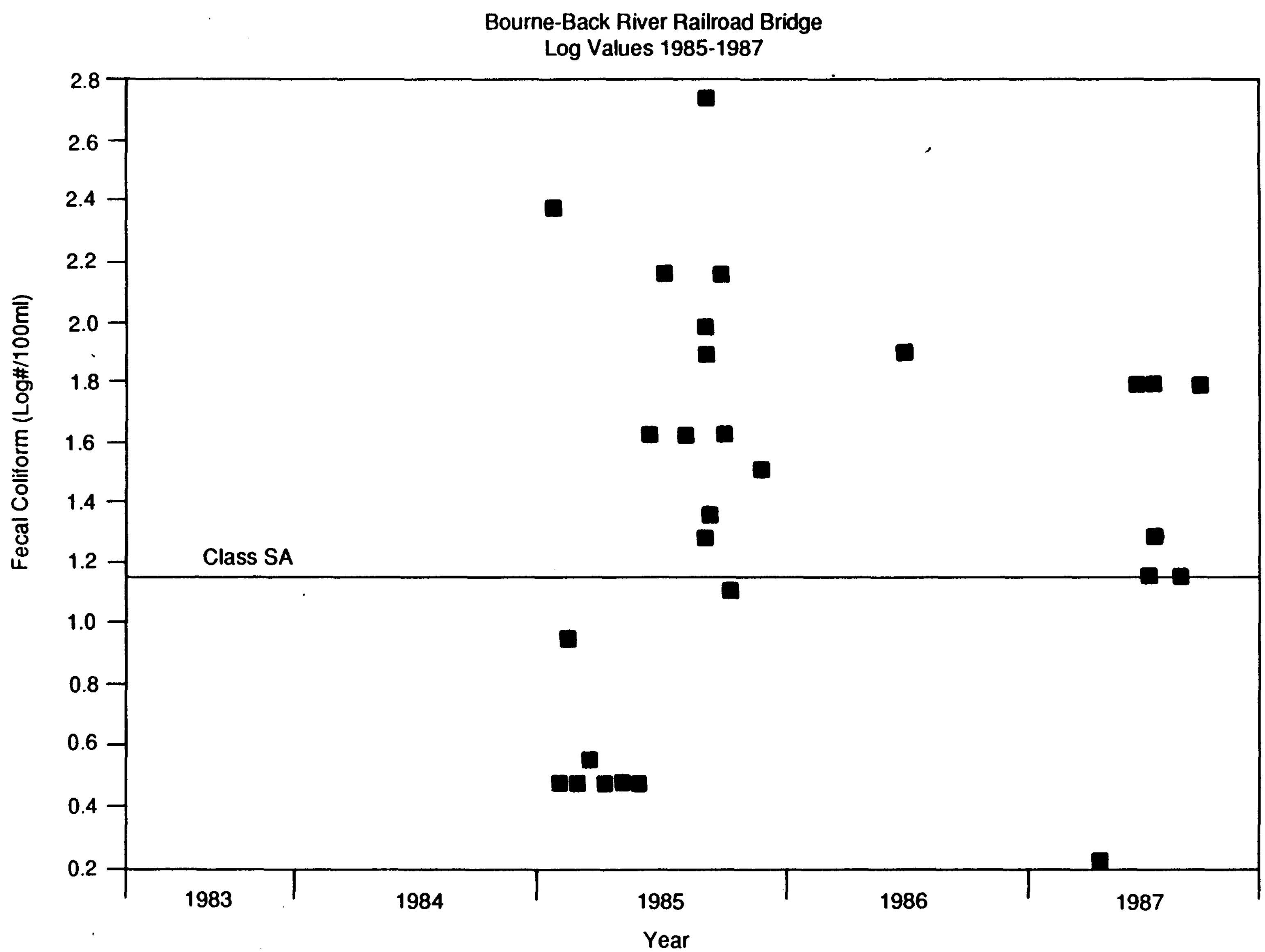

FIGURE 2-6. FECAL COLIFORM VALUES, BACK RIVER RAILROAD BRIDGE 1985-1987

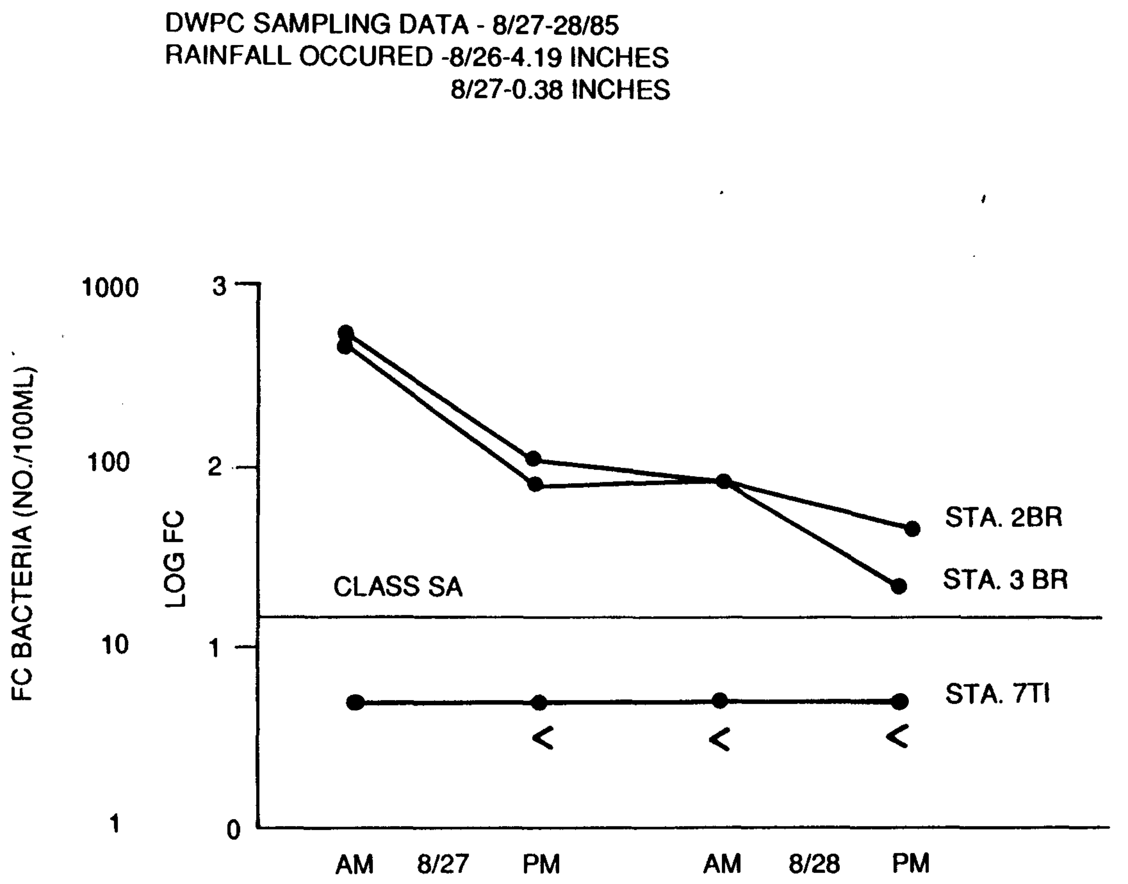

FIGURE 2-7. PHINNEYS HARBOR, WET WEATHER FECAL COLIFORM CONCENTRATIONS

Water samples from the Back River and Phinneys Harbor have been collected and analyzed on a regular basis by both the DWPC and the Bourne Board of Health for the years 1985, 1986 and 1987. The Water Quality Subcommittee of the Bourne Selectmen's Task Force on Local Pollution established a monitoring program to address the "alarming rate of shellfish closures within the town," to verify DEQE test results of surface waters, and to correlate rain data and specific weather conditions with water sample results. The Subcommittee also identified potential pollution sources and made specific recommendations for their abatement. These efforts were described earlier in this chapter. The stations sampled were shown in Figure 2-5 and include stations in Phinneys Harbor, Back River, Eel Pond and Mill Pond including stations in tidal flats where shellfish are abundant. The results of these analyses have been tabulated by the Bourne Board of Health and indicate that bacterial standards for shellfishing (14/100 ml) are rarely exceeded in the outer part of Phinneys Harbor but are more frequently exceeded in the remainder of the harbor and the estuary. Statistical analyses were performed in order to determine the frequency of exceedance of the water quality standards for shellfishing. This analysis showed that 26 to 50 percent of the samples from Phinneys Harbor and greater than 50 percent of the samples from Back River exceeded the standard.

The data collected by both DWPC and the Bourne Board of Health show that fecal coliform counts are directly affected by surface runoff and that the effect of runoff is amplified in Back River as compared to Phinneys Harbor. In addition, the data show that fecal coliform levels decline rapidly following rainfall. These phenomena are exemplified by comparing fecal coliform data collected several days after precipitation with data collected during rainfall at various stations in Back River and Phinneys Harbor. DWPC collected fecal coliform data at 12 stations on May 15, 1985 following rainfall events of 0.33 and 0.45 inches on May 12 and May 13, respectively. As shown in Table 2-8, despite the rainfall just two days prior, fecal coliform levels at most stations had declined to less than 14/100 ml. In comparison, the same stations were sampled on June 25, 1985, a day on which it rained 0.53 inches. The effects of this event can be observed in the elevated fecal coliform counts at stations in the inner harbor, Back River, and at drain pipes in Phinneys Harbor. These data show that while the immediate effects of

TABLE 2-8. FECAL COLIFORM ANALYSES AT STATIONS IN PHINNEYS HARBOR AND BACK RIVER FOLLOWING TWO 1985 STORMS

Station	May 15, 1985	June 25, 1985
Conservation Land off County Road	3	75
Railroad Bridge at Back River	3	150
N. Beach (Stanley Bolles Park)	3	43
119 Old Dam Road	23	-
Plow Penny Road	3	39
28 Old Dam Road	-	2400
East End of Dike Road	3	3
Maryland Ave.	3	-
Drain at Monument Beach	3	93
S.W. End of Mashnee	3	3
N.W. End at Mashnee	3	3.6
Pipe at St. Johns	-	2400

rainfall are pronounced, the flushing rate of Back River and tidal action throughout the area, as well as the rapid die-off of bacteria in saline water, results in rapid declines in fecal coliform bacteria levels.

Based on analysis of the data obtained by the DWPC and the Bourne Board of Health, the Water Quality Subcommittee concluded that areas with large volumes of fresh water input, such as Back River, tended to have higher fecal coliform levels, and that fecal coliform levels increase in direct response to rain events, particularly of 0.5 inches or more.

Nutrients. As was shown in Table 2-7, two sampling studies provided nutrient data in the Phinneys Harbor system. Nutrient and other water quality data collected in Back River and Phinneys Harbor by the DWPC are listed in Table 2-9. The only numerical nutrient criterion involves ammonia, and is

TABLE 2-9. DWPC SAMPLING PROGRAM DATA
8/27-28/85

Parameter	Unit	Saline Stations (3 BR, 4 BR 5 PH, 6 PH, TTI)	Fresh Station (2 BR)
BOD_5	mg/l	1.8-3.3	2.4-3.9
TKN	mg/l	1.1-1.7	2.0-4.1
NH_3	mg/l	0.03-0.11	0.2-0.4
NO_3	mg/l	no data	0.4-0.6
TP	mg/l	0.08-0.14	0.07-0.24
OP	mg/l	0.02-0.06	0.05-0.10
pH	std unit	7.2-8.0	5.6-6.3
Alk.	mg/l $CaCO_3$	62-90	8-15
Cond.	mg/l	24,000-36,000	71-120
TS	mg/l	17,000-30,000	56-75
SS	mg/l	5-18	5
Turb	NTU	1.7-3.1	2.3-5.8
Metals	ppb		
Cd	det. limit = 0.02	All values less than detection limits	
Cr	det. limit = 0.02		
Cu	det. limit = 0.02		
Pb	det. limit = 0.06		
Hg	det. limit = 0.0002		
Na	det. limit = 0.03		

related to ammonia toxicity. The draft Commonwealth of Massachusetts "toxic policy" limits ammonia nitrogen in both fresh and marine waters to a maximum of 0.5 mg/l. The ammonia data available on both Phinneys Harbor and Back River are typically on the order of less than 0.1 to 0.4 mg/l, thus there appear to be no ammonia toxicity concerns for these waterways.

Regarding eutrophication, dissolved oxygen data indicate that eutrophication may be a problem in Phinneys Harbor. The dissolved oxygen data collected by the DWPC were shown in Figure 2-8. These data indicate a diurnal oxygen swing of over 4 mg/l, as well as a range in saturation from 75 or 80 percent to over 120 percent. This is evidence of significant photoplankton activity, although nuisance algal blooms or fish kills are not known to have been reported for this system. The growth of phytoplankton in marine systems is usually limited by the availability of the plant nutrient nitrogen. This is in contrast to freshwater systems, where phosphorus is normally the growth-limiting nutrient.

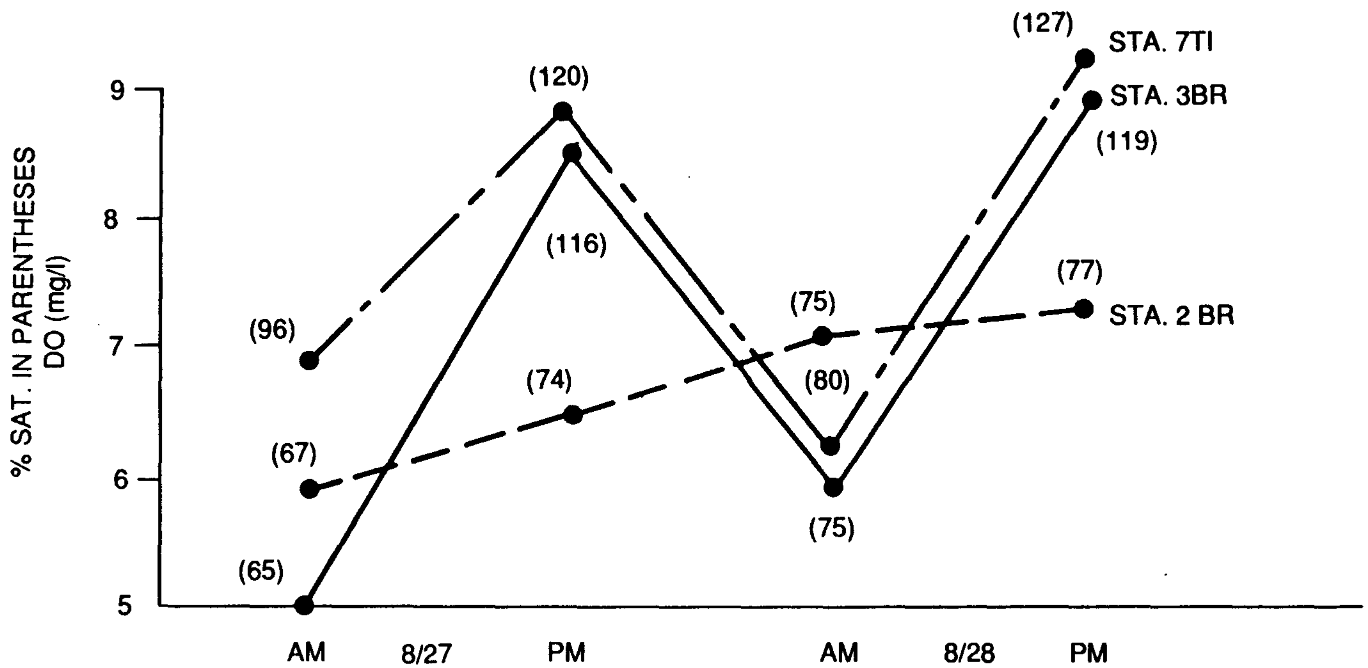

FIGURE 2-8. PHINNEYS HARBOR DISSOLVED OXYGEN CONCENTRATIONS

The dichotomy in nutrient limitation between freshwater and marine systems can be explained based on theoretical considerations of the elemental nitrogen and phosphorus content, and thus nutritional requirements, of plant cells. The well known Redfield ratio (Redfield, 1934) states that the ratio by weight of elemental carbon, nitrogen and phosphorus in both marine phytoplankton and seawater are approximately 53:8:1 (N:P ratio equals 6.6). Other researchers, such as Cooper (1938) and Fleming (1940) have developed a similar ratio for marine systems, suggesting that when the nitrogen to phosphorus weight ratio in seawater is much less than 7, as is usually the case, phytoplankton growth is primarily nitrogen limited. Similarly, at ratios close to 7, both nitrogen and phosphorus may limit phytoplankton growth by similar degrees.

Based on the available data, the typical ratio is at least 16, assuming total N equals 1.6 and total P equals 0.1. This would indicate nitrogen limitation, although the ratio is low enough that phosphorus may also play some role. This is supported by the fairly low concentration of ammonia and total phosphorus which occur in Phinneys Harbor and Back River. The fact that ammonia levels are low (near the typical value of half-saturation constants for this parameter), indicates that it is currently likely to be limiting growth.

Typical nutrient levels in the estuarine portion of Back River and Phinneys Harbor, as well as at the fresh water station, are shown in Table 2-9. Typical nutrient levels are higher in the fresh water station, which indicates that nonpoint sources are contributing nutrients, and some level of control may thus be desireable. However, since there is no existing use impairment with respect to eutrophication, nutrient control would not take as high a priority as bacteria control, which has been shown clearly to be impacting an existing resource.

Solids. There are no numerical solids criteria in the state or federal water quality standards. As was shown in Table 2-1, however, there are aesthetic criteria. Based on the data in Table 2-9, solids do not appear to be a problem in the harbor. Despite this, it is good practice to eliminate areas of excessive erosion which can be created by such activities as construction and agriculture. Other than sensible best management practices to control excessive erosion, there does not seem to be need for solids reduction.

Metals. Data on metals in the water column in Phinneys Harbor and its tributaries were shown in Table 2-9. Although limited, the data indicate no violations of any EPA marine criteria for cadmium, copper, chromium, lead, mercury, and nickel. However, data are insufficient to draw conclusions. Sediment metals data are discussed later in this chapter.

Summary of Existing Water Quality. Waters of Back River, Eel Pond and the inner portion of Phinneys Harbor are periodically closed to shellfishing. The data collected clearly show the effect of rainfall increasing bacteria levels in these waterbodies by an order of magnitude or more. Levels drop after rainfall events, but some dry weather bacteria contamination exists, particularly in Back River and Eel Pond. Bacteria contamination results largely from rainfall-induced nonpoint source runoff from developed areas. The outer part of Phinneys Harbor does not seem to be influenced by this nonpoint source bacterial loading. There is also some evidence of nutrient induced eutrophication in both the inner and outer portions of the Harbor.

The main goal of the nonpoint source management plan will be to achieve the Class SA standards in Back River, Eel Pond and Phinneys Harbor receiving waters as frequently as possible. This will require bacteria reduction during wet weather of about one order of magnitude. Bacteria reduction during dry weather will also be sought where possible. Finally, a secondary goal will be to reduce nutrient input from the drainage basin.

Sediment Quality

Sediment chemistry data are not available for Phinneys Harbor. However, two samples were collected in Red Brook Harbor by DWPC (1987). In order to assess the quality of these sediments, heavy metals, PCB, PAH and solids data were compared with sediment classification criteria from three sources including:

1. Massachusetts dredge material disposal classification (314 CMR 9.00 1986).

2. Massachusetts regulations for land application of sludge (310 CMR 29.00, 1983)

3. Great Lakes sediment rating criteria (MDEQE, 1982).

Table 2-10 compares sediment data with the cleanest criteria in the regulations and guidelines outlined above. This comparison shows that sediments from Red Brook Harbor meet the cleanest criteria. While PAH's were found, it is not known if these exist within Phinneys Harbor. These data, combined with the water column metals results discussed earlier, indicate that there is no apparent need for metals control.

Biological Resources

The Back River estuary, headwater wetlands and part of Phinneys Harbor were recently designated by the Secretary of Environmental Affairs as an Area of Critical Environmental Concern. The area was designated as such, in part, due to its abundant biological resources.

As shown earlier in this chapter, the watershed contains over 73 acres of salt marsh. In addition, there are about 70 acres of inland wetlands which have been designated as restricted wetlands under the Massachusetts Wetlands Restriction Act. These wetlands are valuable habitat resources and provide food and habitat for marine wildlife as well as birds, reptiles, amphibians and small animals. Presently, the estuary is the resting site for the osprey (***Pandion haliaetus***), provides breeding habitat for spotted turtle (***Clemmys guttata***) and is the probable breeding/feeding site for the diamondback terrapin (***Malaclemys terrapin***) (Town of Bourne, 1988). The estuary provides habitat for shellfish and finfish. Mill Brook and Little Mill Pond function as a catadromous fish run for the American Eel (***Anguilla rostrata***) (Town of Bourne, 1988).

TABLE 2-10. SEDIMENT DATA FROM RED BROOK HARBOR (DWPC, 1987) (MG/KG)

Parameter	15 RBH 30 Red Brook Harbor Sample A	Sample B	Dredge and Fill Class (a)	Sludge Classification (b)	Great Lakes Rating (c)
Cd	1.2	<0.8	1 (<5)	I (2-25)	* (<6)
Cr	22	3.6	1 (<100)	I (<1,000)	* (<25)
Cu	30	4.4	1 (<200)	I (<1,000)	* (<25)
Pb	29	12	1 (<100)	I (<300)	* (<40)
Hg	0.112	0.04	1 (<0.5)	I (<10)	* (<1)
Ni	8.8	<2.0	1 (<50)	I (<200)	* (<20)
PCB's	ND (d)	-	1 (<0.5)	I (<2)	
PAH	(e)	-			
% fines (silt & clay)	93	71	Type B: 60-90 Type C: 90-100		

a. 1 = cleanest
b. I = cleanest
c. * = nonpolluted
d. ND= not detected
e. Flouranthane = 0.32 μg/g; Pyrene = 0.21 μg/g/

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CHAPTER 3

IDENTIFICATION AND PRIORITIZATION OF POLLUTION SOURCES

This chapter describes the identification of nonpoint sources within the watershed of Phinneys Harbor, and the process used to prioritize sources recommended for control.

Source Identification and Description

Morehouse (1988) developed a list of nonpoint sources of pollution commonly found throughout New England. This list was used as the basis for the development of a list of pollution sources or watershed profile for the Phinneys Harbor watershed. This Phinneys Harbor watershed profile shown in Table 3-1 was developed through:

- Interviews with local and state officials, members of the project advisory group, local environmental groups, representatives of USDA, and private citizens;
- Review of previous studies;
- Review of recently developed land use maps and aerial photographs; and
- Field visits during February of 1989 with local representatives.

The underlined categories were those thought to be present in the watershed. In order to identify specific sources, detailed field reconnaissance was conducted during the summer of 1989. Field activities included visual observations, drainage system inspections, and photodocumentation. The specific sources identified through field inspection are listed and described with respect to location and pollutant type in Table 3-2. The locations of these sources are shown in Figure 3-1. Detailed descriptions of the sources are provided below by category.

Agriculture. According to the Association of State and Interstate Water Pollution Control Administration and EPA (1985), every region of the United States listed agricultural sources of pollution as the most pervasive nonpoint

TABLE 3-1: PHINNEYS HARBOR WATERSHED PROFILE

NPS POLLUTION CATEGORIES AND SUBCATERGORIES SCREENING FOR BOURNE

10 Agriculture
- 11: Non-Irrigated Crop Production
- 12: Irrigated Crop Production
- 13: Specialty Crop Production
- 14: Pasture Land
- 15: Hayland
- 16: Animal Holding Areas
- 17: Wash and Process Water
- 18: Waste Application Areas

20 Silviculture
- 21: Harvesting
- 22: Reforestation
- 23: Residue Management

30 Construction
- 31: Highway/Road/Bridge
- 32: Land Development

40 Urban Runoff
- 41: Storm Sewers
- 42: Combined Sewers
- 43: Surface Runoff
- 44: Infiltration Wells and Basins

50 Resource Extraction/Exploration/Development
- 51: Surface Extraction Areas
- 52: Processing Facilities

60 Land Disposal (Runoff/Leachate from Permitted Areas)
- 61: Sludge/Septage
- 62: Landfills
- 63: On-Site Wastewater Systems
- 64: Hazardous Waste

70 Hydrologic/Habitat Modification
- 71: Channelization
- 72: Dredging
- 73: Dam Construction
- 74: Earth Fill

80 Other
- 81: Atmospheric Deposition
- 82: Waste Storage/Storage Tank Leaks
- 83: Highway and Bridge Maintenance
- 84: Spills/Illegal Disposal
- 85: In-Place Contaminants
- 86: Natural Vegetation
- 87: Auto Salvage Facilities
- 88: Washing and Processing Areas
- 89: Snow Dumping Areas
- 90: Utility Rights-of-Way
- 91: Domestic and Wild Animals
- 92: Sewer System Leaks
- 93: Boats and Marinas

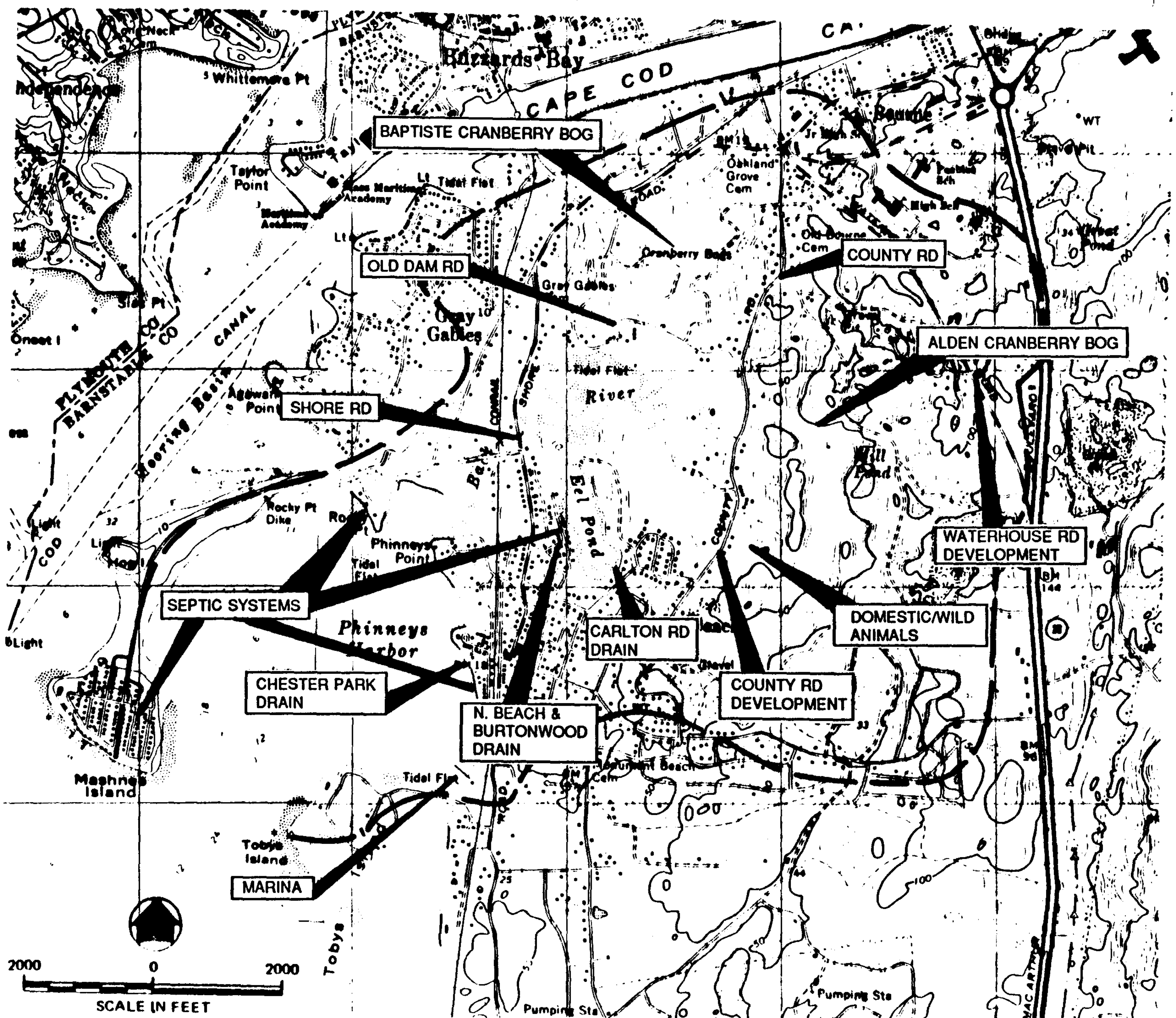

FIGURE 3-1. PHINNEYS HARBOR WATERSHED NONPOINT SOURCE LOCATIONS

TABLE 3-2. PHINNEYS HARBOR NONPOINT POLLUTION SOURCE DESCRIPTIONS

	Pollution Sources	Descriptions	Conventional Pollutant Types
1.	Alden Cranberry Bog	16 acre cranberry bog east of County Road	Nutrients
2.	Baptiste Cranberry Bog	13 acre cranberry bog north of Old Dam Road	Nutrients
3.	Waterhouse Road Development	Proposed development on Waterhouse Road draining to wetlands east of Alden bogs	Nutrients, solids
4.	County Road Development	Cleared land on County Rd. south of Alden Cranberry Bog for construction of new homes	Nutrients, solids
5.	Chester Park	Piped outlet to Phinneys Harbor at Chester Park draining 6 acres of residential and commercial land	Bacteria, nutrients, solids
6.	Beach Boulevard and Burtonwood Avenue	Piped outlet to Eel Pond at Burtonwood Road draining 2.5 acres of residential land	Bacteria, nutrients, solids
7.	Carlton Road	Piped outlet to Eel Pond near Carlton Road draining 17 acres of residential land	Bacteria, nutrients, solids
8.	Shore Road	Drainage enters Phinneys Harbor at one location by overland flow	Bacteria, nutrients, solids
9.	County Road	Drainage enters Back River along most of its length by overland flow	Bacteria, nutrients, solids
10.	Old Dam Road	Drainage enters Back River along its length by overland flow	Bacteria, nutrients, solids
11.	Septic Systems	Watershed-wide and suspected specific problem areas at Rocky Point, North Beach Road, Plow Penny Road, Monument Beach, and Mashnee Island	Bacteria, nutrients

TABLE 3-2 (Continued). PHINNEYS HARBOR NONPOINT POLLUTION SOURCE DESCRIPTIONS

	Pollution Sources	Descriptions	Conventional Pollutant Types
12.	Domestic and Wild Animals	Watershed-wide domestic animals and concentrated waterfowl in Back River and Phinneys Harbor	Bacteria, nutrients
13.	Monument Beach Marina	50-100 boat marina at Monument Beach with no pump-out station	Bacteria, nutrients, hydrocarbons

pollution source. Within the watershed of Phinneys Harbor, agricultural sources include two cranberry bogs at the periphery of Back River. The Baptiste cranberry bog is located north of Old Dam Road and outlets into Back River through a 36" culvert under Old Dam Road. This bog is operated using commercial fertilizers and pesticides. The Alden cranberry bog is located east of County Road and outlets to Mill Pond which eventually enters Back River. The owner of this bog once tried operating without fertilizers and pesticides. The crop was unsuccessful, however, and the program was dropped. These bogs may contribute nutrients to Back River and Phinneys Harbor.

The potential for export of nutrients from cranberry bogs is partially a function of the operation of the particular bog. The cranberry growing season extends from April to October. Cranberry bogs consist of a layer of peat over hard pan with a thin layer of sand on top. Optimum growing conditions require that the bog be kept wet but not flooded. Accordingly, the bogs are sprayed with about one inch of water per week but never flooded during the growing season. Fertilizer is applied approximately five times per year at a rate of 150 to 400 pounds per acre depending on soil requirements, but primarily during the growing season in late June to early August. July and August is a period of high water need so there is little opportunity for runoff of fertilizers (Dapsis, 1986). Research by Duebert (1974) indicates that the net movement of water in the bog during the growing season is into the bog due to evapotranspiration by the plants, allowing little opportunity for nutrient export during this period. Most bogs are flooded during harvest in late September and October and during winter (mid December to late March) to protect against freezing. Irrigation systems are used for frost protection during spring and fall. Thus, the highest potential for export of nutrients from the bogs is during spring when winter flood water is released. Granular herbicide is applied in early April and pesticide is applied periodically from May to early August. The Environmental Protection Agency and the Division of Water Pollution Control have recently conducted research projects to quantify nutrient balances in cranberry bogs. Although these data are not yet published, data collected by the Division of Water Pollution Control indicate elevated levels of ammonia, nitrates and phosphorus in tailwaters released from the bogs in the spring. In comparison, fall water samples showed considerably lower nitrogen levels and continued elevated phosphorus levels.

Overall, nutrient concentrations seem to indicate that cranberry bogs may not be a major source of nutrients to Buzzards Bay and that nutrient loading is partially a function of the operational details of the individual bog. It is generally recommended that operators of cranberry bogs use techniques to minimize nutrient export including retention of nutrient-rich waters in the bog, proper application of fertilizer, use of time release fertilizer, and modification of water retention facilities. Nutrient loading from properly operated cranberry bogs may be substantially less than other sources such as septic tanks, street runoff and lawn fertilizers.

Construction. Construction activities result in erosion and deposition of sediment in nearby waterways. Within the watershed of Phinneys Harbor, there are areas along County Road and Waterhouse Road where developments are in various stages of construction. Along the eastern side of County Road south of the Alden Cranberry Bog, land is being cleared for construction of approximately 15 to 20 residential homes. Runoff from this area can cross County Road and enter the upper reaches of Back River. In addition, a few new homes are being constructed near an existing condominium development, and construction of a housing development and golf course are proposed along Waterhouse Road. Runoff from this large development will enter the wetlands east of the Alden Cranberry Bog. These areas are identified on Figure 3-1.

Urban Runoff. On a national level, stormwater runoff is seen as the most pervasive nonpoint pollution problem after agriculture. In highly developed areas and major roadways, drainage systems cause urban runoff to bypass natural vegetation which promotes infiltration and filtering of solids. Therefore, the pollutants which buildup along the road sides during dry weather are washed off directly into adjacent waterways during wet weather. These pollutants include bacteria, nutrients, sediments, and heavy metals.

Sources of urban runoff in the watershed of Phinneys Harbor include two piped drainage systems discharging to Eel Pond and a third piped drainage system discharging to Phinneys Harbor at Chester Park. Figures 3-2 and 3-3 depict the two systems at Eel Pond which include two catch basins that discharge runoff from 2.5 acres west of Eel Pond at Beach Boulevard and Burtonwood Avenue and a second system at Carlton Road draining 17 acres of recently developed residential land. The third piped drainage system discharges directly to Phinneys Harbor at Chester Park from six acres of residential and commercial development as depicted in Figure 3-4.

Other sources of urban runoff near Back River and Phinneys Harbor are identified on Figure 3-1 and include surface runoff from Shore Road, County Road and Old Dam Road which all cross Back River at various locations. These areas, however, are not drained by piped drainage systems, and pollutant runoff from these areas may be attenuated through infiltration and by filtration by roadside vegetation. Shore Road crosses near the mouth of Back River in a well developed residential and commercial area consisting of a restaurant and boat repair shop. Runoff from this area directly enters Back River by overland flow. Old Dam Road is at the northern boundary of Back River and crosses it at the outlet of the Baptiste Cranberry Bog. County Road is at the eastern boundary of Back River and crosses it at the outlet of Mill Pond. Runoff from both of these roadways enters Back River by overland flow through dense vegetation.

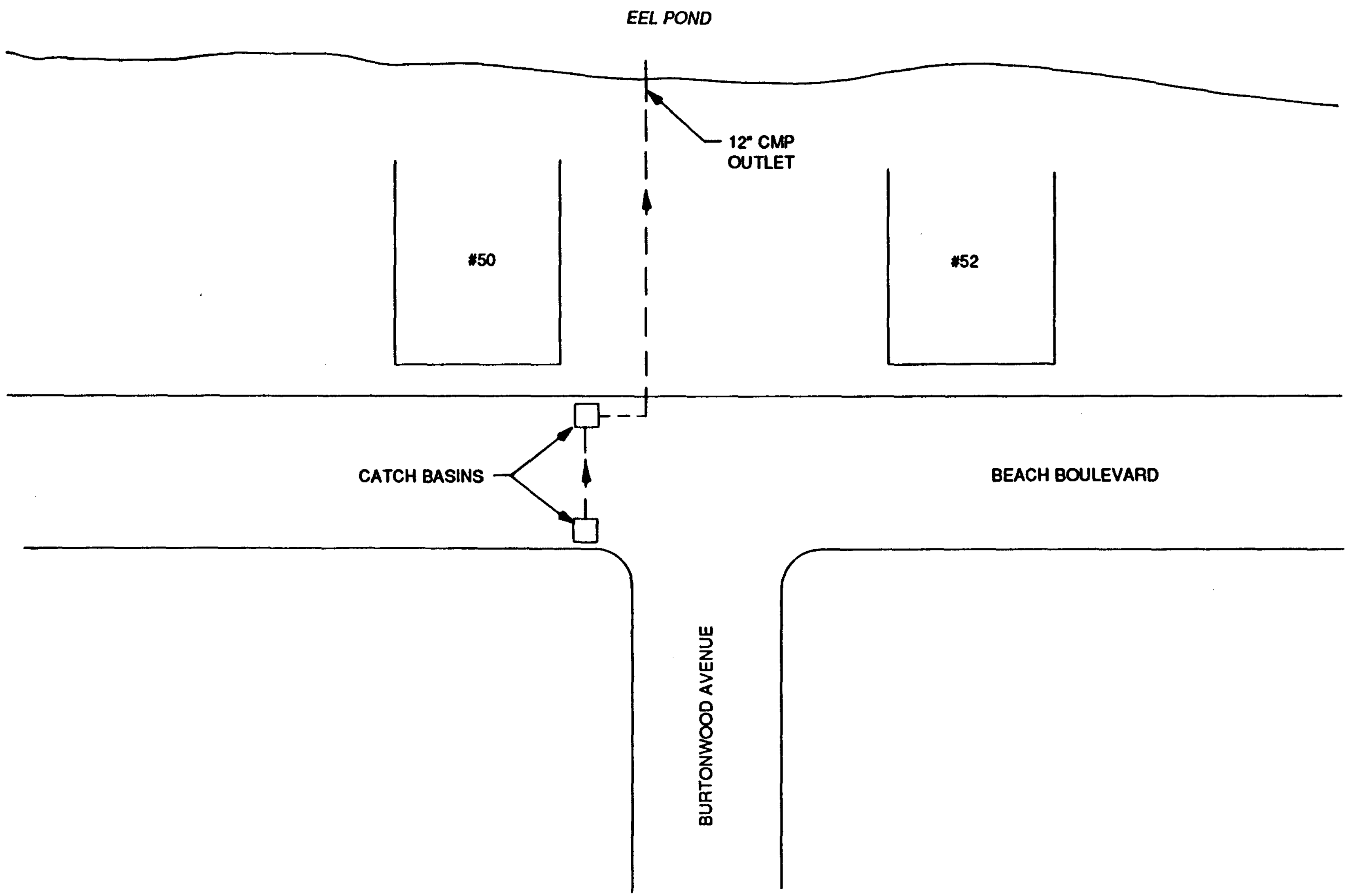

FIGURE 3-2. BEACH BOULEVARD/BURTONWOOD AVENUE DRAINAGE SYSTEM

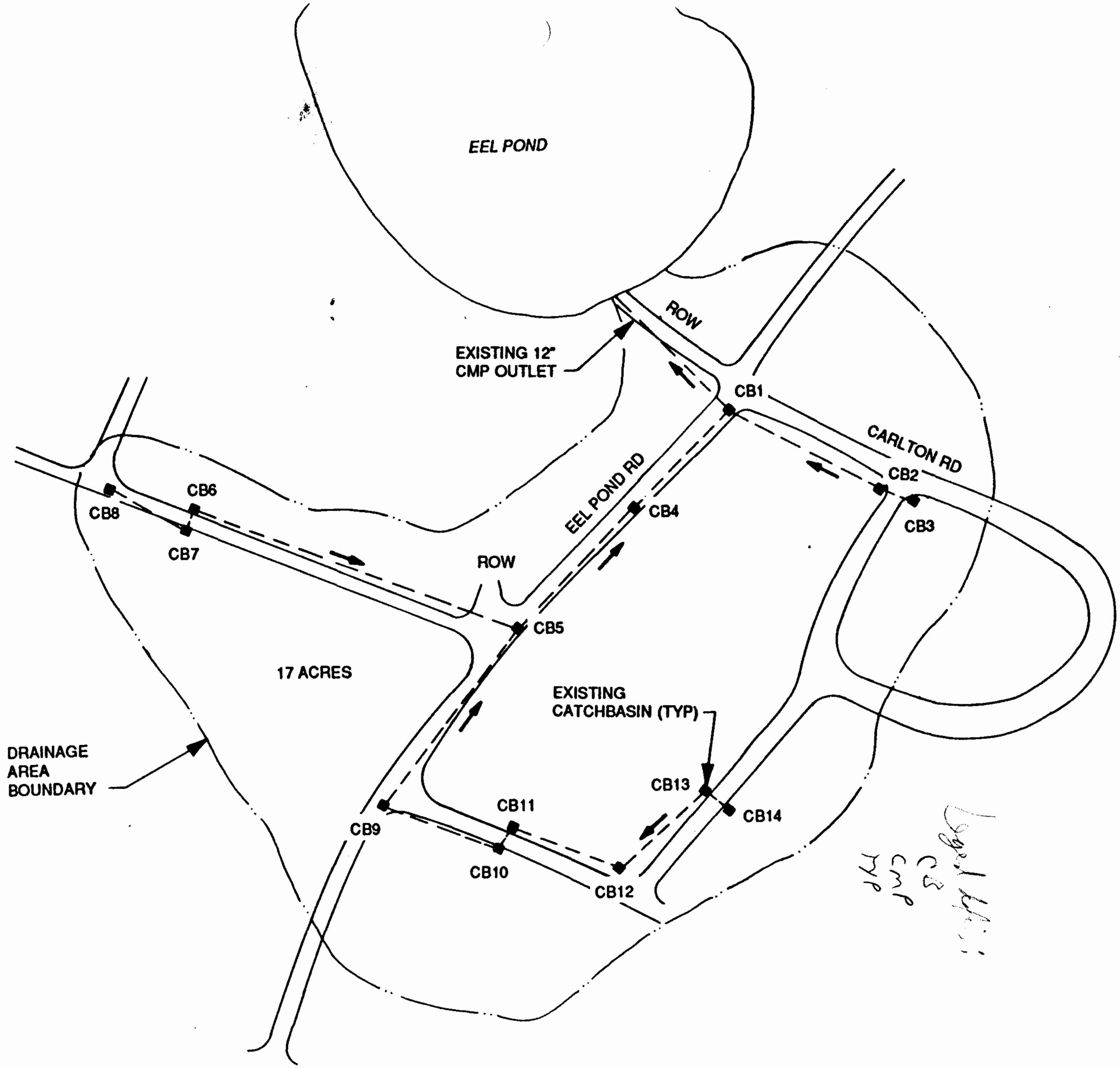

FIGURE 3-3. CARLTON ROAD DRAINAGE SYSTEM

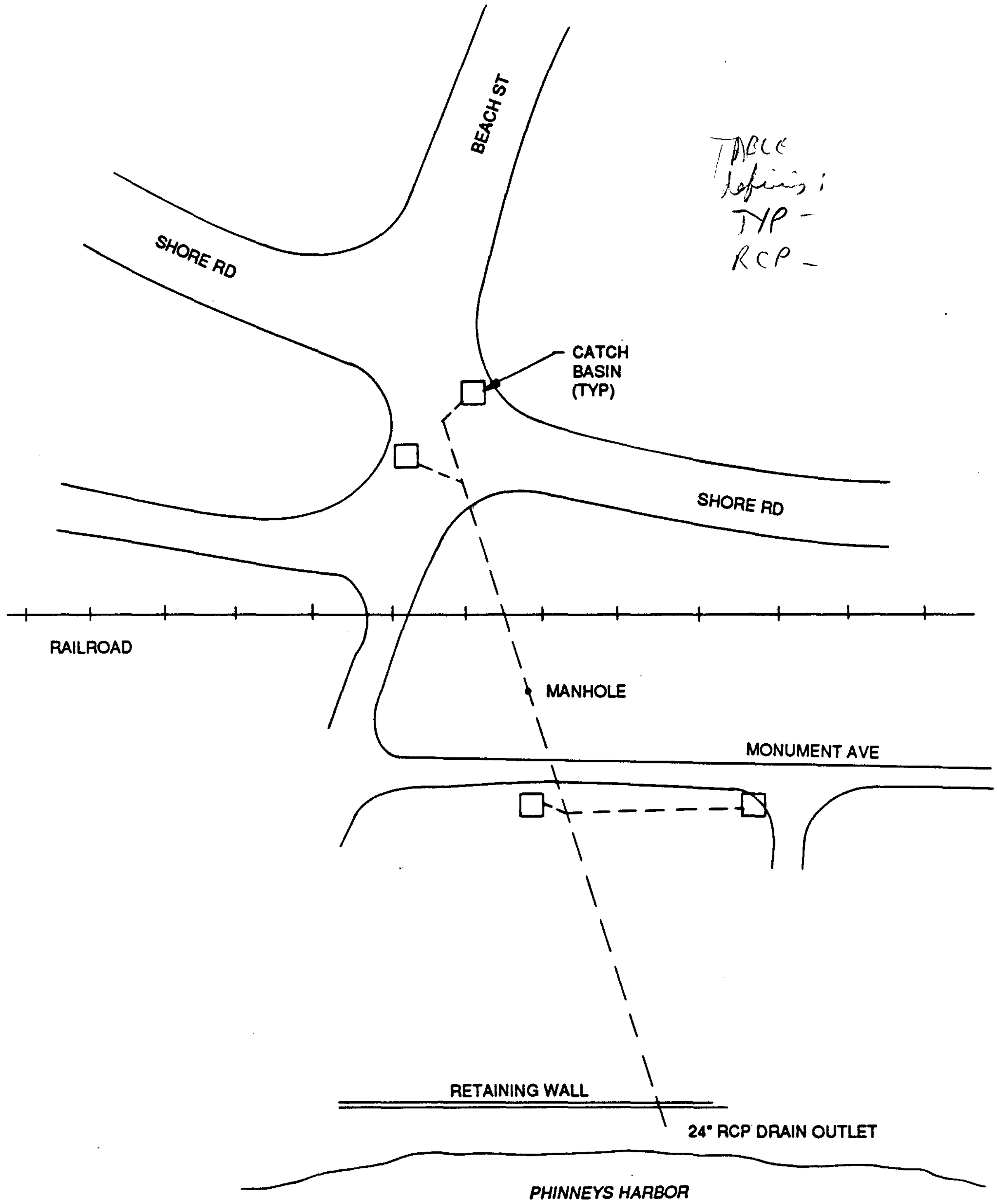

FIGURE 3-4. CHESTER PARK DRAINAGE SYSTEM

Land Disposal. Land disposal sources include on-site wastewater disposal systems. Since the watershed of Phinneys Harbor is not sewered, each home has a septic tank. Septic tanks may contribute nutrients and bacteria to groundwater which flows to Phinneys Harbor and Back River. If systems are properly operated, solids are removed periodically during maintenance. Bacteria and nutrient loading from septic systems, however, is substantially reduced by filtration and contact with soils. In recent studies of the impact of septic tank effluent on groundwater quality at Buttermilk Bay (Weiskel, et. al, 1989), horizontal transport of fecal coliform with flowing groundwater was observed to be extremely limited. Previously, DWPC (1987), in a study conducted in Westport, was not able to isolate sources of fecal contamination through differentiation of coliform bacteria in samples collected in areas thought to have widespread Title V violations and areas thought to be in compliance. Septic tanks are among the most difficult nonpoint sources to identify due to their location (largely on private property) and their extremely diffuse nature since septic tanks discharge underground.

During field reconnaissance with members of the Bourne Department of Natural Resources, a number of areas were pointed out where septic systems are suspected to be out of compliance with Title V. These include homes at Rocky Point, on North Beach Road and Plow Penny Road, in Monument Beach and on Mashnee Island. Many homes in these areas of the Phinneys Harbor watershed are constructed very close to the surface water and approximately 100 are within 100 feet of Eel Pond, Back River, and Phinneys Harbor.

Other nonpoint sources identified include domestic animals and areas where wild animals congregate such as Monument Beach and the wetlands feeding Back River, and possible illegal boat discharges at the 50-100 boat Monument Beach marina.

Source Prioritization

The U.S. Environmental Protection Agency has published several nonpoint source guidance documents setting forth a pollution source identification and prioritization process. This process is outlined in Figure 3-5 and is

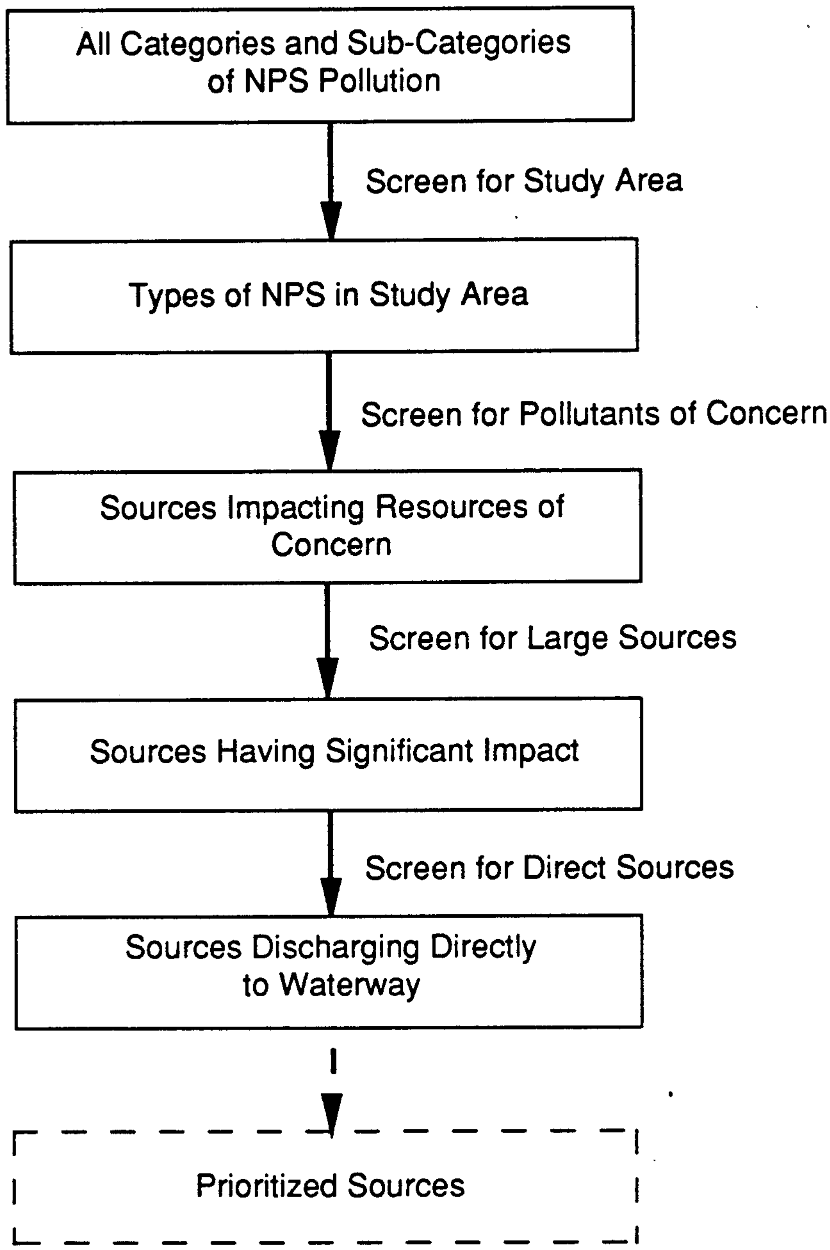

FIGURE 3-5. IDENTIFICATION AND PRIORITIZATION PROCEDURE

designed to isolate the sources of pollution in a target area and determine which of these sources should be prioritized for control. EPA (1987) recommends, in the nonpoint source guidance document Setting Priorities, that pollution control efforts be concentrated on limited areas causing substantial degradation or loss of resources. Through this targeting approach, water quality improvements can be optimized given limited financial resources.

The process begins with review of a list of all possible categories and subcategories of nonpoint pollution sources. The list is then screened to establish a watershed profile or a list of all the sources occurring in the study area. This list is then ranked to develop a priority list of those sources which should be addressed to optimize water quality improvements. The ranking process separates significant sources from those that do not contribute pollutants of concern, sources of relatively small magnitude and sources that do not discharge directly and whose pollutant load may be attenuated by vegetation or infiltration. In order to optimize water quality improvements in Phinneys Harbor, a priority list of pollution sources was developed, starting with the complete list in Table 3-2. Ranking criteria included pollutant type, source magnitude, and transport considerations. The paragraphs below describe the application of this process to the watershed of Phinneys Harbor.

Pollutant Type. As discussed in Chapter 2, historical water quality data indicate that violation of the fecal coliform bacteria standard for shellfishing and possible eutrophication due to excess nutrient loads are significant water quality problems in Phinneys Harbor and Back River. Frequent violations of the Class SA fecal coliform standard occur in Back River and Eel River during both wet and dry weather. Violations also occur in the near shore areas of Phinneys Harbor. In addition, nutrient loading to Back River results in excess phytoplankton activity as evidenced by the observed dissolved oxygen variations. Therefore, the sources presented in Table 3-2 which would not contribute to current fecal coliform shellfishing standard violations or excess nutrient loading, are of lowest priority. These sources include the developments on Waterhouse Road and County Road which do not contribute to current bacteria standard violations. However, these development could contribute to future bacteria violations and nutrient loading but are considered small compared to other existing and potential sources.

Source Magnitude. In the second ranking phase, pollution sources were prioritized based on their relative magnitude. The ranking is based on field observations, existing water quality data, and estimates. As discussed in Chapter 2, water samples from the Back River and Phinneys Harbor have been collected and analyzed on a regular basis by both the DWPC and the Bourne Board of Health for the years 1985, 1986, and 1987. Some of these samples were collected at suspected sources of coliform bacteria throughout the watershed during both dry and wet weather. Using these data and literature values, an effort was made to estimate the fecal coliform bacteria and nutrient loadings from the identified sources. A summary of these loadings are given in Tables 3-3 and 3-4.

There are many inherent problems with attempting to estimate accurately, loads from these sources. Some of these problems include the lack of site specific data on each source, the extremely high variability of bacteria concentrations, and the extensive data required to derive a statistically valid estimate. The source loadings for Phinneys Harbor can be checked to some extent using the water quality database established. Where a large number of samples exist for a station, the log mean bacteria counts upstream and downstream of a source provides some indication of the long-term average strength of that source. Such checking could be accomplished using available data for certain sources including the storm drains sampled by the Town of Bourne. In general, however, the estimates are order of magnitude at best. They are more suited as relative comparisons between source loading, and as a rough check on the ranking system.

The loads in Table 3-3 indicate the dominance of directly discharged stormwater runoff as bacteria sources. These sources must be given the highest clean-up priority for the Phinneys Harbor demonstration project. The loads calculated in Table 3-4 indicate the dominance of the cranberry bogs, the Carlton Road drain, and septic tanks.

TABLE 3-3. PHINNEYS HARBOR WATERSHED FECAL COLIFORM BACTERIA SOURCE LOADING ESTIMATES

Pollution Sources	Source Area	Estimated Source Concentration (MPN/100 ml)	Estimated Loading (MPN/day)	% Total Loading
1. Alden Bog[a]	13 Ac.	100	$2.5x10^8$	5
2. Baptiste Bog[a]	16 Ac.	100	$3.2x10^8$	6
5. Chester Park Drain[a]	7 Ac.	2,500	$1.5x10^9$	27
6. Beach Boulevard/ Burtonwood Avenue Drain[a]	2.5 Ac.	1,000	$1.8x10^8$	3
7. Carlton Road Drain[a]	17 Ac.	1,000	$1.2x10^9$	22
8. Shore Road[b]	3700 LF	100	$2.8x10^7$	<1
9. County Road[b]	3300 LF	100	$2.4x10^7$	<1
10. Old Dam Road[b]	3300 LF	100	$2.4x10^7$	<1
11. Septic Systems[c]	100 homes	100	$7.3x10^7$	1
12. Wetlands	10 Ac.	50	$9.6x10^7$	2
13. Monument Beach[d] Marina	1 discharge	-	$1.3x10^9$	24
Direct Drainage	141 Ac.	100	$5.4x10^8$	10
			$5.5x10^9$	100

a. Estimated from available in-water data.

b. Estimated from EPA (1983) with refinements for overland flow.

c. Assumed conservative concentration at point where plume enters river.

d. Based on one illegal discharge per day during peak season from a boat containing one day of waste from two people. One person contributes $2x10^9$ fecal coliform per day (Metcalf & Eddy, 1979). Estimated loading of $4x10^9$ is divided by 3 for annual average conditions. 12 months/ peak season (4 months) = 3

TABLE 3-4. PHINNEYS HARBOR WATERSHED NUTRIENT SOURCE LOADING ESTIMATES

Pollution Sources	Source Area	Phosphorus			Nitrogen		
		Estimated Source Concentration (mg/1)	Estimated Loading (mg/day)	% Total Loading	Estimated Source Concentration (mg/1)	Estimated Loading (mg/day)	% Total Loading
1. Alden Bog[a]	13 acres	0.3	7.4×10^{4}	15	1.0	2.5×10^{5}	10
2. Baptiste Bog[a]	16 acres	0.3	9.7×10^{4}	20	1.0	3.2×10^{5}	13
5. Chester Park Drain[b]	7 acres	0.3	1.9×10^{4}	4	2.0	1.2×10^{5}	5
6. Beach Boulevard/ Burtonwood Avenue Drain[b]	2.5 acres	0.3	5.7×10^{3}	1	2.0	3.8×10^{4}	2
7. Carlton Road Drain[b]	17 acres	0.3	3.9×10^{4}	8	2.0	2.6×10^{5}	11
8. Shore Road[c]	3700 LF	0.2	5.4×10^{3}	1	1.0	2.7×10^{4}	1
9. County Road[c]	3300 LF	0.2	5.0×10^{3}	1	1.0	2.5×10^{4}	1
10. Old Dam Road[c]	3300 LF	0.2	5.0×10^{3}	1	1.0	2.5×10^{4}	1
11. Septic Systems[d]	100 homes	0.1	7.3×10^{4}	15	1.0	7.3×10^{5}	30
12. Waterfowl[e]	100 birds	0.7g/kg/bird	7.0×10^{4}	15	0.35g/kg/bird	1.4×10^{5}	6
13. Monument Beach[f] Marina	4 boat washes	10	0.6×10^{2}	<1	1.0	0.06×10^{2}	<1
Direct Rainfall[g]	224 acres	0.03	8.5×10^{4} 4.8×10^{5}	18	2kg/ha/yr	5.0×10^{5} 2.4×10^{5}	21

a. Estimated from Gil (1988)
b. Estimated from EPA (1983)
c. Estimated from EPA (1983) with refinements for overland flow
d. Assumed concentration at point where plume enters river
e. Estimated from Krenkel & Novotny (1980)
f. Based on 2 boat washes per day, and 5 gallons of concentrated washwater per wash. Concentrations based on Metcalf & Eddy (1979)
g. Estimated from Brezenik (1972)

Transport Considerations. The priority of the remaining sources was based upon transport considerations, such as whether the pollution load is attenuated by vegetation or infiltration. In this comparison, sources in close proximity to Back River, Eel Pond, or Phinneys Harbor were ranked above those which discharge distally. Sources with clear paths to the waterway, such as ditches or gulleys, were given higher priority than those which must travel through natural filters such as forested or grassy areas. Applying this criterion, the Baptiste and Alden Cranberry Bogs, discharging directly to Back River, and the three piped drainage system discharging into Eel Pond and Phinneys Harbor are of highest priority. Runoff from Shore Road, County Road, and Old Dam Road is screened since this runoff is not discharged through a piped drainage system but passes overland and vegetation before reaching Back River. Septic systems and sheet surface runoff, which both pass through natural filters before reaching the water, have a lower priority for bacteria control based on transport considerations.

Figures 3-6 and 3-7 illustrate the ranking of sources within the Phinneys Harbor watershed. The process proceeded from a watershed profile to a detailed list of the sources within the watershed. Criteria were then applied to rank those sources which can be most effectively controlled to optimize water quality improvements. Highest on the priority list are the two cranberry bogs and the three piped drainage system discharges. By focusing implementation efforts, tangible water quality improvements can be realized more quickly and cost-effectively.

Phinneys Harbor Pollution Source Profile	Pollutant Type	Source Magnitude	Transport Considerations	Priority Sources
1. Alden Cranberry Bog		X		
2. Baptiste Cranberry Bog		X		
3. Waterhouse Rd. Development	X			
4. County Rd. Development	X			
5. Chester Park Drain				●
6. Drain at Beach & Burtonwood				●
7. Drain at Carlton Road				●
8. Shore Rd. Runoff			X	
9. County Rd. Runoff			X	
10. Old Dam Rd. Runoff			X	
11. Septic Systems			X	
12. Wetlands East of County Rd.		X		
13. Monument Beach Marina				●

FIGURE 3-6. PRIORITIZATION OF NONPOINT SOURCES OF BACTERIA IN PHINNEYS HARBOR WATERSHED

Phinneys Harbor Pollution Source Profile	Pollutant Type	Source Magnitude	Transport Considerations	Priority Sources
1. Alden Cranberry Bog				●
2. Baptiste Cranberry Bog				●
3. Waterhouse Rd. Development	X			
4. County Rd. Development	X			
5. Chester Park Drain				●
6. Drain at Beach & Burtonwood		X		
7. Drain at Carlton Road				●
8. Shore Rd. Runoff			X	
9. County Rd. Runoff			X	
10. Old Dam Rd. Runoff			X	
11. Septic Systems				●
12. Wetlands East of County Rd.		X		
13. Monument Beach Marina		X		

FIGURE 3-7. PRIORITIZATION OF NONPOINT SOURCES OF NUTRIENTS IN PHINNEYS HARBOR WATERSHED

REFERENCE

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CHAPTER FOUR

ASSESSMENT OF BEST MANAGEMENT PRACTICES

In this chapter, a range of pollution control measures or best management practices which address the water quality problems identified in Phinneys Harbor are identified, evaluated and screened. Based on the water quality evaluations conducted in earlier chapters, the practices presented focus primarily on bacteria and nutrient control, although control of solids and other potential contaminants is also addressed. Each control practice is described and assessed with respect to various technical, environmental and socio-economic criteria. Based on this process, appropriate control measures are selected to be part of the recommended plan. This plan is described in detail in Chapter 5.

BMP Assessment Criteria

Based on the discussions and evaluations presented in this chapter, BMP's are selected for implementation in the recommended nonpoint source control plan. This selection is based on a variety of qualitative and quantitative factors. In this section, the BMP screening and assessment criteria considered important for development of a nonpoint source control plan are presented.

Technical Feasibility. To be technically feasible, a BMP must be buildable in the area being considered for its use. Such factors as land area requirements, site constraints (size, elevation, slope), land ownership, and potential permitting problems are considered.

Monetary Factors. This category includes both cost and funding availability. Costs include both capital and operations and maintenance costs for a given BMP. Given the limited funding currently available for nonpoint source control, availability of funding is a critical concern. In general, BMP's costing more than several hundred thousand dollars would be extremely difficult to justify, given current funding availability. This factor ties together with BMP cost, since a technically feasible or desirable BMP may not be economically feasible.

Water Quality Improvements and Benefits. The main purpose of nonpoint source control is to effect a desired level of water quality improvement in Phinneys Harbor and the Back River. In particular, as set forth in earlier chapters, at least a one order of magnitude (90 percent) reduction in bacteria loading from storm drains is sought. In addition, where possible, reduction in nutrients and solids loadings will be sought, although solids are considered far less important than bacteria and nutrients.

Public and Agency Support. Support of pollution control measures is gaged in part through a series of public and Project Advisory Group meetings, as well as through extensive discussions with various individuals representing these groups. This support is further gaged by the technical comments received on various project outputs and reports. In addition, agency support will be sought in selected cases through funding applications for implementation.

Experience of Other Nonpoint Source Control Efforts. NPS control programs already implemented elsewhere can be used to gain knowledge on what is expected to work, and what problems may arise. Such programs include the Massachusetts Clean Lakes Program, the USDA Rural Clean Water Program (implemented in Westport), various activities ongoing as part of the Buzzards Bay program (such as the construction and testing of stormwater infiltration BMP's at Electric Avenue Beach), and other test cases cited in various literature and programs.

Demonstration Value. For this project, it is of special interest to demonstrate methods for NPS control which can be effectively implemented in other coastal areas where similar problems exist. It is also important to select BMP's which can be implemented in other areas of the EBWR outside of the Phinneys Harbor watershed.

The above criteria are all utilized during screening, development and assessment of BMP's described in the following section.

Identification of Best Management Practices

Best management practices (BMP's) as used in this report is a general term which could include any pollution control practice. This term is also often interpreted to mean low-cost, nonstructural types of control measures. It is important to stress low-cost, nonstructural control methods where feasible due to the limited funding resources within which nonpoint source control programs must currently be implemented.

Extensive efforts at development and implementation of nonpoint source control methods have resulted in identification of numerous potential BMP's which could be utilized at Phinneys Harbor. The list of possible BMP's may be narrowed to reflect those applicable to the pollution sources which exist in the Phinneys Harbor study area. Based on these sources, which were described in detail in Chapter 3, a list of potential BMP's is given in Table 4-1.

The list of BMP's in Table 4-1 is compiled from several sources. Morehouse (1988) compiled a list of BMP's applicable to pollution sources in New England. The Soil Conservation Service (1989) has developed extensive BMP descriptions with planning considerations and design criteria for agricultural BMP's. Other sources include Division of Water Pollution Control (1987), EPA (1987), and others.

The following paragraphs describe and assess BMP's for each major type of pollution source (agricultural, urban runoff and land disposal) which occurs in the Phinneys Harbor drainage area. In addition, a number of non-structural, institutional BMPs are assessed. Following this, a summary assessment of BMP's is provided as a final basis of selection for inclusion in the recommended plan.

Agricultural Best Management Practices

This section presents a variety of agricultural best management practices to control nutrient loading on Back River from area cranberry bogs including fertilizer management, water management and water treatment.

TABLE 4-1. POTENTIAL BEST MANAGEMENT PRACTICES FOR SNELL CREEK DEMONSTRATION AREA

AGRICULTURE
Fertilizer Management
Water Management
Water Treatment
URBAN RUNOFF
Source Control
Solid Waste Management
Street Sweeping
Catch Basin Cleaning
Commercial/Industrial Runoff Control
Animal Waste Removal
Soil Erosion Control
Snow Removal and Deicing Practices
Air Pollution Reduction
Fertilizer and Pesticide Control
Stormwater Infiltration
Filter Areas and Buffers
Infiltration Basins
Porous Pavement
Wetland Treatment
Storage
Treatment
LAND DISPOSAL (On-Site Systems)
Sewering
Alternative Disposal Systems
MARINE DISCHARGES
Pump-out Facilities
NONSTRUCTURAL/INSTITUTIONAL
Regulation and Enforcement
Tax Incentives
State BMP Financing
Local BMP Financing
Beneficiaries Finance BMPs
Public Education

Fertilizer Management. Fertilizers are used to increase the productivity of the land and are necessary for crop production. However, use of fertilizer can increase the amount of pollutants, especially nitrogen and phosphorus, available for transport (EPA, 1987). Therefore, proper fertilizer application is important for increasing cranberry production and decreasing impacts on water quality.

Fertilizer management approaches the problems of nitrogen and phosphorus loading from a source control perspective. The North Carolina Agricultural Extension Service (EPA, 1982) suggests that avoiding excess fertilizer use is the first step in nutrient control. Various methods include soil testing, liming, proper application, and timing. Soil testing isolates the fertilizers needed, liming can increase the fertilizer effectiveness, proper application assures efficient use of the nutrients, and application near the time of maximum growth can maximize plant utilization of nutrients (EPA, 1982). Fertilizer management can reduce costs by decreasing the amount of fertilizer purchased and reducing the labor hours required to apply the fertilizer (EPA 1987). Fertilizer management is recommended for both cranberry bogs in the watershed and a plan to coordinate this effort through the Soil Conservation Service is presented in Chapter 5.

Water Management. During periods of fertilization and application of herbicides and pesticides, release of nutrients and chemicals can be minimized by retaining water in the bog for a period of several days after chemicals are applied. This technique allows for plant uptake of applied fertilizers and attenuation of chemical concentrations. This is accomplished by water control structures such as dikes, dams, flumes and spillways. Additional control of these tailwaters can be achieved by the used of tailwater recovery systems consisting of ditches and pipes which collect water and convey it to storage lagoons. Water stored in such lagoons can be reused or released after neutralization. A plan for water management to control nutrient release is currently being developed for the Alden bog by the Soil Conservation Service. It is recommended that a similar plan be developed and implemented at the Baptiste bog. Conceptual plans for both bogs were developed in close consultation with the Soil Conservation Service and are presented in Chapter 5.

Water Treatment. The best management practices previously discussed in this section are, for the most part, nonstructural, high management techniques to control nutrients from cranberry bogs. In the absence of fertilizer and water management, a structural technique involves construction of a filter barrier. A plan and cross section of a typical filtration barrier is illustrated in Figure 4-1 and consists of an earthen berm and a leaching chamber. Water exiting the bog would pass through the leaching chamber which is filled with a sand/alum mixture. These systems can be effective in removing phosphorus and also remove solids and bacteria. Potential constraints on use of filter barriers include hydraulic capacity, maintenance requirements and potential wetlands and waterways impacts and permitting difficulties. Due to the availability of nonstructural techniques and the fact that reduction of nutrients is a secondary objective, filter barriers are not recommended.

Urban Runoff Best Management Practices

As discussed in Chapter 3, piped drainage systems near Eel Pond and Chester Park at Phinneys Harbor are significant sources of stormwater runoff in the Phinneys Harbor watershed. Pollutants washed off the roadway during wet weather travel through these piped drainage systems and discharge directly to Eel Pond and Phinneys Harbor. Potential methods of controlling bacteria loading from such a piped drainage system include source controls, promotion of infiltration, storage, and end-of-pipe treatment. This section presents a variety of stormwater best management practices to control bacteria and nutrient loading from these drainage systems.

Source Controls. Source control measures include actions within a drainage basin which effectively reduce the stormwater pollution before it is washed off by rainfall and enters the receiving waters. Source controls do not usually require large capital expenditures. However, they are generally labor-intensive; therefore, the associated maintenance costs can be high.

Solid Waste Management - Although intentional disposal of waste material on streets and sidewalks is prohibited, it may occur to a small degree in the watershed of Phinneys Harbor, especially during summer. This street litter

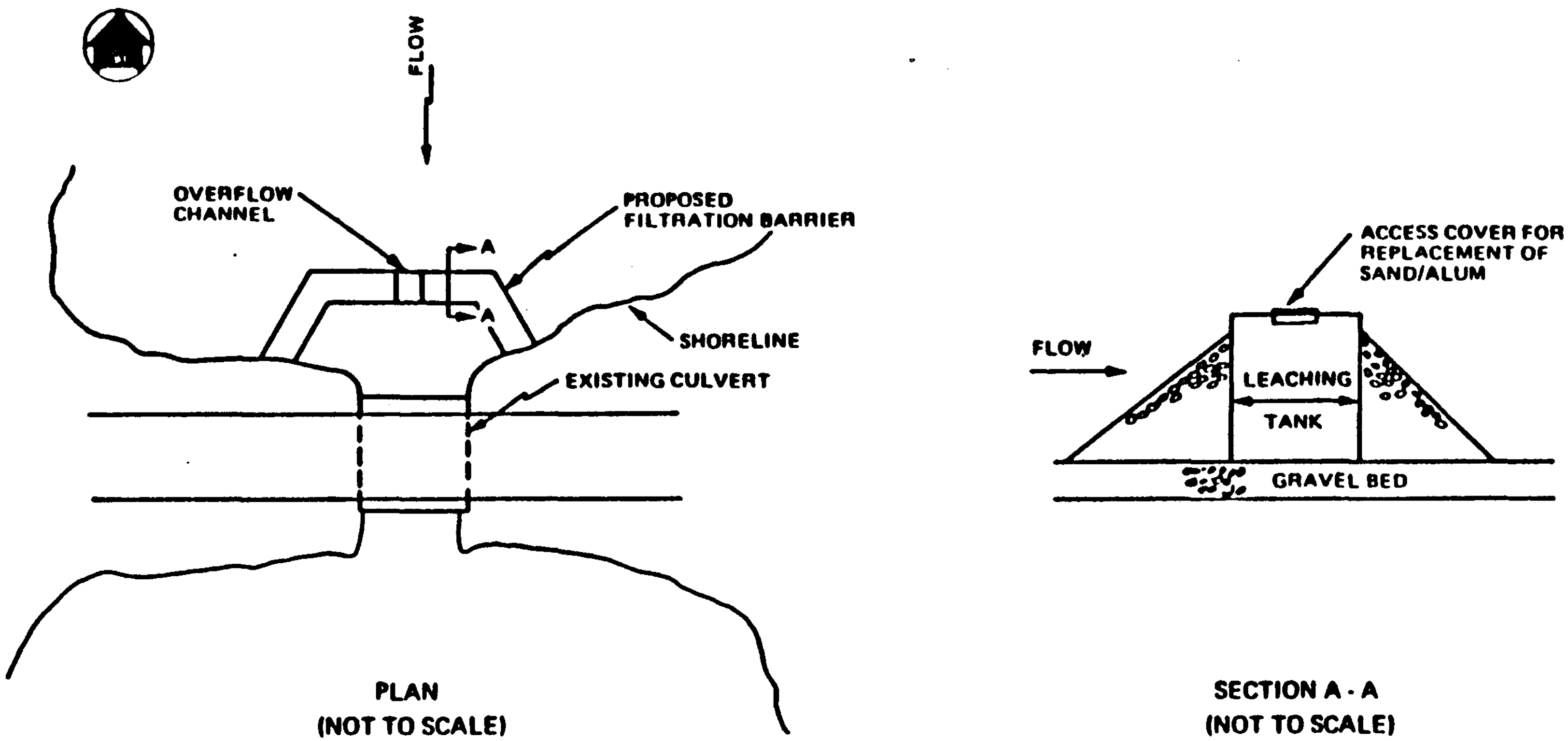

FIGURE 4-1. TYPICAL FILTRATION BARRIER

commonly includes metallic, glass, and paper containers; cigarettes; newspapers; food wrappers; and a variety of other such items. If not removed from the street surfaces by cleaning equipment, these items often end up in stormwater discharges. This can result in visible pollution due to the floatable nature of many of these items.

Enforcement of anti-litter ordinances is generally given a relatively low priority by law enforcement agencies due to the limited personnel and funds, and the difficulty of identification and conviction of violators. Public education programs and conveniently placed waste disposal containers may both be effective, low cost alternatives. Since leaves, grass clippings, crankcase oil, paints, chemicals and other such wastes are sometimes disposed of in catchbasins or street inlets, proper disposal of these materials can be addressed in a public education program. However, since the results of such a program are dependent on voluntary cooperation, no level of effectiveness can be predicted. While such an education program is desirable, it can not be considered a reliable bacteria and nutrient control alternative. Further, solid waste pollution is not considered a serious pollution problem in this area.

Street Sweeping - Street sweeping is often considered a practical best management practice (BMP) for stormwater pollution control. Frequent street sweeping can prevent accumulations of dirt, debris and their associated pollutants. The first-flush of pollutants from streets and other tributary areas to a drainage system would be reduced if accumulations were prevented. However, street sweeping requires high maintenance costs and has been shown not to remove significant amounts of bacteria or nutrients, especially in a residential setting. Thus, it is unlikely that substantial reductions in bacterial or nutrient pollution will result from more frequent cleaning.

Catchbasin Cleaning - Regular cleaning of catchbasins can remove accumulated sediment and debris that could ultimately be discharged from storm drains. The frequency of catchbasin cleaning varies, but is typically one to two times annually and is targeted towards maintaining proper drainage system performance rather than pollution control. Research by EPA has determined

This should be defined better.

that a frequency of catchbasin cleaning of two times a year maintains effective pollutant removal. The option of increased catch basin cleaning would not increase bacteria removals by any substantial amount, and like street sweeping, it is also maintenance intensive.

Commercial/Industrial Runoff Control - Commercial and industrial lands can contribute quantities of grit, oils and grease to drainage systems. In the study area, such contaminants may runoff into sewers from gasoline stations, and parking lots. Pretreatment of runoff from these areas may be achieved by installing and maintaining oil and grease separators in catch basins and area drains. However, commercial development in the Phinneys Harbor watershed is light and there are no directly discharging drains from these areas.

Soil Erosion Control - Properly vegetated soils will not erode and thus will not be transported through the storm drains during wet weather. Controlling soil erosion is important in two respects: (1) soil particles create turbidity in receiving waters, block sunlight and in general create a nuisance; (2) soil particles carry nutrients and metals. Nutrients and metals fixed onto soil particles may be released and become available for aquatic plant uptake or intake by organisms. In the study area, however, there do not appear to be any major sources of continuous soil erosion.

Snow Removal and Deicing Practices - This abatement measure involves limiting the use of chemicals for snow and ice control to the minimum necessary for public safety. This in turn would limit the amount of chemicals, primarily salt, and sand washed into the collection system and ultimately discharged. Since little or no bacteria or nutrient reduction would occur, this option is not considered viable.

Air Pollution Reduction - One method of controlling pollutant loadings from urban runoff is to limit the amount of pollutants that are contributed to local air. Particulate and gaseous pollutants in air are carried to the ground by rainfall. Air born particulates also settle to the ground during dry weather.

Certain metals, such as lead and zinc, are by-products of automobile use. Reducing automobile emissions of lead and zinc would likely decrease their concentrations. However, it is extremely difficult to quantify the potential reduction in stormwater pollution associated with air quality improvement. It is doubtful that there would be any reduction in bacterial or nutrient pollution, hence this option is not considered realistic.

Animal Waste Removal - Essentially, this refers to removing animal excrement from areas tributary to storm drains. The town of Bourne recently enacted local regulations related to control of pet litter. It is anticipated that some (although unpredictable and probably minor) reduction in bacteria load may be achieved. This best management practice could also be emphasized during public information programs.

Fertilizer and Pesticide Control - Fertilizers and pesticides washed off the ground during storms contribute to the runoff pollutant levels. Controlling the use of these chemicals on public lands can help reduce nutrient loads. Care should also be taken to properly store and protect chemicals from exposure. Since most of the problems associated with these chemicals are a result of improper or excessive usage, a public education program may be worthwhile. Control of these chemicals, however, is not expected to achieve bacteria reduction in the drainage area but could help to control nutrients.

In summary, source controls can improve stormwater runoff quality and may achieve some nutrient control. They cannot, however, be relied upon to provide a consistent reduction in bacteria loading. A public education program to inform residents of what can be done to reduce urban runoff pollution can be effective. Such a program could encourage a number of activities including proper disposal of household chemicals and motor oil, animal waste control, regular cleanup of litter, and control of pesticides/fertilizer application.

Stormwater Infiltration. Methods to infiltrate stormwater into the ground prior to direct discharge into receiving waters can be highly effective in removing bacteria, solids, and certain nutrients and metals. It is a desirable BMP approach because high bacteria removals (over 99 percent) can be obtained, even in permeable soils, and because costs are lower than more structurally intensive methods such as end-of-pipe treatment. While generally no pumping or power costs are involved, some maintenance is usually required. Infiltration methods are being studied, utilized and tested as part of the Buzzards Bay project, particularly at Buttermilk Bay. Leaching facilities have been constructed at Electric Avenue Beach in Bourne (Metcalf & Eddy, 1989).

Filter Areas and Buffers - In this BMP, the drainage system is altered through diversion or detention to promote overland flow through natural vegetation which acts as a filter to decrease the runoff velocity, allows solids to settle, and promotes infiltration. Design considerations include type of pollutant and expected flow and load, type of vegetation present and slope. In general, bacteria in road runoff does not attach to sediments and infiltration is required to remove bacteria. Therefore, unless large areas are used, these systems are not effective in removing bacteria from urban runoff. If the filter area is large enough, some removal of nutrients and solids may also be achieved. Filter areas may be less effective in winter due to frozen ground. Filter areas are inexpensive and do not require extensive maintenance. Due to lack of available land, lack of effectiveness in winter, and availability of other techniques, filter areas are not recommended.

Infiltration Basins - In order to promote infiltration within piped drainage systems, infiltration basins may be constructed within the drainage system. According to the Soil Conservation Service (1987), the soils in the watershed consist of well drained sandy and gravelly deposits which are conducive to the use of infiltration. A typical stormwater infiltration catch basin is shown in Figure 4-2 and a stormwater drainfield or leaching galley, a similar system with larger hydraulic capacity, is shown in Figure 4-3. Another common infiltration system consists of dry wells retrofitted to existing catch basins. The dry wells, when used with a hooded catch basin, are less likely to clog than infiltration catch basins because oil, grease, and other floatables are captured before infiltration.

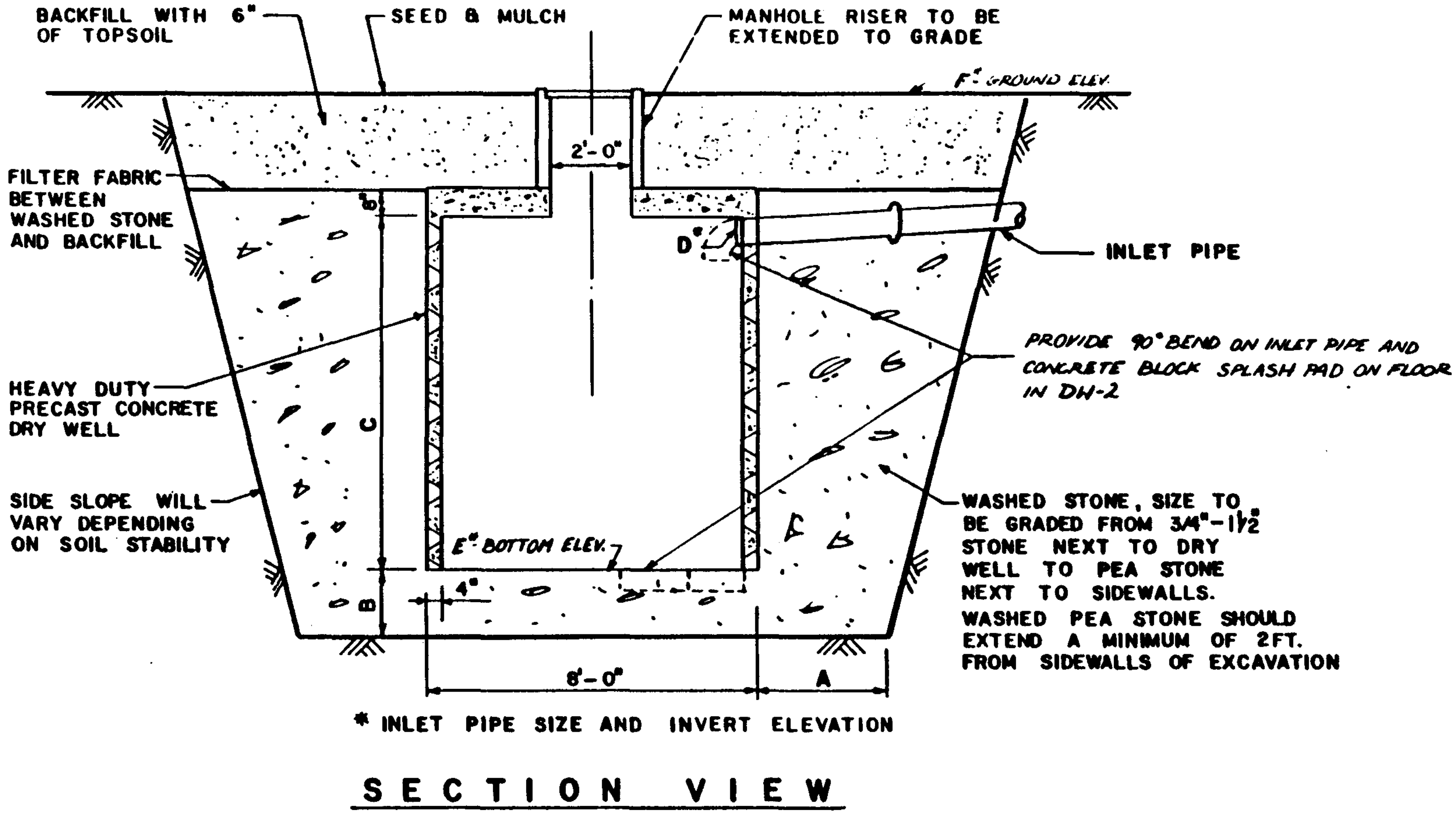

FIGURE 4-2. TYPICAL STORMWATER INFILTRATION CATCH BASIN

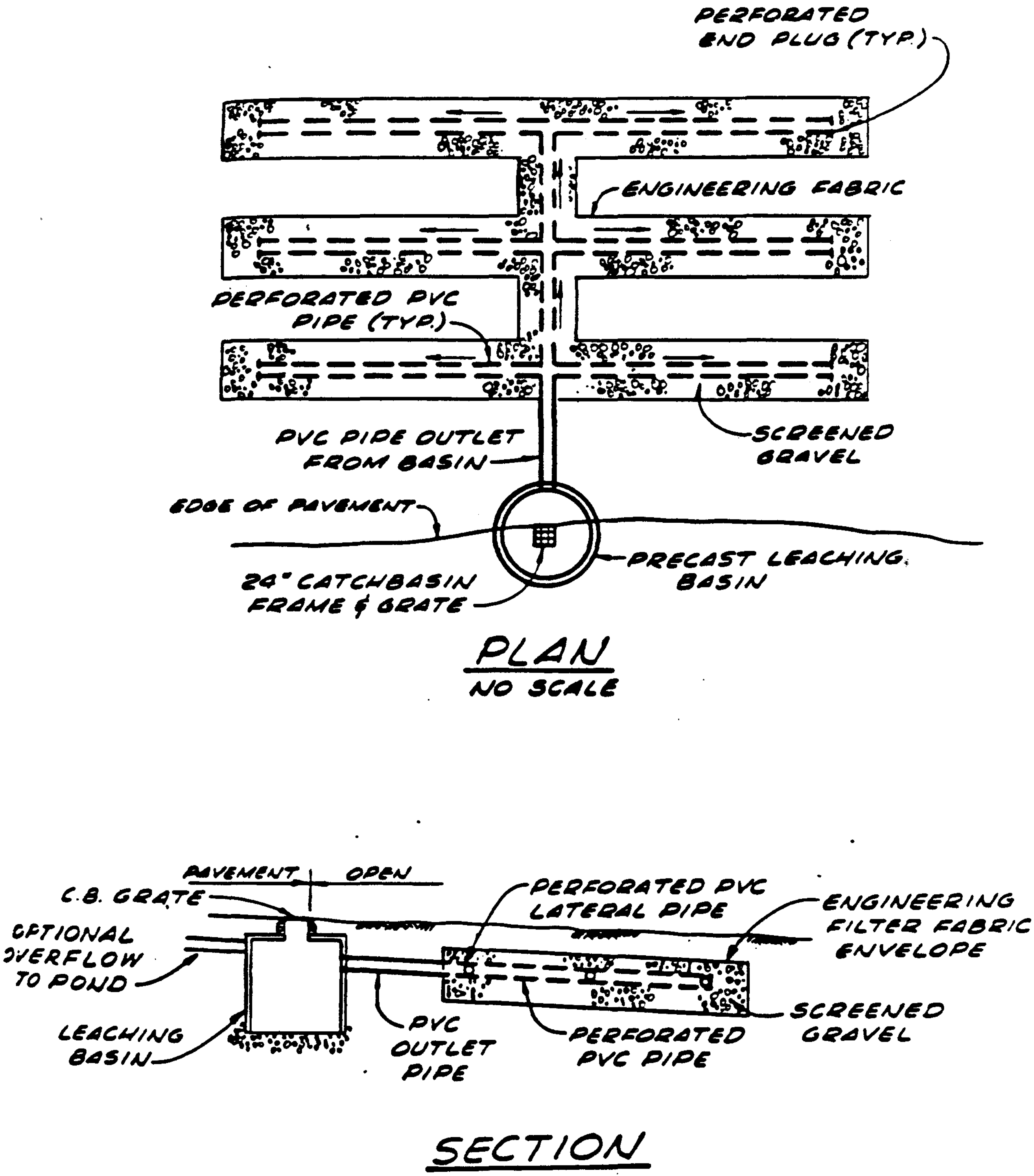

FIGURE 4-3. TYPICAL LEACHING GALLEY DESIGN

EPA (1974) showed in "Water Quality Management Planning for Urban Runoff" that during the first ½-inch of rainfall, an intensity of 1.0 inch/hour for thirty minutes is considered heavy enough to remove 90 percent of the pollutants from pavement. This phenomenon, in which the majority of pollutants are "washed-off" paved surfaces at the beginning of a rainfall event, is known as the "first flush". Using this rule of thumb, infiltration basins or leaching gallies installed for pollution control are typically designed to infiltrate runoff from a 1 or 2-year storm in order to maximize water quality benefits. Given the effectiveness of infiltration coupled with sandy soils in the watershed, stormwater infiltration is recommended to control direct discharges of stormwater to Eel Pond and to Phinneys Harbor at Chester Park. Conceptual plans for dry wells and leaching galleys are presented in Chapter 5.

Porous Pavement - Porous pavement consists of a porous top course of varying thickness covering a layer of gravel over a crushed stone recharge bed. Porous pavement provides temporary storage and promotes infiltration in otherwise impervious areas, and is typically designed to enhance groundwater recharge rather than pollution control. Porous pavements can be installed over existing impervious pavements, keeping the replacement costs about equal to the original installation costs. However, these systems are not as effective as porous pavement installed over pervious soil (EPA, 1987). This technique is most frequently used in small but highly erodible areas subject to considerable traffic, such as parking lots. Porous pavement is not recommended, however, for areas subject to heavy high-speed traffic and would not likely be technically feasible for use on streets in the watershed.

Wetland Treatment - Wetlands provide natural detention and filtering areas through vegetation and infiltration. Use of wetlands to treat stormwater may not be permittable, however, under the Massachusetts Wetlands Protection Act Regulations which do not permit alteration of wetlands. Discharge of large volumes of polluted stormwater to existing wetlands may constitute a significant negative impact and would not likely be permitted by the local conservation commission. Further, there are no suitable existing wetlands to serve as treatment areas for runoff from streets in the watershed.

Storage. The use of storage for urban runoff control can involve in-system or off-line facilities. In-system facilities rely on excess capacity in the drainage system to control peak discharges. Off-line storage includes such facilities as retention/detention ponds. Storage facilities are generally used for hydraulic control of peak flows. For example, conservation commissions routinely require that pre- and post-development flows cannot be altered. Storage facilities are not generally used for urban runoff pollution control unless in combination with treatment methods. Given that their feasibility for bacteria removal is limited, unless in combination with high cost treatment methods, further consideration of these methods is not warranted.

Treatment. Numerous end-of-pipe treatment methods for bacterial and nutrient control exist. These include physical, chemical and biological methods in various combinations, often with disinfection for bacteria removal. These methods are normally used to treat wastewater and sometimes combined sewage, but are rarely used to treat stormwater because of the high cost. Since these methods involve land acquisition, significant environmental impact and high cost, and are beyond the limits of available funding for nonpoint source control, they will not be considered further.

Land Disposal Best Management Practices

As discussed in Chapter 2, there are no water quality data collected in studies of Phinneys Harbor and Back River that indicate a bacteria pollution problem caused by septic tanks. In many areas of the watershed of Phinneys Harbor, however, due to improperly installed or undersized systems, septic tanks may be a source of fecal coliform bacteria and nutrients in certain areas or intermittently depending on weather conditions, tides, and occupancy.

Due to widespread concern over the impact of septic tanks on water quality, several potential BMPs to control discharge of bacteria from septic tanks are evaluated below including sewering, and alternative disposal systems. Nonstructural/Institutional methods of controlling bacteria from septic tanks are discussed later in this chapter.

Sewering. Sewering involves the construction of underground conduits to convey wastewater from an entire community to a municipal wastewater treatment facility. Although sewering would effectively eliminate on-site system failures, no significant amount of failures or surface breakouts has been observed either directly or through water quality analyses and sewering may not improve bacterial water quality significantly. Further, such a recommendation would not likely receive public support, may be prohibitively expensive, and may not be eligible for funding through the state construction grants program in the near future. Thus, sewering is not recommended to control bacteria from septic tanks near Phinneys Harbor.

Alternative Disposal Systems. Alternative wastewater disposal systems include pressure sewerage systems, vacuum sewerage systems, package wastewater treatment plants and large on-site systems to treat sewage from a group of homes. Like sewering, these systems may be effective in preventing septic system breakout. There is, however, no evidence of widespread breakout problems in Bourne and construction of these systems may not result in a significant water quality improvement. In addition, these systems may not be eligible for state funding and would not likely receive public support or local or private funding. There are, however, no dry weather water quality data that indicate that beat discharges contribute to bacteria concentrations in Phinneys Harbor. Any water quality impacts from this marina may be dissipated by the rapid tidal flushing rate around Toby's Island.

Boats/Marinas Best Management Practices

The Monument Beach Marina is located at the southern end of Phinneys Harbor near Toby's Island. Approximately 50 to 100 boats dock at this marina. Because of the large concentration of boats in the area, this may be a source of pollution including bacteria, surfactants, and petroleum products. This marina does not have pump-out facilities to accommodate boats with holding tanks returning after a full day trip. Therefore, many people reportedly discharge accumulated wastes directly into the surface water on their way to the marina. This could be a direct source of bacteria to Phinneys Harbor and could contribute to shellfish closures in the area. There are, however, no dry weather water quality data that indicate boat discharges as a significant source of fecal coliform bacteria to Phinneys Harbor. Any water quality impacts from this marina may be dissipated by the rapid tidal flushing rate around Tobys Island. Since boat discharges may occur occasionally and could be a threat to public health, this section evaluates construction of pump out facilities as a method of reducing discharges from marine sanitation devices into Phinneys Harbor. Institutional means to control these discharges including regulation and enforcement and education are discussed in a later section of this chapter.

Pump-out Facility Construction. Throughout the Cape Cod area there are very few boat pump-out facilities. For example, the nearest facility to the Monument Beach marina is the facility at the Massachusetts Maritime Academy by the Cape Cod Canal, a significant trip for boats in Phinneys Harbor. The Commonwealth of Massachusetts has developed a task force designed to study this problem and develop solutions. One task is to find suitable locations for new pump-out facilities and funding sources for their construction.

Construction and operation of these facilities is expensive and may not be feasible at the Monument Beach marina. However, the state task force may be able to identify a centrally located site suitable for a facility. Given the lack of a documented water quality problem and the above factors, construction of a pump-out facility is not recommended at this time.

Nonstructural/Institutional Best Management Practices

In addition to the various structural means to control nonpoint sources, a number of nonstructural or institutional means of nonpoint sources control have been evaluated. This section presents a number of nonstructural and institutional means to control agricultural runoff, urban runoff, and contamination from on-site wastewater systems and boats including regulation and enforcement; tax incentives; state, local and beneficiary financing of BMPs; and public education. It must be noted that enactment of local bylaws or regulations must occur through the town meeting process. Further, there is currently no local or state institutional framework to grant tax incentives for BMP installation, and there is no basis to charge polluters or beneficiaries a fee to generate revenue for pollution control. Thus, the implementability of several of the BMPs described below is questionable in the absence of widespread public and political support.

Regulation and Enforcement. Opportunities for regulatory control of pollution include bylaws, regulations, enforcement, and incorporation of measures to address water quality concerns in local permits issued by the health department, planning board, and conservation commission. Local environmental bylaws and regulations may be enacted to conserve health; to provide for water, water supply, drainage, sewerage, open space and conservation of natural resources; and to prevent blight and pollution of the environment. A zoning bylaw may be adopted to protect designated land uses with critical environmental concerns from inappropriate uses of land (SRPEDD, 1989). Sample bylaws and regulation have been developed by the Southeast Regional Planning and Economic Development District (1989) under contract to EPA Buzzards Bay Project. This section describes potential regulatory means to control nonpoint source pollution from agriculture, stormwater runoff, proposed developments and subsurface disposal systems.

Agriculture - There are a myriad of federal, state and regional agencies dealing with agriculture including the U.S. Department of Agriculture, the Environmental Protection Agency, the Massachusetts Department of Environmental Management, the Massachusetts Department of Food and Agriculture, and the Massachusetts Soil and Water Conservation Districts. Most of the programs implemented by these agencies, however, provide technical and financial assistance and do not serve in a regulatory or enforcement capacity. The strategy for control of agricultural nonpoint sources, as presented in the Massachusetts Nonpoint Source Management Plan (DEP, 1988), suggests source identification, prioritization and control through BMPs, education and technical assistance rather than a regulatory approach. One method to control agricultural pollution is through establishing agricultural districts through zoning bylaws.

Stormwater Runoff (Existing and Future) - Water quality in Phinneys Harbor and Back River is directly influenced by the cumulative effect of existing development and activities in the watershed and the resultant stormwater runoff in the drainage basin. Future development represents a threat of further deterioration in water quality. Within the Phinneys Harbor watershed, over half of the acreage, or about 1000 acres, could be developed with home sites under current zoning. Development of any significant fraction of that property could generate impacts in terms of surface runoff quality and quantity, erosion, sedimentation, disruption of natural drainage patterns, coliform bacteria and leachates from septic tanks, and other potentially damaging effects. There is at least one large development proposed within the Phinneys Harbor watershed.

The existing institutional and statutory framework for regulating urban runoff is not cohesive. On the federal level, amendments to the Clean Water Act of 1987 established a municipal and industrial stormwater discharge permit program. This program will not apply to Bourne, however, due to the low population of the town and lack of a large municipal storm sewer system. Within well-established municipal authority, however, there are numerous tools available that can be of major assistance in controlling water pollution from new development. A set of enhanced municipal tools constitutes an ideal future complement to a program of direct structural improvements designed to mitigate existing conditions. Bourne has moved aggressively since the early 1970's to adopt a number of these local methods. This has been particularly so in the areas of on-site sewage disposal within Board of Health authority, and Environmental Overlay Water Resource Protection Districts within the zoning bylaws. The community could, however, benefit further both from tightening of certain local regulations already adopted, and by consideration of additional available methods. Table 4-2 provides a more complete list of the tools that might be considered.

In order to illustrate the need for additional strengthening of local regulations, selected comments follow. These observations do not constitute a comprehensive analysis or plan, but they do serve to highlight areas for future discussion.

TABLE 4-2. WATER POLLUTION CONTROL FROM NEW DEVELOPMENT: POTENTIAL LOCAL REGULATORY TECHNIQUES

Techniques to consider	Description	Comments
A. Zoning Strategies		
1. Environmental Overlay District MA Genl. Laws, Chap. 40A	By imposing a protection overlay over any base district(s) desired, special requirements addressing surface runoff, as well as subsurface intrusion, can be established for all development within that zone.	Is only as strong as the special standards created for it, and is best supplemented by other zoning tools.
2. Special Performance Zoning MA Genl. Laws, Chap. 40A	Ties the impact of any development directly to the physical carrying capacity of the land on which it lies. Explicit performance criteria are needed. Carrying capacity for each district must be determined.	Requires extensive technical analysis and review process, which must engender developer opposition and require a professional staff or consultant capability.
3. Special Permit Authority C. 40A, Sec. 4	By making certain uses conditional and requiring special review and permitting, the community gains great power to: require appropriate site design; mitigate on- and off-site impacts; and even to share mitigation costs.	Provides community with opportunity to set protective standards and subsequent mitigations and, unlike most other methods, offers a means to levy fair-share costs as a legally supportable quasi-impact fee. Potentially, a powerful tool. Well-established technique, but could be subject to legal challenge if all uses in a district are conditional.
4. Site Plan Review (As in No. 1 above.)	Allows designated types of developments to receive a detailed administrative review, in regard to basic site features such as driveways, building siting, drainage patterns.	More limited in scope than most other tools, and they are more constrained as an environmental protection tool.
5. Performance Standards (Not the same as No. 2 preceding.) (As in No. 1 above.)	Quantifiable limits are set on objectionable or nuisance conditions, such as noise, glare, dust, heat, odors, etc., and can be expanded to cover various environmental protection areas.	Focuses on impacts rather than development, so it treats all parties equitably, clearly and objectively. Standards can differ, however, from existing federal or state regulations for the same impact.

TABLE 4-2 (Continued). **WATER POLLUTION CONTROL FROM NEW DEVELOPMENT: POTENTIAL LOCAL REGULATORY TECHNIQUES**

Techniques to consider	Description	Comments
A. Zoning Strategies (Cont.)		
6. Open Space Residential Districts C. 40A, Sections 2 and 9	Uses clustering options and variable lot size provisions (even if only single family detached homes are involved) as a means of preserving open space.	Tends to be ignored by developers, unless several factors are present, such as: bonus unit incentives; clear and comprehensive open space system goals and definitions; and streamlining of administrative procedures.
7. Stormwater Management By-Law (Infiltration Requirements)	Provides a method for diverting surface runoff entirely away from wetlands, and, in rural areas, for maximizing recharge/infiltration into subsurface of soil.	Can also be handled under: environmental overlay district, site plan review, or performance standards. If adopted, there should be a reciprocal clause within subdivision control.
8. Transfer of Development Rights C. 40A, Sec. 9	Transfer development rights from the "sending" or protection zone to the "receiving" or development zone, usually by sale of such rights. Theoretically, a major planning tool to keep development away from where it's not desired, and into where it is sought.	Is difficult and controversial to plan for, particularly designating receiving sites. It is also hard to assess monetary value of the development rights in an equitable manner.
9. . Earth Removal By-Law . Sedimentation/ Erosion Control By-Law . Nutrient Loading By-Law	Provides standards for managing pollution from all construction sites, permanent sites and agriculture, by setting quantitative limits and requiring structural improvements of various types.	Can be implemented as separate by-laws outside of zoning, and similar provision can (and should) be placed into subdivision regulations.
10. Floodplain Districts	Provides a degree of shoreline protection by limiting building below 100-year storm elevation.	Most communities, including Westport, have already adopted, in order conform to requirements of federal flood insurance.

TABLE 4-2 (Continued). **WATER POLLUTION CONTROL FROM NEW DEVELOPMENT: POTENTIAL LOCAL REGULATORY TECHNIQUES**

Techniques to consider	Description	Comments
B. Regulatory Strategies: Non-Zoning		
1. Subdivision Control Amendments MA Genl. Laws, Chapter 41, Sections 81K-81GG	Subdivision control regulations can be amended to contain numerous requirements for stormwater management, environmentally sensitive land development practices, and design standards.	There are two distinct limitations: (1) subdivision control applies only when land is being divided, but not in cases of new construction on already-divided property; and (2) the improvements exacted as a result of the subdivision control process have traditionally applied largely to on-site improvements.
2. Board of Health Powers (Public Health) MA Genl. Laws, Chap. 111 and Chap. 41, Sec. 81-U; Title V specifically governs on-site sewage disposal	The traditional land-related functions of local Health Boards, septic permits, non-residential establishment inspections, subdivision review, sewer/water connections, etc., can be expanded to include broader powers over almost any environmental risk, provided the risk is apparent and demonstrable.	There must be a clear and present danger to public health, which can be difficult to document, particularly from non-point sources.
3. Wetlands Protection Act MA Genl. Laws, Chap. 131, Sec. 40	Can be applied more aggressively in a public health hazard situation, such as requiring additional buffers along statutory wetlands, when a relatively large development is constructed.	Exceeding the narrow interpretation of the statute in terms of what is required, would impel a verification of clear and present danger by the Conservation Commission and probably by MA DEP.
4. Groundwater and Aquifer Protection By-Laws	By creating a special overlay district, objectionable uses can be prohibited, recharge areas preserved, buffers created, and conditional permit requirements and conditions instituted.	Often functions as a special permit granted by Board of Appeals or other designated authority.

TABLE 4-2 (Continued). **WATER POLLUTION CONTROL FROM NEW DEVELOPMENT: POTENTIAL LOCAL REGULATORY TECHNIQUES**

Techniques to consider	Description	Comments
B. Regulatory Strategies: Non-Zoning (Cont.)		
5. Underground Fuel Storage Regulations	Offers a means of monitoring and upgrading petroleum tanks.	Becomes part of either building-related codes (building, housing, life safety, plumbing and wiring codes), or part of public health regulations.
C. Other: Negotiated Techniques		
1. Conservation Restrictions M.G.L. Chap. 181, Secs. 31-33	(Voluntary) Agreement between a land owner to keep all or part of his property in a mostly unaltered state and the Conservation Commission. Owner still pays some property taxes and maintains the property in full, but receives in return life occupancy rights.	Low cost means of preserving open space, but is a voluntary method and therefore limited in application.
2. Conservation Easements MA Genl. Laws, Chap. 184 and Chap. 232, Secs. 1 and 2	Within any regulatory review, but particularly in subdivision control, conservation easements and buffers can be negotiated by Planning Board and bound as a recorded deed attachment.	Probably not a method for saving large open space tracts in their entirety, but can be helpful on environmentally important segments.

TABLE 4-3. SUMMARY OF BMP ASSESSMENT

BMP	Technical Feasibility	Monetary Factors: Capital	Monetary Factors: O&M	Monetary Factors: Funding	Water Quality Improvements	Public and Agency Support	Other NPS Control Efforts	Demonstration Value	Comments
Agricultural									
Fertilizer Management	+	Low	Low	+	+	+	+	+	• Requires a soil test and operational planning • Assistance available to operators from USDA
Water Management	+	Moderate	Low	+	+	+	+	+	• Capital costs for installation of water structures • Requires management by bog operator • Very effective for retaining and reusing contaminated tailwater
Water Treatment	+	High	Moderate	-	+	-	+	-	• High capital cost • Potential wetland impacts • Does not address nutrient source
Urban Runoff									
Source Controls	+	Low	Moderate	-	-	-	+	-	• Does not achieve WQ goals • Implement through public education
Infiltration	+	Moderate	Low	+	+	+	+	+	• Feasibility depends on soil type and groundwater elevation

[illegible]

TABLE 4-3 (Continued). SUMMARY OF BMP ASSESSMENT

BMP	Technical Feasibility	Monetary Factors: Capital	Monetary Factors: O&M	Monetary Factors: Funding	Water Quality Improvements	Public and Agency Support	Other NPS Control Efforts	Demonstration Value	Comments
									• Effective for bacteria, nutrient, solids and metals removal
									• Low maintenance
Storage	+	High	High	-	-	-	-	-	• No bacteria removal
Treatment	+	High	High	-	+	-	-	-	• High capital cost
									• Environmental Impacts
Land Disposal									
Sewering	+	High	High	-	-	-	-	-	• High capital cost
Alternative Disposal Systems	+	High	Moderate	-	-	-	-	-	• High capital cost
									• Likely public opposition
Nonstructural/ Institutional									
Regulation and Enforcement	+			-	+	+	+	+	• Requires extensive coalition building and public support
Tax Incentives	-			-	+	-	-	+	• No programs in place
Local Financing	+			+	+	-	+	+	• Depends on availability

In the zoning by-laws, the five water resource protection overlays in IV-4700 are of value, but do not address management of surface runoff in an explicit way. The designation of numerous land uses as being conditionally allowed by special permit is a sound control strategy, but in many cases is not enhanced by specific standards. For example, underground fuel tanks might best be regulated by a separate and far more detailed bylaw which applies to the entire town, not only within the water resource districts.

Another example for possible improvement in the zoning pertains to the earth removal provisions in IV-4400. These regulations are brief and lack certain detail, such as depth-to-water table requirements.

Another example involves the apparent exclusion in the site plan review process in I-1100 of single family housing. A small number of dwellings can be excluded, but larger developments should be evaluated in terms of drainage practices, and on-site open space design. Some of these considerations would be addressed in subdivision control, but if a relatively large number of lots have already been recorded, construction could occur without detailed assessment of site plans.

A local wetlands protection bylaw also might be worth considering. At present in Bourne, wetlands are governed by municipal conservation commission powers under the Chapter 131, Section 40 statutes, under Department of Environmental Protection aegis. Local regulations would, however, allow more detailed definitions and protective criteria to be promulgated, and would strengthen all local review procedures in terms of compelling more careful land planning and site design. (This is not to be confused with the town lowlands regulations, which cover flood hazard requirements).

In Board of Health regulations under Chapter 11 and Title V, the board has added various provisions over the years to strengthen control of on-site sewage disposal and its effect on wells, watercourses, and wetlands. One area in which more clarity would be desirable is in the setback requirements for septic tanks from water and wetlands. The 100' and 150' setback provisions from Title V perhaps should be refined to specify different types of wells, watercourses, and water bodies, and should be tightened to allow for tidal variations in shoreline, seasonal fluctuations, wetlands buffers (particularly with bordering vegetated wetlands) and other variables. Applicability of separation requirements in both on-site and off-site circumstances could be clarified as well.

The preceding examples convey an idea of the local regulatory improvements that might merit examination. There are other examples that also could be discussed. Table 4-2 provides a more complete list. Bourne has implemented a number of water pollution protection measures including the water resources district and stronger Board of Health provisions, but might benefit from other methods. Potential local tools described in Table 4-2 include conservation bylaws and local subdivision and site plan review regulations for nutrient loading control and stormwater management through the planning board. Existing means of control, as described in Table 4-2 include the Wetlands Protection Act and the Subdivision Control Act implemented by the conservation commission and the planning board. In either case, the purpose of such controls would be mainly to limit any increase in bacteria loading, and secondarily to limit nutrient and solids loading to the receiving waters. The paragraphs below complement Table 4-2 and describe, in more detail, potential new regulations and means of using existing regulations for water quality protection.

New Regulations - Stormwater runoff pollution control bylaws have been implemented by some communities. Although they are currently not common, they are becoming more frequent as the recognition of stormwater as a nonpoint pollution source increases. One example bylaw enacted by the town of Wellfleet (Article 7, Section 30 of the General Bylaws) is as follows (Southeastern Regional Planning and Economic Development District, 1989):

> "In order to protect the quality of the waters of the harbor and other wetlands within the town limits, no road or other surface shall be regraded, constructed, or maintained in such a manner as to divert or direct the flow of runoff, defined as including stormwater or any other surface waters, excepting natural pre-existing water courses, into any wetland, as defined in Massachusetts General Laws Chapter 131, Section 40. Uncontaminated runoff shall be directed in such a way as to

recharge the groundwater within the lot where it originates and in such a manner as not to alter natural runoff into any wetland, nor to cause erosion, pollution or siltation into or towards any wetland."

While this bylaw does not specifically mention bacteria, it would allow for bacteria control by requiring on-lot groundwater infiltration. However, this type of bylaw may not be workable in areas of poor soil infiltration capacity.

In Falmouth, Massachusetts, where there are extensive water resources combined with rapid development in areas without public sewer facilities, a nutrient loading by-law has been established for controlling development. Under this by-law, developers are required to determine the nutrient loading of the proposed development and evaluate the impact of this increased loading on the water body. Pre-established criteria are used to define the loading from the development. If the proposed development will push the receiving waters to or above the pre-established critical level in terms of eutrophication, the regulations call for the developer to present mitigating measures to reduce the nutrient loading. One disadvantage of establishing a town by-law of this nature is the fact that it may be cumbersome for the town to administer. Due to the uncertainty involved in precisely predicting critical nutrient loading levels and associated impacts, it is also possible that the by-law would be disputed frequently. As a long-term objective, however, it would be advisable for the town to explore adopting of some type of by-law aimed at control of stormwater pollution.

Existing Development Review - A simpler method of controlling impacts due to development would be through use of existing regulatory reviews which are already required. One example of this is when a project requires wetlands review through the conservation commission. The Wetlands Protection Act Regulations (310 CMR 10) require that anyone planning work in or within 100 feet of a wetland must submit a Notice of Intent to the local conservation commission. The conservation commission enforces the regulations by issuing an order of conditions which either denies the project or requires that certain conditions and mitigating measures by incorporated into the project design to protect the functions of nearby wetlands and waterways which include, among others, protection of public and private water supply, prevention of pollution, protection of land containing shellfish, protection of fisheries, and protection of wildlife habitat. Such conditions may include measures to mitigate the short-term impact of construction and other measures to mitigate long-term changes in runoff quantity and quality. A common order of condition prevents new developments from increasing the peak runoff rate of a parcel of property. With this restriction, new developments are required to construct stormwater retention/infiltration basins and/or leaching fields. These facilities could be designed to infiltrate runoff into the ground, and prevent direct discharge to the receiving waters. The facilities are designed for a particular runoff event (e.g. 50 yr. storm), and allow no more than the existing peak runoff to be discharged. This type of regulation would be easier to enforce since the hydrologic calculations are more directly computed and less debatable than pollutant loading calculation. Infiltration facilities must be used with caution, however, in areas of critical groundwater supply resources. In general, with the requirement that retention facilities be designed to infiltrate runoff, the effectiveness in reducing bacteria and nutrient loading would be enhanced. Although projects not regulated under the Wetlands Protection Act could not be reviewed, this could still be an effective strategy in Bourne due to the ACEC designation and the fact that the projects of greatest concern are likely to be within the 100 foot buffer zone of the receiving waters. Planning board review of other proposed developments, as well as MEPA review, may allow further opportunities for town input on pollution control requirements.

It seems appropriate to initiate development of a "standard order of conditions" for use by town agencies which could be quickly implemented and used when appropriate. Such a condition could be patterned after the common hydrologic condition aimed at preventing increased runoff, however it could be modified to be more specific to pollution control. Potential conditions may include requirements for sumps and oil/gasoline traps, and inspection and maintenance. A longer term objective would be to develop specific new by-laws to control such activity.

Subsurface Disposal Systems - On-site wastewater disposal is currently regulated by Title V: minimum requirements for the disposal of sanitary sewage (310 CMR 15.00). Title V governs the siting, design and construction of septic systems and is administered by local boards of health. Although local boards of health may adopt stricter regulations than those of Title V such as a local bylaw requiring inspection of on-site systems, it is often a difficult process due to local politics and the tough situation of enforcing regulations against one's neighbors. In general, enforcement, proper care and maintenance, rather than stringent regulation, are the best means to assure that such systems will serve the purpose intended and prevent danger to public health and the environment (DEP, 1988). The DEP is currently initiating an effort to review certain aspects of Title V including system maintenance, setback requirements, and determination of maximum groundwater elevation, and may ultimately develop revisions to Title V to recommend for promulgation to the commissioner of DEP.

It is generally agreed that local boards, especially boards of health, are underutilized in enforcing health and conservation regulations. Accordingly, the Division of Water Pollution Control is initiating a program of technical and legal assistance to local communities on Title V administration and enforcement.

Marine sanitation devices are regulated by the U.S. Coast Guard shipboard sewage regulations as well as Massachusetts DEP regulation which requires that marinas be licensed by the Division of Water Pollution Control and that marine sanitation pumpout facilities be provided. The Massachusetts regulations, however, have not been enforced. As a result, there are few pumpout facilities available to mariners in Massachusetts. Several towns such as Plymouth have enacted harbor bylaws containing provisions related to shipboard sewage. Another potential local measure involves development of local regulations which require the installation of sanitary waste pumpout facilities at all marinas.

Tax Incentives. Tax incentives involve abatements on taxes to farmers for establishment of greenways or buffers strips along waterways, or to farmers and developers for construction of pollution control facilities. Such incentives are not currently in place through federal or state programs and are not anticipated. Federal financial assistance for farmers comes in the form of cost sharing through a number of USDA programs.

State BMP Financing. One potential source of funding for BMPs is through the Massachusetts Nonpoint Source Program. Although the program was initiated several years ago, none of the intended $400,000,000 have been appropriated for nonpoint source control projects. On April 14, 1988, Senator Robert A. Durand proposed legislation for a Massachusetts Nonpoint Source Pollution Control Program. The legislation provided seventy-five percent funding for feasibility studies, design, and implementation of best management practices, and up to ninety-five percent funding for innovative projects. Although this program represents an excellent potential source of future funds for prioritized nonpoint source control projects, there is currently no funding available.

Local BMP Financing. Revenues for BMP construction and maintenance may be creatively generated locally through attachment of stormwater control fees to a utility bill and by requiring developers to pay in advance for stormwater facility maintenance. These methods may require local or state regulations not currently in place. Local financing of BMPs may require a property tax increase. Stormwater BMPs may gain voter appeal if combined with other public works projects such as road improvements and maintenance.

Beneficiaries Finance BMPs. Construction and maintenance of BMPs may be financed by those who benefit directly from their positive impact on water quality. Ideally, this technique would involve an organization to which all the beneficiaries of water quality improvements must belong. This organization could collect and administer funds for bacteria control through stormwater control, lobbying and public education. In the case of Bourne, this BMP would require the formation of an organization to administer this effort. Prerequisites would involve extensive coalition building in the town and considerable education of shellfishermen and town officials.

Public Education. Public education is an effective means of keeping local citizens informed of implementation activities and to educate individual property owners of what contributions they can make to improving local water quality. Public education could serve to increase residents awareness of proper system inspection and maintenance. Septic system efficiency can be improved by reducing the amount of solid waste entering the system. Use of garbage disposals contributes substantial quantities of organic material and suspended solids to septic systems, thereby increasing the rate of sludge and scum accumulation in the systems. Reducing these and other solid wastes from septic systems will reduce the amount of organic materials and suspended solids discharged from the systems, and will also provide for a reduction in nutrient loads from the septic tanks. Additional septic system efficiency is possible through reduced hydraulic loading. Water saving devices such as waterless toilets, water-saving showerheads and flush dams for toilet tanks will help to reduce hydraulic loading thereby reducing discharge of effluent to groundwater and increasing phosphorus removal. Hydraulic loading can also be reduced by expanding the septic systems of summer cottages which have been converted to permanent residences. There are a variety of other household practices that can be altered to reduce export of bacteria and nutrients from residential properties including use of low phosphorus-containing detergent, organic slow-release fertilizer use, and proper grass clipping and leaf disposal. In addition, education of boat owners could raise awareness of the water quality impacts of improper discharges of sanitary wastes from holding tanks.

Public education could be achieved through public meetings, distribution of educational materials, seminars, newspaper and TV coverage, and coalition building. A meeting could be held in the form of a symposium in which a variety of pollution control related subjects could be discussed. Meetings could be conducted by the DEP or their consultant with the town and the watershed association in order to answer questions and present educational material. Educational materials could be distributed which describe the nature of water quality problems and behavioral modifications which may help to alleviate those problems.

Summary of BMP Assessment

A summary matrix of the various BMP's considered for use in the Snell Creek watershed is presented in Table 4-3. In this table, the BMP's are compared against the criteria defined at the outset of the chapter.

Based on the results of this assessment, the following BMP's are selected for incorporation into the recommended plan:

- Agricultural
    - Fertilizer and water management
- Urban Runoff
    - Infiltration practices at Eel Pond and Phinneys Harbor at Chester Park
    - Selected source controls through public education
- Institutional/Nonstructural
    - Regulation and Enforcement
    - Public Education

TABLE 4-3 (Continued). **SUMMARY OF BMP ASSESSMENT**

BMP	Technical Feasibility	Monetary Factors Capital	O&M	Funding	Water Quality Improvements	Public and Agency Support	Other NPS Control Efforts	Demonstration Value	Comments
Beneficiaries Financing	-			-	+	-	-	+	• Complex organizational requirements
Public Education	+	Moderate	Low	+	+	+	+	+	• Builds public awareness and support

+ = Favorable, Present
- = Unfavorable, Not Present

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CHAPTER 5

NONPOINT SOURCE MANAGEMENT PLAN

This chapter integrates the steps required to implement the best management practices recommended in Chapter 4. Each BMP is described and information is also provided on critical elements of BMP implementation including:

- Responsibilities of the municipality, DEP, consultants, and other involved parties
- Implementation schedule including planning, design, construction, and monitoring
- Cost estimates for design, construction and monitoring

In addition, institutional and regulatory aspects of the implementation are discussed including consistency with local, state, and federal regulations; funding sources; and permitting requirements.

Recommended Plan

The recommended plan for the watershed of Phinneys Harbor consists of several major elements including:

- Enhance existing water quality sampling programs
- Implement agricultural best management practices at the Alden and Baptiste cranberry bogs
- Implement stormwater best management practices at Beach Boulevard and Burtonwood Avenue, Carlton Road and Chester Park
- Utilize existing environmental regulations and enact additional local zoning or conservation bylaws oriented toward nonpoint source control
- Conduct a public education program
- Conduct pre- and post-implementation BMP monitoring and wet and dry weather sampling
- Water quality analysis

These recommendations are described in detail in the following sections.

Enhance Existing Water Quality Sampling Programs. As discussed in Chapter 2, water quality sampling efforts have been conducted by the state and the town of Bourne. These data allow a general assessment of water quality, but optimization of sampling program locations, frequencies and parameters would allow more quantitative assessments to be made. In order to optimize existing sampling programs, it is recommended that a sampling protocol be developed for use by organizations collecting water quality data in Phinneys Harbor and Back River and that the DEP and the Town of Bourne coordinate to maximize sampling efforts.

Sampling Protocol - The Bourne Board of Health should adopt a sampling protocol in order to establish a more quantitative water quality database to supplement that established in previous years. It is recommended that the town's sampling efforts be expanded to include nutrients and that flow data be collected where possible. This data collection protocol should be implemented immediately and followed for all subsequent sampling including during and after implementation of BMP's. Sampling information should be recorded in a format compatible with the database established for this project as described in Chapter 2, which could easily be adapted to other data management systems such as STORET, DATATRIEVE, RBASE or DBASE. Field and laboratory data should be recorded on data sheets similar to that presented in Appendix B with data fields including:

Collection Program	-	eg. Massachusetts Shellfish Monitoring Program
Sample Number	-	Program Specific
Laboratory Number	-	Program Specific
Station Number	-	Station number should be consistent with past programs and a graphic and verbal description of the station should be recorded
Date Collected	-	Month/Day/Year

Time Collected	-	Hour/Minute
Date Analyzed	-	Month/Day/Year
Sampling Technique	-	Grab or Composite
Tide Stage	-	Low, High, Flood, Ebb
Parameter	-	Refer to parameter code list in Appendix B
Concentration	-	Of Constituent
Units	-	Milligrams per liter for conventional parameters and #/100 milliliters for bacteria analysis
Flow	-	As recorded at the time of sampling in cubic feet per second or in liters per second as appropriate for extreme low flow conditions
Rainfall	-	Record rainfall on the day the sample is collected and on the previous day
Laboratory	-	Indicate the name of the laboratory that conducted the analysis
Analytical Technique	-	EPA or Standard Methods identification number and detection limits
Comments	-	Any special comments related to field conditions or observations

New sampling procedures should be adopted to ensure the representativeness and comparability of the data sets being assembled. Representativeness is defined as the extent to which data define an environmental condition. In order to achieve this goal, samples must be collected at consistent locations, and accurate flow and weather conditions must be recorded. Data sets being collected at different times and places by different groups using the same procedures can be made comparable by coordinating efforts. The ability to compare data sets is particularly critical when a set of data for a specific parameter is applied to an action level, permit limits, criteria or standards (Fairless and Bates, 1989). For example, appropriate detection limits should be selected to insure that field program objectives are met. Field samplers must be familiar with the objectives of the sampling program so that appropriate logical choices can be made in response to changing field conditions. Exact station locations must be selected to facilitate flow measurements and sampling station locations should be marked on a map.

Interagency Sampling Effort Coordination - It is recommended that the DEP and the Town of Bourne attend a meeting to maximize sampling efforts. Through a meeting and a tour of the area, the group could agree on exact sampling locations, coordinate sampling schedules to distribute sampling temporally to avoid duplication of effort, and coordinate maintenance of the database established by the Bourne Board of Health.

Agricultural Best Management Practices. As discussed in Chapter 3, recent studies on the impact of cranberry bogs on water quality are not conclusive and impacts may depend on practices at individual bogs. Due to potential impacts on Back River and Phinneys Harbor from cranberry bogs, it is recommended that agricultural best management practices be implemented at the Alden and Baptiste cranberry bogs. In this section, conceptual plans, developed in close consultation with the Soil Conservation Service, are outlined for each operation.

Alden Cranberry Bog - Mr. John Alden and the Soil Conservation Service have developed an agreement to implement conservation measures on this 14-acre cranberry bog. The plan, depicted in Figure 5-1, involves measures to retain water and consists of a five acre-foot water impoundment reservoir to be used to store floodwaters for pest management and as a tailwater recovery system to store and retain pesticide and nutrient contaminated water. The pond will also serve as a reservoir for irrigation management and frost protection. The components of the tailwater recovery system include conveyance pipe, water control structures, transfer pipe and a bypass canal. The Soil Conservation Service is currently conducting detailed design of the reservoir and the tailwater recovery system. Construction of the impoundment reservoir is planned in spring of 1990 with the water control structures, transfer pipe

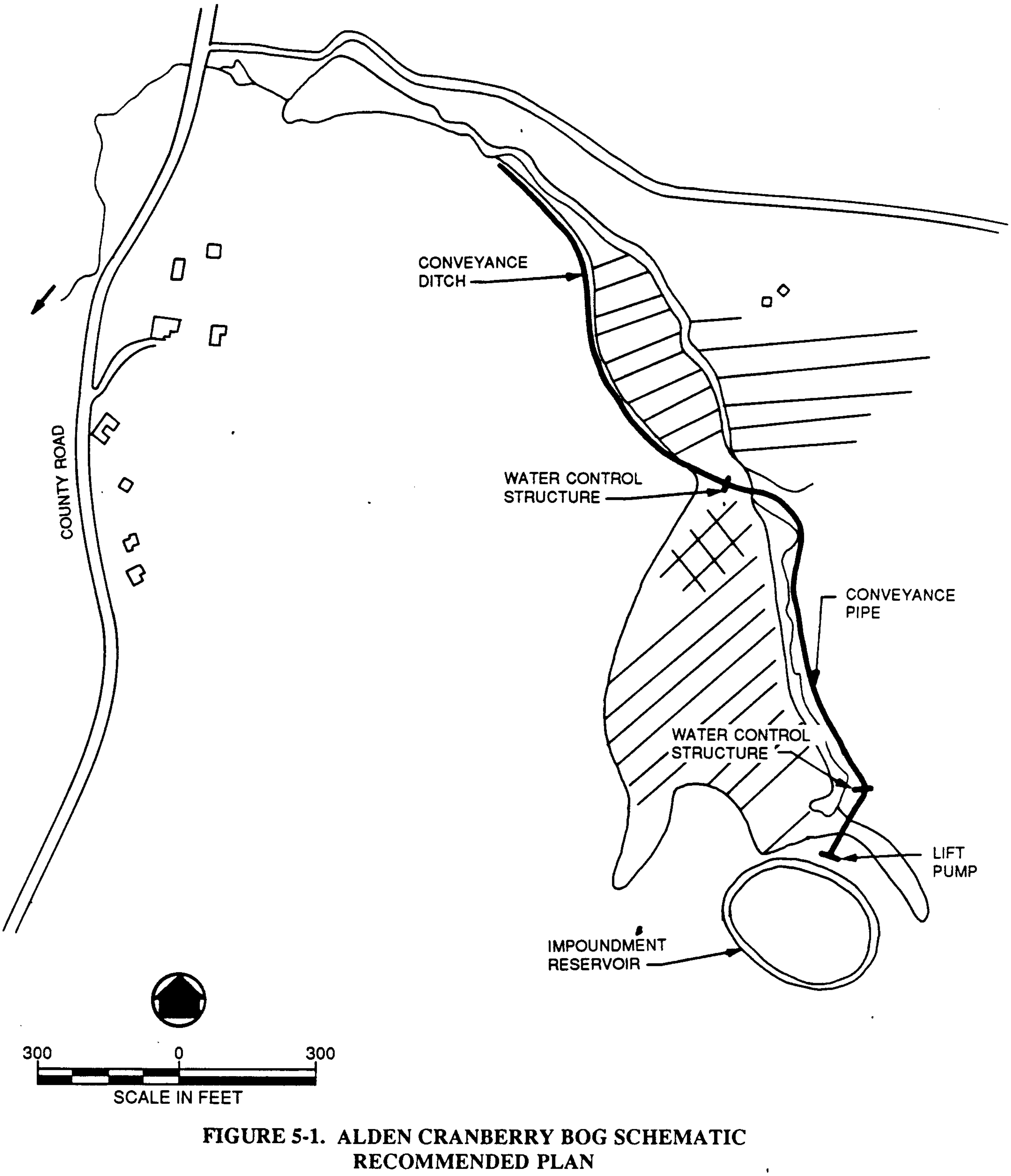


FIGURE 5-1. ALDEN CRANBERRY BOG SCHEMATIC RECOMMENDED PLAN

and appurtenances in the summer and fall of 1990. The Soil Conservation Service estimates the cost of this construction at $32,000 (Liptack, 1989).

Baptiste Cranberry Bog - During development of this conceptual plan, Mr. Peter Baptiste was contacted by the Soil Conservation Service to investigate his interest in implementing conservation measures on his cranberry bog. Although he was not available for a meeting due to his work schedule, he expressed interest and stated that he would be able to meet in the future. On August 23, 1989 Metcalf & Eddy and the Soil Conservation Service conducted a site visit to investigate opportunities for water management. As with the Alden bog, there appear to be a number of opportunities to improve water retention including construction of an impoundment reservoir and upgrades and modifications to water control structures and the irrigation system. The water retention pond could be used to collect and reuse pesticide and nutrient contaminated water. Water control structures and the irrigation system could be modified to provide more efficient control and retention of water in the upper bogs for nutrient control.

During the site visit, it was apparent that several of the cranberry bogs were contiguous with emergent freshwater wetlands. This does not allow separation of irrigation water for fertilization and pest control from other surface waters entering Back River. One method of achieving this separation is through construction of low flow dikes between the cranberry bogs and adjacent wetlands. This method, however, would be expensive and could result in significant adverse wetland impacts. Figure 5-2 depicts a conceptual design for this bog, developed in close consultation with the Soil Conservation Service, including three water control structures, a water impoundment reservoir and two low flow dikes.

It is recommended that the Soil Conservation reestablish contact with Mr. Baptiste, conduct a site visit with him to obtain information on the details of his operation, and discuss methods of controlling nutrient export from the bog. It is recommended that an agreement be developed between him and the Soil Conservation Service to implement best management practices. In order to keep this bog on a schedule consistent with the Alden bog,

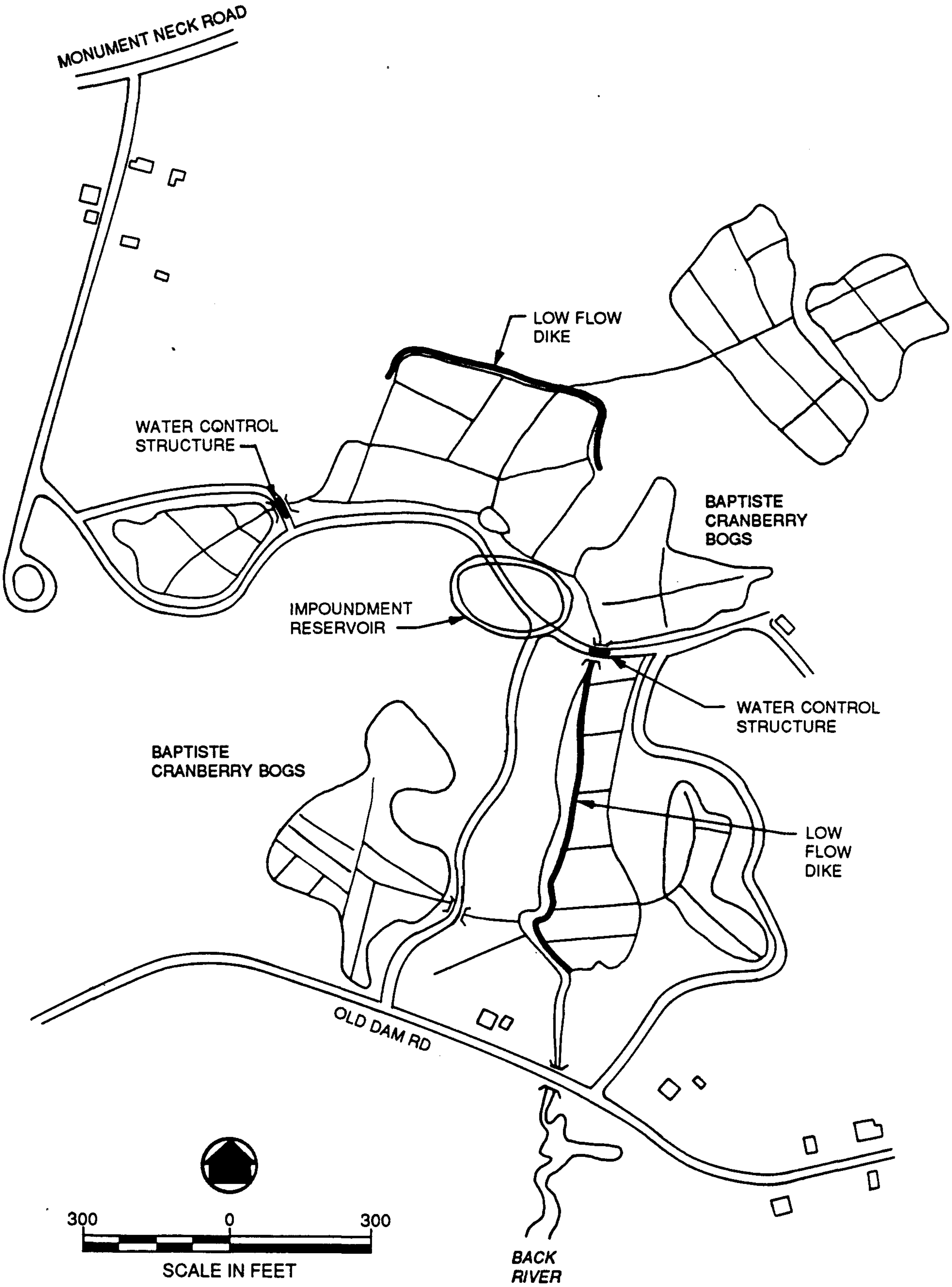


FIGURE 5-2. BAPTISTE CRANBERRY BOGS SCHEMATIC RECOMMENDED PLAN

Mr. Baptiste should be contacted immediately and water control structures and irrigation improvements should be implemented during 1990, if possible. Due to the wetland impacts associated with construction of the low flow dikes, careful fertilizer management should be used to control release of nutrients to the adjacent wetlands. Costs were not developed by the Soil Conservation Service due to lack of design information. However, absent the low flow dikes, these improvements are very similar to the measures being developed for the Alden Bog and will likely cost at least $30,000.

Stormwater Best Management Practices. There are three drainage systems directing runoff into the surface waters of Phinneys Harbor and Back River. The recommended plan to reduce bacteria and nutrient loading from these sources includes using dry wells and leaching galleys to promote infiltration of rainfall and reduce direct discharges to surface waters. The recommended plans for areas adjacent to Eel Pond and Phinneys Harbor require the design of structural modifications to the existing drainage systems. These designs are based upon a one inch/hour intensity, 1/2 hour duration rainfall event. In an EPA-sponsored study, Water Quality Management Planning for Urban Runoff (EPA, 1974), it was found that during the first 1/2 inch of rainfall an intensity of one inch/hour for 30 minutes is considered sufficient to remove 90 percent of pollutants from pavement. Also, over 90 percent of the rainfall events occurring produce less than one inch of precipitation and even fewer have intensities greater than one inch/hour. Therefore, designing the infiltration systems for this one inch/hour intensity and providing overflows for greater intensity storms results in treatment of more than 90 percent of the rainfall runoff. In addition, an urban runoff BMP manual from the Metropolitan Washington Council of Governments (1987) states that designing infiltration structures for a one inch/hour storm results in 90 percent removal of bacteria from runoff. Thus, these structures are sufficient for effective pollutant removal and are significantly smaller than structures designed for 10-year or 25-year design storms. Conceptual design information for storm drain improvements in three areas of the watershed of Phinneys Harbor is provided in the paragraphs below.

Beach Boulevard/Burtonwood Avenue - The drainage system outleting to Eel Pond between 50 and 52 Beach Boulevard consist of two catchbasins located on Beach Boulevard at its intersection with Burtonwood Avenue. These two catchbasins collect runoff from approximately 2.5 acres of residential land directly west of Eel Pond and discharge it directly to the surface water. The recommended plan for this drainage system involves adding a dry well sized to detain the runoff resulting from the first 1/2 hour of a one inch/hour storm. As shown in Figure 5-3, this dry well will be placed in the road right-of-way, and the outlet to Eel Pond will be maintained as an overflow during large storms. In addition, the existing catchbasin outlets should be retrofitted with hoods to prevent floatables such as oil and grease from entering the dry wells and clogging the system. These system modifications will provide infiltration of rainfall thereby reducing the level of pollutants entering Eel Pond.

Carlton Road - The drainage system outleting into the southern end of Eel Pond consists of 14 catchbasins draining the land around Eel Pond Road and Carlton Road. These catchbasins collect runoff from 17 acres of residential land directly south of Eel Pond. The recommended plan for this drainage system involves installing dry wells sized using the same criterion as above. As shown in Figure 5-4, seven dry wells are located throughout the system and each collects runoff from 500 to 1000 feet of roadway. The existing drainage system should be maintained as an overflow system to direct large flows to Eel Pond. As for Beach and Burtonwood, the existing catchbasin outlets should be retrofitted with hoods.

Chester Park - Unlike the other two direct discharge drainage systems which discharge to Eel Pond, the Chester Park system outlets directly to Phinneys Harbor. This drainage system collects runoff from six acres of land consisting of approximately two acres of commercial land with the balance being residential. Data from the Bourne Board of Health (1988) indicate that this drainage system is the largest fecal coliform source in the Phinneys Harbor watershed.

The recommended plan for this drainage system involves installation of leaching galleys, dry wells and a gross particle separator. It is recommended that leaching galleys be installed under the playground area of Chester

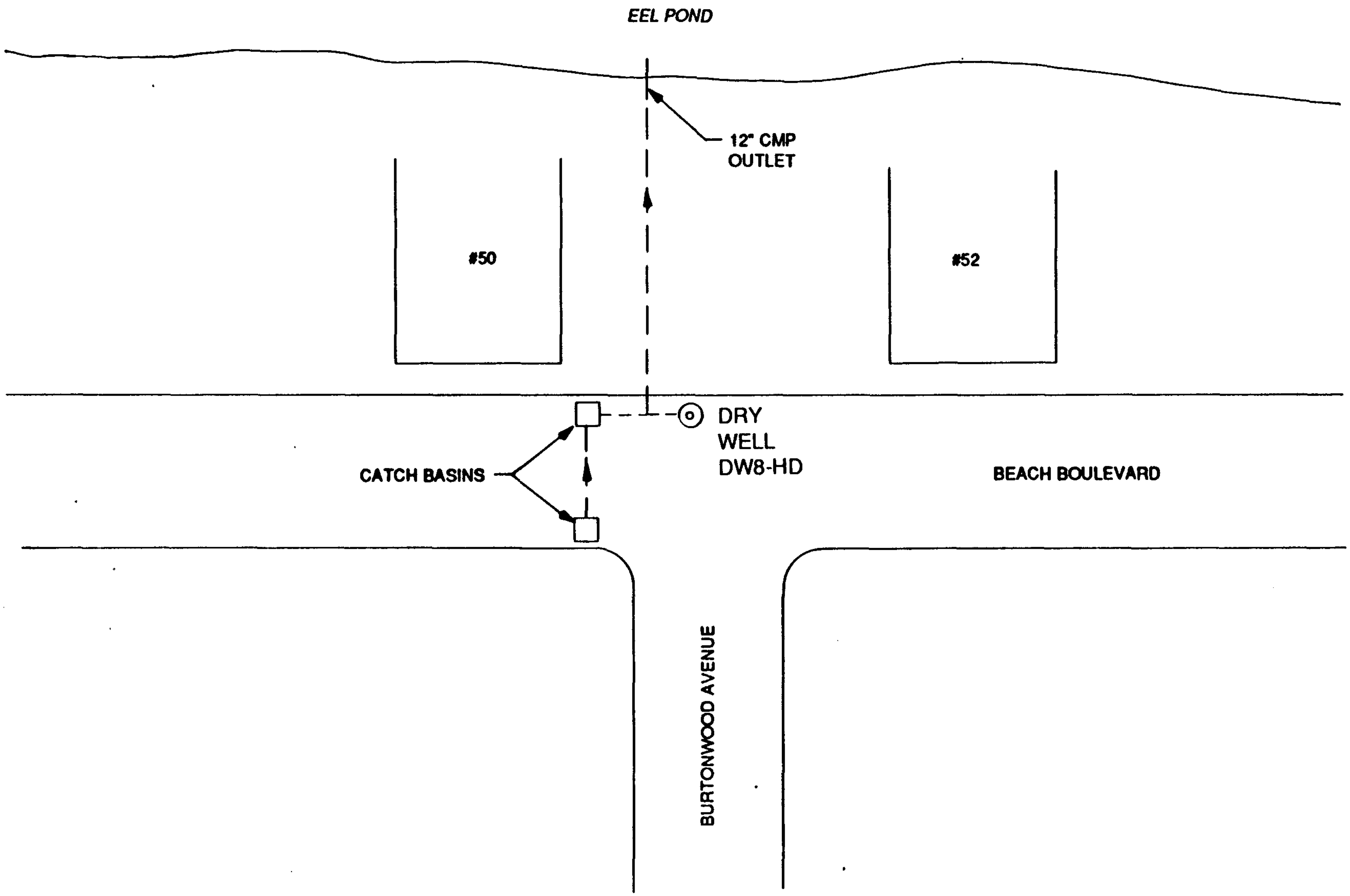


FIGURE 5-3. BEACH BOULEVARD/BURTONWOOD AVENUE RECOMMENDED DRAINAGE MODIFICATIONS

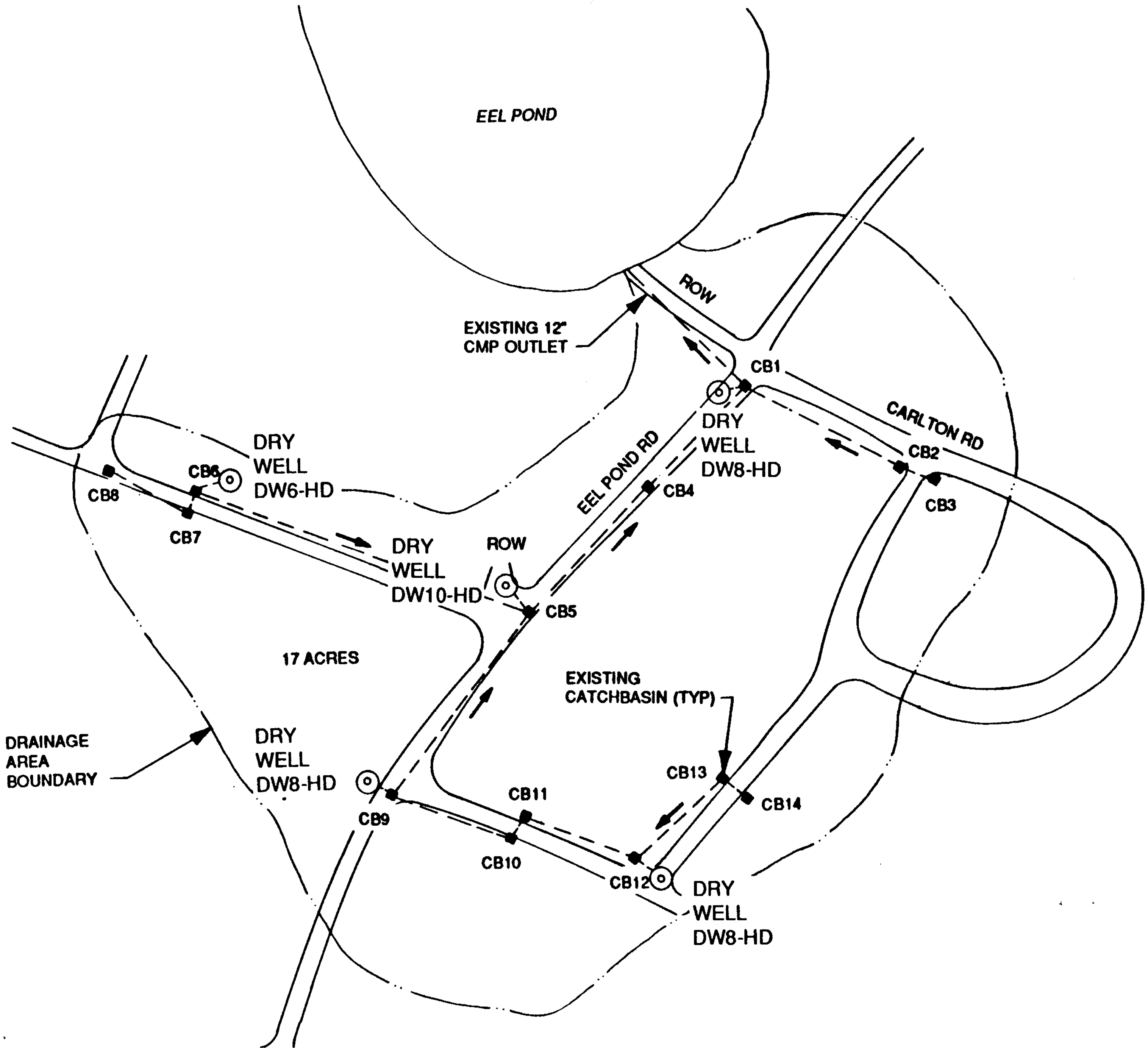


FIGURE 5-4. CARLTON ROAD RECOMMENDED DRAINAGE MODIFICATIONS

Park. Since the drainage area has a high runoff rate, it is also recommended that dry wells be installed in the two existing catchbasins near the intersection of Beach Street and Shore Road to treat a portion of the first flush from the commercial areas of the drainage basin. These dry wells will be similar in design and function to those used near Eel Pond.

The recommended system configuration is illustrated in Figure 5-5. In addition to the leaching galleys, this system includes a gross particle separator for pretreating the runoff and reducing clogging of the system. This separator removes floatables and promotes settling of suspended sediments. Therefore, it must be periodically cleaned, usually twice per year. Figure 5-6 illustrates a typical dry well configuration. Figures 5-7 and 5-8 show a more detailed conceptual plan and cross sections of the gross particle separator, distribution box and leaching galleys for Chester Park.

As discussed in Chapter 2, the town of Bourne Department of Public Works has installed various infiltration structures at Electric Avenue Beach as part of the Buzzards Bay program. This program involved installing dry wells similar to those recommended for the Phinneys Harbor watershed as well as a gross particle separator and leaching galleys like those recommended for Chester Park. By purchasing the necessary materials and utilizing Department of Public Works personnel to install the Phinneys Harbor watershed infiltration structures, the town of Bourne can realize a substantial savings over using a private contractor. Therefore, it is recommended that the installation procedures used at Electric Avenue Beach also be used within the Phinneys Harbor watershed. Funding for this recommendation could be sought through the EPA Buzzards Bay Project Minigrants program should additional funds become available. Maintenance of the facilities should be conducted by the town.

Regulatory Controls. In order to develop a BMP aimed at preventing increased pollution loading from proposed development, a two-phased approach is recommended. Initially, a standard order of conditions should be developed which would prevent substantial increases in bacteria load (as well as nutrient and solids load). Secondly, a bylaw should be developed and ultimately adopted which would be specific to runoff pollution control. The

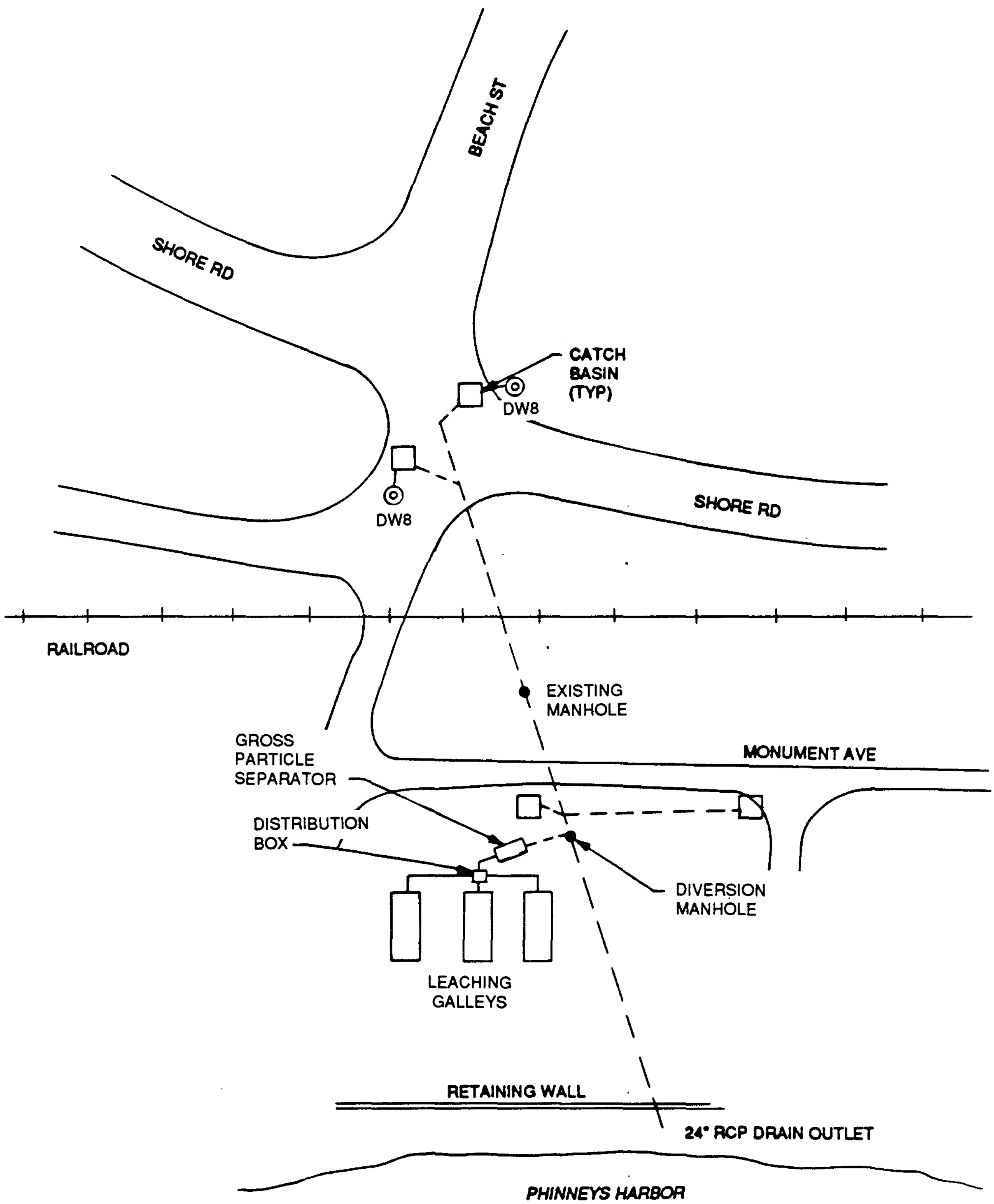


FIGURE 5-5. CHESTER PARK RECOMMENDED DRAINAGE MODIFICATIONS

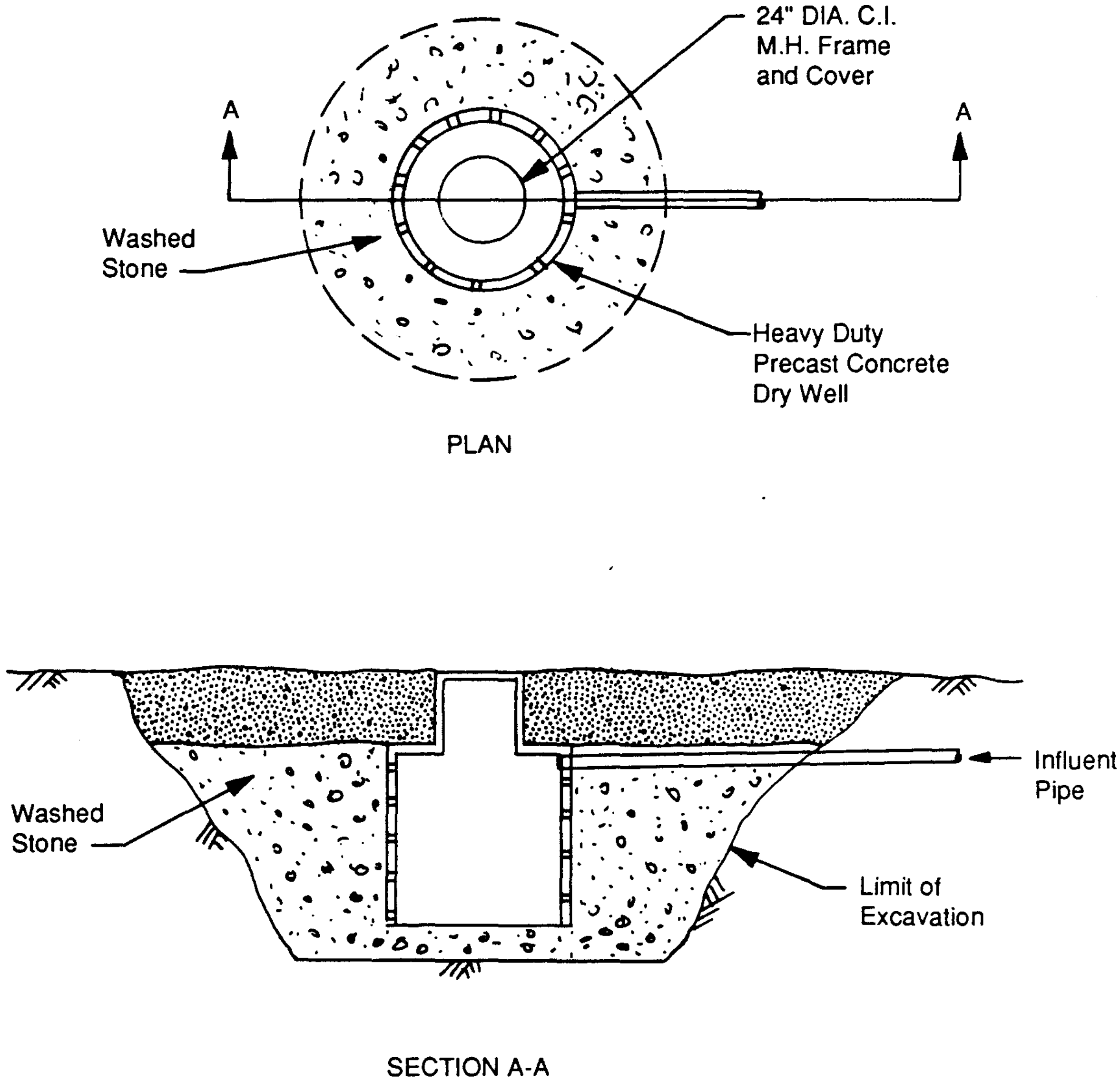


FIGURE 5-6. TYPICAL DRY WELL

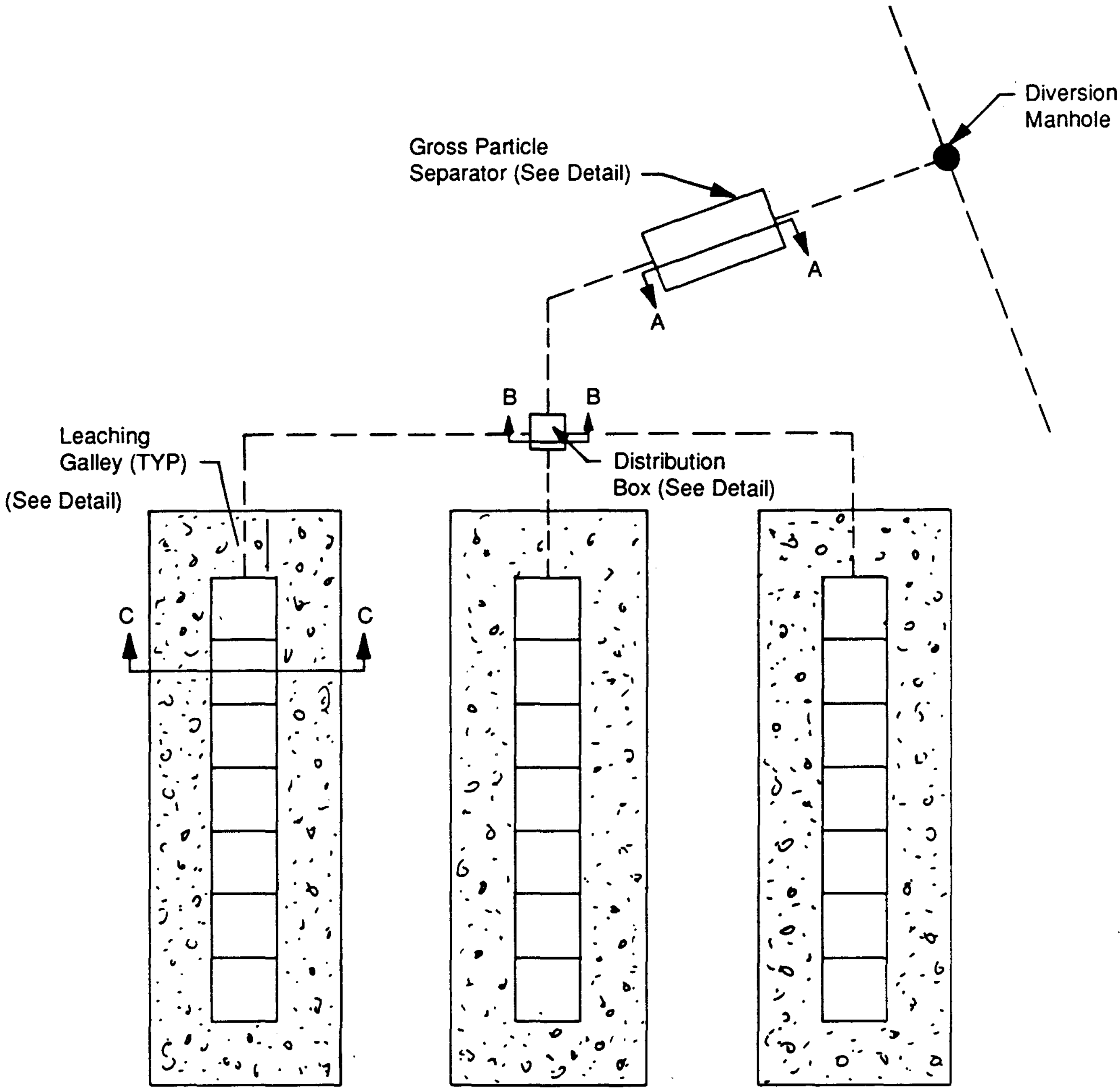
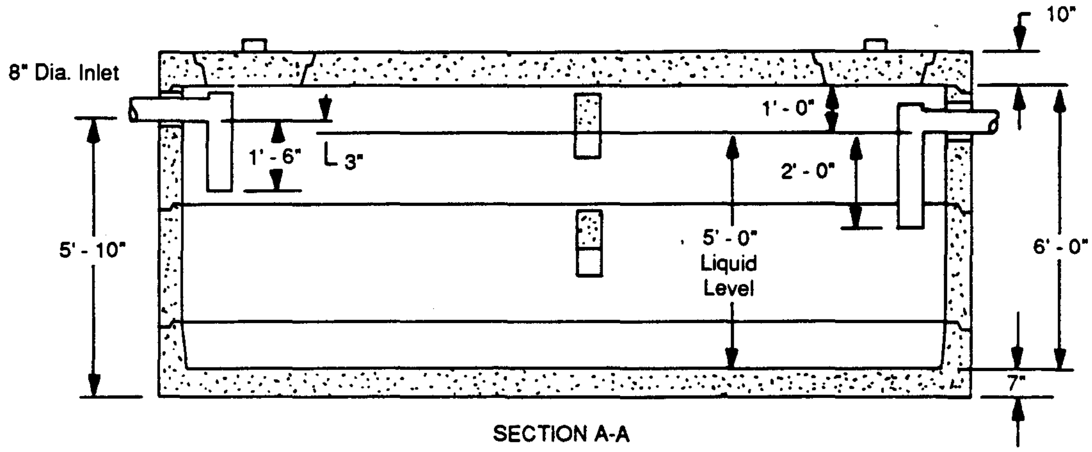
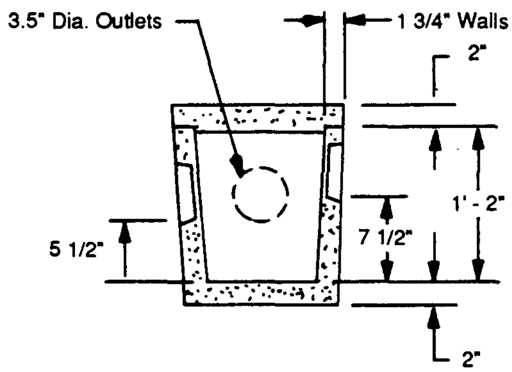


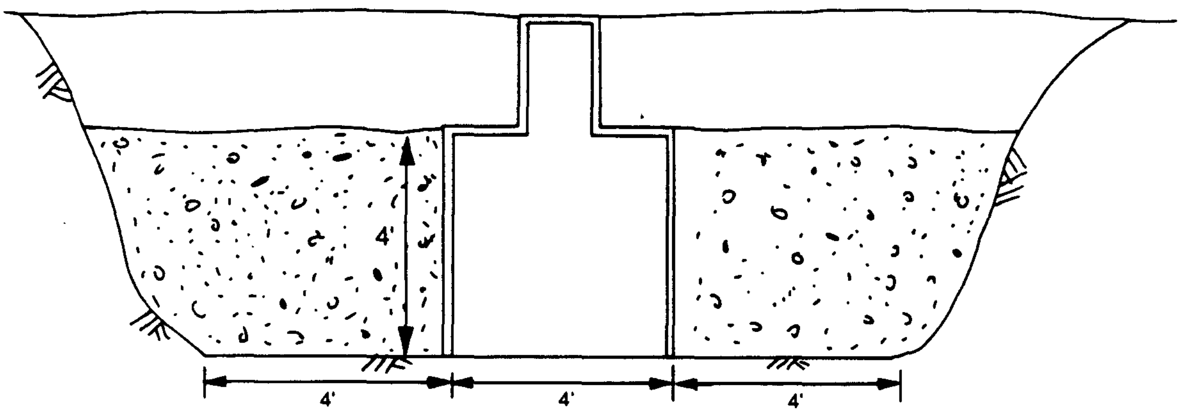
FIGURE 5-7. CHESTER PARK LEACHING GALLEY PLAN



SECTION A-A



SECTION B-B



SECTION C-C

FIGURE 5-8. CHESTER PARK STRUCTURAL DETAILS

standard order of conditions should be developed by the Bourne Conservation Commission with assistance from the DEP or their consultant. Once developed, coordination with the conservation commission, board of health, and planning board would be required to obtain concensus on the intent, wording, and appropriate instances for its use.

Second, it is recommended that the town consider development of additional pollution control bylaws. Currently, a pollution control bylaw is under development as part of the Buzzards Bay project which can be used as a model. For development of a town bylaw, it is proposed that the Massachusetts CZM, in conjunction with the Buzzards Bay program as well as other shellfish protection efforts, be responsible for drafting language. These proposed regulations could provide a model for most coastal areas in the Commonwealth. Taking this approach, involved communities such as Bourne would then be given an opportunity for review and input. Finally, the town itself would be responsible for its adoption, with any appropriate changes. In addition, it is recommended that the town of Bourne review and scrutinize the potential means of water pollution control outlined in Table 4-2 as well as the specific suggestions outlined in Chapter 4 to assist in developing an appropriate set of local pollution control bylaws.

Public Education Program. Although no septic system outbreaks were discovered during field reconnaissance efforts, many septic systems in the area are not in compliance with Title V. Occasional outbreaks and groundwater impacts could be reduced by proper maintenance of septic systems and by improved practices in the home. Short of a mandatory program of septic tank maintenance, improved maintenance could be accomplished through a public education/outreach program. Since it would be impractical to approach only residents in the watershed of Phinneys Harbor, it is recommended that a town-wide education program be conducted. The recommended public education program would consist of:

- A public meeting
- Distribution of education materials

- Media coverage through newspaper articles and cable TV, and

- Coalition building through the Bourne Board of Health and local environmental groups like the Monument Beach Civic Association and the Coalition for Buzzards Bay

Through surveys conducted under the Massachusetts Clean Lakes Program, septic tank owners frequently are not aware that their system is undersized or that it should be cleaned and inspected on a regular basis. Proper septic system use and maintenance is of particular concern. Poor household practices often contribute to system failure or overload; a few examples are indicated as follows. Cooking grease can be containerized in regular household refuse; paper products, tissues, plastic wrap and aluminum foil also can be disposed of in the home garbage. White toilet paper should be used instead of colored tissue, because the latter inhibits bacterial processes. Hazardous and toxic household substances (e.g., paints, solvents, disinfectants, lubricating oil, medicines, etc.) should never be placed into the on-site system, and should be disposed of at an acceptable off-site location. Large quantities of vegetable and fruit waste and coffee grounds should go into the home garbage or be composted.

A public meeting could be held in Bourne in the form of a symposium on water quality to educate septic tank owners on harmful activities, such as improper garbage disposal use, and on means of reducing hydraulic loading such as water-saving showerheads, and proper maintenance procedures, including regular pumping and inspection. Additional subjects that could be addressed as part of the symposium include:

- A demonstration project update to report on the status of implementation of other recommendations by the Division of Water Pollution Control.

- An update on other pollution control efforts ongoing in the town by the Bourne Board of Health

- An update on the Comprehensive Conservation and Management Plan being prepared for Buzzards Bay by Coastal Zone Management

- An update on the development of the Massachusetts Nonpoint Source Program by the Division of Water Pollution Control

The meeting/symposium could be organized by the Division of Water Pollution Control or their consultant with assistance from the Bourne Board of Health and Selectmen's Office, and the Monument Beach Civic Association. The meeting or symposium should be advertised by local and regional newspaper articles; newsletters such as EPA's Buzzards Bay Project newsletter and CZM's Coastlines; notification of project advisory group members and town officials; posting in public buildings; and through cable TV advertising and coverage.

Additional public outreach can be achieved through distribution of educational materials. Previously prepared materials which could be used directly or adapted for use in Bourne include documents prepared by the New Jersey Department of Environmental Protection (1987) as recently adapted by the Westport River Watershed Alliance for use in Westport, Heufelder (1989), and the Lake Cochituate Watershed Association (1985). These materials could be prepared by the DWPC or its consultant with assistance from the Bourne Board of Health, and should describe the nature of local water quality problems and behavioral modifications that could help to alleviate these problems such as septic tank maintenance, reduced water consumption and solids loading. These educational materials could be distributed town-wide using a number of town and private mailing lists and could be distributed widely as an insert to the EPA and CZM newsletters described above. Public education can be enhanced by newspaper articles, cable TV advertising, and coalition building through cooperation between town departments such as the conservation commission and health department and local environmental groups such as the Monument Beach Civic Association.

BMP Effectiveness Sampling. Phinneys Harbor and Back River fecal coliform bacteria levels increase dramatically during wet weather, resulting in shellfish standard violations. While ongoing sampling programs will provide baseline data over some conditions, it is recommended that wet and dry weather sampling be conducted by the Division of Water Pollution Control, or its consultant. A detailed protocol should be developed for this sampling effort, modelled after the protocol developed earlier in this section for routine sampling programs, with the following amendments:

- Sample multiple stations within Phinneys Harbor and Back River
- Sample suspected sources (such as stormdrains at Eel Pond and Chester Park) and in receiving waters in these areas
- Conduct sampling of sources at regular intervals including the first flush and for a period before, during, and after a storm event
- Analyze samples for bacteria and nutrients

The wet weather data will be used for source quantification and BMP effectiveness evaluation, and will allow calculation of wet weather loading to Phinneys Harbor and Back River. Dry weather sampling will provide baseline data on nutrient concentrations not available in the existing database. In order to provide data before and after BMP implementation in the vicinity of suspected sources, it is recommended that water quality samples be collected at the three stormdrains recommended for modification, near the outlets of the two cranberry bogs, in the vicinity of suspected septic tank problems and near the marina in Phinneys Harbor. During wet weather, samples should be collected at regular intervals at each station for a minimum of 4 to 8 hours depending on the size of the storm. Samples should be properly preserved and handled and should be analyzed for bacteria, nutrients, and solids. Flow data should also be collected at the stormdrains at each sampling interval. Samples should be collected on two wet weather and two dry weather occasions prior to implementation and during similar meteorological conditions on two occasions after implementation.

The sampling recommendations outlined above should be implemented as soon as is practical. A suggested schedule is outlined later in this chapter. These efforts could be conducted by the DEP, through a cooperative interagency effort, or through a contract with a consultant. The sampling effort could be supplemented by other agencies already conducting regular sampling by adjusting sampling schedules to collect pre- and post-storm routine samples, and by providing a local meeting place from which to deploy workers and to drop-off, composite and preserve samples.

Water Quality Analysis. Following collection of routine water quality samples before and after construction, as well as pre- and post-implementation wet and dry weather sampling, it is recommended that these data be analyzed. Flow measurements and grab samples collected during this period will allow refinement of loading estimates and will allow an assessment of the success of the recommended pollution control measures. It is recommended that this analysis be conducted by the Division of Water Pollution Control or its consultant.

Implementation Responsibilities

In order to implement the recommendations described in this chapter, extensive cooperation and coordination will be required. Proposed implementation responsibilities for each major component of the program are summarized in Table 5-1.

In order to initiate the implementation phase of this project, several administrative actions must be conducted by the DEP. One administrative task that may be vital to the implementation of all the recommendations described herein is the development of a memorandum of understanding establishing an interagency agreement on specific implementation and funding responsibilities. This agreement would include water quality sampling, analysis and management; design and coordination of agricultural BMPs; design, permitting, construction supervision, and maintenance of stormwater BMPs; public education; and reporting.

Cost Estimates

Preliminary cost estimates have been prepared for each of the major program components described in this chapter and are presented in Table 5-2. Tasks to be conducted by existing programs have not been assigned costs.

TABLE 5-1. IMPLEMENTATION TASKS AND RESPONSIBILITIES

Task	Responsibility
Administrative	
Overall Program Coordination	Division of Water Pollution Control
Develop Interagency Memorandum of Understanding	Division of Water Pollution Control
Water Quality Sampling and Analysis	
Continue Sampling in Phinneys Harbor and Back River	Division of Water Pollution Control Bourne Board of Health Division of Marine Fisheries
Conduct Interagency Sampling Coordination Working Session	Division of Water Pollution Control
Maintain Database for Phinneys Harbor and Back River	Division of Water Pollution Control Bourne Board of Health
Conduct BMP Effectiveness Sampling	Division of Water Pollution Control
Water Quality Analysis	Division of Water Pollution Control
Agricultural Controls	
Develop Water Quality Management Plan for Alden and Baptiste Cranberry Bogs	Soil Conservation Service
Install Cranberry Bog BMPs	Mr. John Alden Mr. Peter Baptiste
On-Site Coordination and Follow-up at Bogs	Soil Conservation Service Agricultural Stabilization and Conservation Service
Stormwater Controls	
Designs, Specifications, and Permitting for Storm drain Modifications	Division of Water Pollution Control Town of Bourne

TABLE 5-1 (Continued). IMPLEMENTATION TASKS AND RESPONSIBILITIES

Task	Responsibility
Construct Storm drain Modifications	Bourne Department of Public Works
Maintenance of Catch Basins, Leaching Galleys and Dry Wells	Bourne Department of Public Works
Institutional/Nonstructural Controls	
Develop Pollution Control Bylaws and Standard Order of Conditions	Coastal Zone Management Bourne Conservation Commission and Planning Board
Prepare and Distribute Educational Materials	Division of Water Pollution Control Environmental Protection Agency Monument Beach Civic Association
Public Meeting/Symposium	Division of Water Pollution Control Monument Beach Civic Association Town of Bourne - all Boards Coalition for Buzzards Bay Environmental Protection Agency Coastal Zone Management
Prepare Press Releases	Division of Water Pollution Control

Schedule

The overall schedule of activities for the implementation phase is outlined in Figure 5-9. The schedule includes water quality sampling and analysis, design and construction, maintenance, monitoring, public education, and regulatory activities.

Regulatory Requirements

This section outlines regulatory requirements associated with the recommended plan. Since no fill is being placed in wetlands or waterways and since no federal permits are required, the only permit that will be required for this project will be an order of conditions for work in the buffer zone and banks of the cranberry bogs as well as coastal beach and bank for work at Eel Pond and Chester Park. Neither MEPA nor NEPA compliance is anticipated to be necessary.

TABLE 5-2. COST ESTIMATES FOR PROGRAM COMPONENTS

Item	Estimated Cost ($)
Water Quality Sampling and Analysis	
Continue Sampling in Phinneys Harbor and Back River	*
Conduct Interagency Sampling Coordination Working Session	*
Maintain Database for Phinneys Harbor and Back River	12,000
Conduct BMP Effectiveness Sampling	40,000
Water Quality Analysis	16,000
Agricultural Controls	
Develop Water Quality Management Plan for Alden and Baptiste Bogs	2,000
Conduct Educational Activities	2,000
Install Agricultural BMPs	
Alden Bog	32,000(1)
Baptiste Bog	30,000(1)
On-Site Coordination and Follow-Up	4,000
Stormwater Controls	
Design	
Engineering Design, Plans, Specifications	30,000
Obtain Permits	12,000
Construction	
Materials	56,000
Labor	*
Construction Supervision	*
Maintenance	3,000(2)
Institutional/Nonstructural Controls	
Develop Pollution Control Bylaw and Standard Order of Conditions	*
Prepare and Distribute Educational Materials	12,000
Public Meeting/Symposium	12,000
Prepare Press Releases	6,000

(1) Rough estimates based on discussions with Soil Conservation Service.

(2) Annual Cost

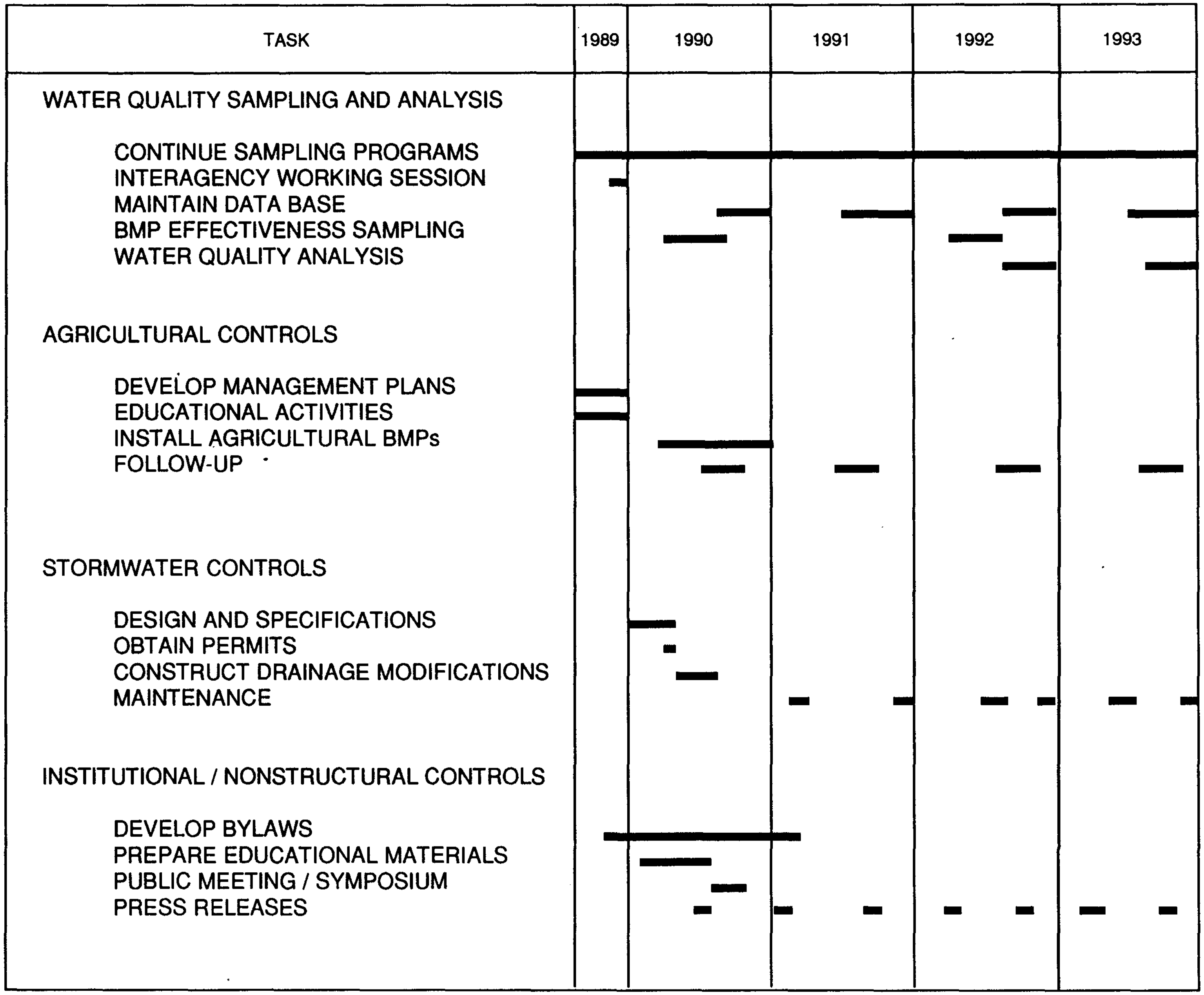


FIGURE 5-9. IMPLEMENTATION SCHEDULE

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