South Shore Nonpoint Source Management Plan

The Towns of:

Cohasset, Duxbury, Hanover, Hingham, Marshfield, Norwell, Rockland, Scituate, Weymouth

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Credits and Acknowledgements

This report was prepared by the staff of the Metropolitan Area Planning Council under the supervision of the Executive Director. The Metropolitan Area Planning Council is the officially designated regional planning agency for 101 cities and towns in the Boston metropolitan area. The Council offers technical assistance to its member communities in the areas of land use, housing, environmental quality, energy, transportation, and economic development.

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Executive Summary

> ***"Nonpoint source pollution is the primary source of surface water and groundwater contamination. It is caused when rainwater or snow melt flows over land that has been altered by human activity, including uses ranging from commercial to industrial to agricultural, and washes pollutants that have accumulated on those land surfaces into storm drains, streams, rivers, and groundwater, and eventually into lakes, streams, or coastal embayments."***
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> *- Nonpoint Source Pollution: A Handbook for Local Governments (Jeer, et al. 1997)*

ES-1 Project Background

This comprehensive water quality project was conducted for nine South Shore communities: Cohasset, Duxbury, Hanover, Hingham, Marshfield, Norwell, Rockland, Scituate, and Weymouth. Funding was provided by the Massachusetts Department of Environmental Protection under a Clean Water Act 604(b) grant, with some supplemental funding provided by the South Shore Coalition, a subregion of MAPC. The project identifies nonpoint source pollution issues, compiles existing water quality data, evaluates existing regulatory measures, and makes recommendations for further action to reduce nonpoint source pollution and improve water quality in the project towns.

The project began with the formation of a regional committee to assist with data gathering and review of project materials. The committee, known as the South Shore Water Resources Advisory Committee, and referred to in this report as the "project committee," consisted of one or two members from each community, appointed by their Board of Selectmen. The committee met eight times over the course of the project, between June 1996 and June 1998.

In addition to the input of the project committee, MAPC staff interviewed local officials in each community, including members and staff from the Boards of Health, Departments of Public Works, Planning Boards and Conservation Commissions. These local officials and the project committee identified water quality issues and provided the basis for much of the information in this report.

One of the objectives of the project was to view water quality conditions and issues from a watershed perspective, consistent with the Commonwealth's Watershed Initiative. Although classified by MassGIS as falling within two major watersheds (the South Coastal Watershed and the Boston Harbor Watershed), the project area actually consists of many independent coastal drainage areas. To better understand water quality issues in terms of watersheds, MAPC, the MassBays Program and the project committee divided the nine towns into 12 "project subbasins" that represent the major river systems and coastal embayments in the project area. These 12 project subbasins are shown on Figure ES-1. To the extent possible, the report presents information by project subbasin.

This project includes several GIS maps, including water resources and withdrawals, land use, water quality monitoring stations, potential pollution sources. The report presents these maps in a reduced scale. The original maps were compiled and printed at a 1:25,000 scale. Each project community has been provided with a full set of the 1:25,000 scale maps.

ES-2 Report Organization & Content

Chapter 1 is a regional overview of land use and water resources. It describes how the project subbasins were created, identifies land use, drinking water supplies, and shellfish bed resources in each project subbasin, and also provides population and employment data and projections by town. This chapter includes GIS maps of water resources and withdrawals and 1990/1991 land use.

Chapter 2 is a compilation of existing water quality data for the project area. The chapter begins with a review of the federally-mandated 305(b) Water Quality Assessment. The bulk of the chapter focuses on the water quality database compiled by MAPC. This database contains 822 fecal coliform samples and 220 nitrate-nitrogen samples collected in the period between 1990 and 1997. Most of these data were collected by or for local watershed organizations. Chapter 2 presents the information in chart and graphic formats. Appendix A provides data summaries by subbasin

Figure ES-1: Study Area & Project Subbasins

Chapter 3 focuses on potential pollution sources in the project area. MAPC developed a potential pollution sources database (Appendix B) and GIS map (Figure 3-1A and B). The database contains 237 potential pollution sources in the nine towns, all of which are shown on the GIS map. The categories of potential pollution sources include septic system problem areas, active and closed landfills and junkyards, confirmed hazardous waste sites, stormwater and wastewater discharge permits, golf courses, sand and gravel or rock mining, road salt storage, and other sites of concern that do not fall into the above categories. In addition, the map shows cranberry bogs and areas of impervious surface greater than 5 acres. Chapter 3 explains how the database was created and discusses potential pollution sources by project subbasin.

Chapter 4 includes a detailed assessment and stormwater modeling for three subwatersheds: the Town Brook subbasin in Hingham, the Aaron River Reservoir subbasin in Cohasset, Hingham, Norwell and Scituate, and the Bluefish River subbasin in Duxbury. Each subbasin supports a sensitive water resource, such as drinking water wells or reservoirs, shellfishing and/or bathing. The P8 Urban Catchment Model (developed for the Narragansett Bay Project) was used to estimate stormwater runoff volumes and pollutant loads for the three subbasins under baseline (1991) and projected year 2020 conditions. The subbasin assessments and stormwater modeling results are contained in Chapter 4 and Appendix C.

Chapter 5 and Appendix D contain a review of local bylaws, regulations, and management practices relative to water quality, along with town-specific recommendations.

Chapter 6 contains nonpoint source management recommendations that are applicable to all of the towns. Appendix E features several model programs that have addressed septic system problem areas. Appendix F contains model bylaws and regulations.

ES-3 Findings & Recommendations

ES-3.1 Data Needs

Findings

The Commonwealth's Watershed Initiative includes an "assessment year" as part of the five-year cycle for each of the state's 27 major watersheds. While this presents an excellent opportunity for understanding environmental quality in the watersheds, state resources devoted to assessment have been very minimal for most watersheds. At present, the state does not have enough statewide staff or resources to conduct meaningful watershed assessments.

Water quality data is sparse and sporadic. The Massachusetts Division of Marine Fisheries (DMF) conducts monitoring of shellfish growing areas. Outside of these areas, watershed associations are the primary source of fecal coliform and nitrate-nitrogen data (the two parameters in the MAPC database). Of the 1,042 fecal coliform and nitrate samples in the MAPC database (which does not include DMF data), 912 were collected by or for local watershed associations. The North and South River Watershed Association and the Fore River Watershed Association conduct routine monitoring of some locations, but for many rivers, tributaries and embayments there is no baseline or routine monitoring. It is often difficult for watershed associations to utilize state or federal funding for water quality monitoring because of the substantial requirements for Quality Assurance Project Plans (QAPPs) and the lack of standardization of sampling and analytical techniques.

Recommendations: Data Needs

- The Commonwealth's Watershed Initiative should be backed up by substantial resources for environmental monitoring in the "assessment year" of the five-year program cycle.
- Additional resources should be provided to the Division of Marine Fisheries to conduct sampling, analysis and assessments of shellfish growing areas. Staff resources and laboratory capacity are severely overburdened.

Recommendations: Data Needs (cont.)

- If watershed or other "grassroots" organizations are going to continue to collect the majority of water quality data, they need to have the tools and the funds to conduct this charge. To the extent possible, sampling and analytical methods should be standardized, and requirements for Quality Assurance Project Plans should be clarified and streamlined.
- Follow-up monitoring and analysis could be utilized to determine whether bacteriological contamination originates from human or animal wastes. Sampling for *enterococcus* bacteria, or utilizing analytical methods being developed at the Commonwealth's Lawrence Experiment Station, could be helpful.
- Communities and the EOEA Basin Team should use monitoring data to help guide decisions about pollution remediation needs.

ES 3.2 Wastewater

Findings

One of the major pollution problems identified in the nine South Shore towns is that of failing on-site wastewater systems. Failing septic systems can contribute to the closure of shellfish beds and swimming beaches, as well as cause a general degradation of water quality. All of the predominantly unsewered communities noted several septic system problem areas. Many areas of the South Shore have no available alternative to on-site wastewater systems, yet they have conditions that will inevitably lead to system failure, including soils that do not percolate well, and shallow depth to bedrock or groundwater. Many septic system problem areas are located in dense developments where there is insufficient room to construct new systems.

The project identified 50 septic system problem areas, based on interviews with local Board of Health Agents and other local officials. See Chapter 3 and Appendix B for more information about these areas. Commercial and industrial areas with septic system problems include:

- Route 53 (Washington Street) area in Hanover and Norwell,
- Downtown Marshfield, where the Board of Health is trying to encourage businesses to install tight tanks,
- The South Shore Industrial Park in Hingham, and

- Industrial Way in Hanover where there are old, substandard systems located in groundwater.

Of the nine project towns, only Weymouth and Rockland are more than 90 percent sewered. There are four wastewater treatment plants in the project area, serving the towns of Cohasset, Marshfield, Rockland and Scituate. The plants for the three coastal towns discharge to the coast. Rockland's plant discharges to French Stream, at the headwaters of the Indian Head/North River basin. The MWRA sewer system serves about 17 percent of the town of Hingham and over 90 percent of the town of Weymouth. Hanover and Norwell have no municipal sewer system. Duxbury has a small municipal treatment plant at the High School, Middle School, Elementary School, Old and New Libraries, and municipal swimming pool. In addition Duxbury's section of the Gurnet Road Area north of Duxbury Beach serves Marshfield's wastewater treatment plant. The Snug Harbor and Bluefish projects are both Public/Private collection systems using forced flow to off-site leaching fields.

In Cohasset and Scituate, the towns are proceeding with wastewater treatment plant upgrades and expansion of the sewer service area to serve areas with high percentages of failures. Marshfield's sewage treatment plant has excess capacity, but Town Meeting has twice voted down expansion of the sewer area to serve the downtown area, over concerns that sewers will bring unwanted development.

Some sewered areas suffer chronic sewer surcharging during wet weather, which can have impacts on swimming beaches, shellfish beds and drinking water resources. Sewer surcharging is caused by a number of factors, including infiltration and inflow, insufficient capacity, and/or insufficient gradient. In Weymouth, surcharging events pose a concern for drinking water quality. This surcharging has a degradation effect which may be cumulative in nature, but the water supplies have not as of yet exhibited permanent damage. The surcharging could represent a conduit for permanent contamination under catastrophic conditions.

Recommendations: Wastewater

- Towns should take maximum advantage of available state funding resources to plan, design, fund and construct wastewater solutions. Available funding sources include:
- The Clean Water State Revolving Loan Fund (or SRF), offered by the Mass. Department of Environmental Protection (DEP), which provides loans that can be used to conduct wastewater management planning;
- The Community Septic Management Program, offered by the DEP, which provides grants and loans to develop Comprehensive Community Septic Management Programs and local betterment loan programs;
- Section 319 Nonpoint Source Grants, offered by the Mass. DEP, which can be used to fund alternative wastewater treatment systems, particularly for problem areas that are adversely affecting ponds or other waterbodies;
- Grant funds from the MassBays Program, which can be used to remediate wastewater problems that are contributing to the closure of shellfish beds.
- The DEP Bureau of Municipal Services should help towns identify appropriate grant programs, help towns work through the grant process, and otherwise help towns to take full advantage of available funding resources.
- Wastewater management planning can help towns develop a comprehensive understanding of wastewater problems and tailor solutions to each problem area, for example by identifying where shared systems or decentralized treatment plants might be feasible. Towns that have few sewer alternatives and many septic system problem areas (e.g., Duxbury, Hanover, Norwell) or towns that are opposed to expansion of their sewer system (e.g., Marshfield) would likely benefit from wastewater management planning. Multi-town wastewater planning would be useful for the Route 53 commercial corridor, which spans Hanover and Norwell.
- Towns should strive to develop equitable solutions for homeowners burdened by septic system repair costs. Towns should take advantage of “betterment” programs that allow homeowners to repay septic system repair costs over a 20-year period. Betterment funds should prioritize loans based on their environmental sensitivity and degree of failure.

Recommendations: Wastewater (cont.)

- As appropriate, towns should become involved in the planning, design, funding and construction of wastewater alternatives for problem areas. Joint solutions, such as shared systems or decentralized treatment plants, may in some cases provide more equitable and workable solutions than the individual upgrading of many on-site systems, each of which has to be maintained in good working order. In some cases, individual remedies are not feasible because of the lack of space for septic system leaching fields. Duxbury's two innovative shared septic systems in the Bluefish River and Snug Harbor areas provide a good model for town involvement. The town used MassBays grant money, a DEP low-interest loan, and town funds to pay for design and construction. Appendix E provides information on the Duxbury systems and other alternative systems.
- Towns should consider adopting a local septic system management program to help the town track information about on-site systems, including inspection and maintenance records, and proximity to wells and other sensitive resources.
- Chronic sewer surcharging problems should be pursued aggressively, particularly where these problems threaten sensitive water resources such as drinking water supplies or shellfish beds.

ES-3.3 Stormwater Runoff

Findings

Stormwater runoff from roads, highways and other impervious surfaces contributes heavy metals, organic chemicals, oil, grease, salt and sand to local waterways. Several studies have shown that degradation of water quality in rivers and streams is a direct function of the percent of impervious surface in a watershed. Figure 1-2 shows land use in the project area. The potential pollution sources maps (Figures 3-1A and 3-1B) show areas with greater than five acres of predominantly impervious surface.

Developed land uses account for about 39 percent of total land use in the project study area. The project area in the Weymouth/Weir Basin is about 49 percent in developed land uses; whereas the project area in the South Coastal Basin is 36 percent in developed land uses. The range of developed land use by project subbasin varies widely, from 4 percent for the Jones River subbasin (Duxbury only) to 77 percent for the Fore River basin (Weymouth only).

It is clear, based on the many interviews that MAPC conducted with local officials, that local Departments of Public Works (DPW's) need more resources (staff, training, equipment and funding) to upgrade and maintain stormwater infrastructure. Catch basins in most towns are cleaned only once per year, a schedule that may not be sufficient to remove pollutants before they enter waterways.

Many DPWs do not have the staff, training or equipment to properly maintain hooded catch basins or other catch basins designed for removal of oil and grease ("flotables"), although towns are routinely requiring that this equipment be installed in new basins. Proper cleaning requires removal of flotables with a portable vacuum truck, but many communities do not have this equipment or are not subcontracting it. In addition, the hoods on these basins can break during cleaning and are often not repaired due to lack of training, budget or manpower. On the same note, community officials noted the lack of staff or equipment to properly maintain structural stormwater infrastructure, such as detention and retention basins, again despite the fact that they are required to be installed in many new developments.

Remediation of current stormwater pollution problems is another clear need. Chapter 4 includes the results from the P8 stormwater model that MAPC ran for three subwatersheds under current and projected future conditions. The model showed that, in areas that are already significantly developed, removal of 80 percent of the Total Suspended Solids (TSS) load from new developments will fail to result in a significant decrease in total TSS loads. In short, stormwater pollution problems cannot be solved by addressing future development alone. Existing problems should be remediated. Many stormwater retrofit technologies are now available to reduce pollutant loads from existing discharges and state programs provide grant and loan funds for remediation of stormwater pollution.

Although some communities (most notably, Duxbury and Marshfield) have adopted strong stormwater controls through subdivision regulations, most other communities could strengthen subdivision and site plan review regulations to address stormwater and erosion/sedimentation impacts. Conservation Commissions are now enforcing the DEP Stormwater Management Standards for projects that fall within wetland buffer zones. In most towns, there are few stormwater requirements for projects outside of the Commission's jurisdiction.

Recommendations: Stormwater Runoff

- Towns need to ensure that they have the staff, training and equipment to adequately maintain stormwater infrastructure. Town budgets should include a line item for maintenance of catch basins, detention ponds and other stormwater infrastructure.
- Local DPWs should consider prioritizing catch basin cleaning schedules to include more frequent cleaning of basins that drain to sensitive environmental areas such as drinking water supplies, swimming beaches and shellfish beds.
- Towns that do not have access to a vacuum truck for cleaning hooded catch basins should consider combining their resources to purchase a regional vacuum truck or jointly hiring a contractor for this service.
- Ongoing communication between Planning Boards and local DPWs is needed to ensure that towns have the access, equipment, training and staff to adequately maintain stormwater infrastructure in new developments. Planning Boards need to communicate the purpose of new planned infrastructure to the DPW to ensure adequate support for routine maintenance and to the public to ensure adequate funding from Town Meeting.
- Towns could revise local bylaws to require private developers to put funds in escrow for future maintenance of stormwater infrastructure. The Buzzards Bay model stormwater regulation (see Appendix F) requires maintenance funds for a 20-year period.
- Towns should take advantage of grant programs to fund stormwater remediation projects. Sources of funding include the DEP's section 319 program, the Mass Bays Grant Program, the Shellfish Bed Restoration Program, the State Revolving Fund, the Transportation Enhancements Program, and the Coastal Pollution Remediation Program (see Chapter 6 for more information about these programs). Proposals should target critical resources, such as drinking water supplies, shellfish beds, swimming beaches, and aquatic habitat.

Recommendations: Stormwater Runoff (cont.)

- Stormwater regulations should be consistent (or at least not contradictory) among local boards and departments (e.g., Planning, Conservation, DPW).
- Planning Boards should consider incorporating the DEP Stormwater Management Standards, or similar standards, into Subdivision and Site Plan Review regulations. These standards are now required to be implemented in wetland resource areas.
- Chapter 5 and Appendix D contain a review and evaluation of local stormwater regulations, with specific recommendations. MAPC encourages the towns to give full consideration to these recommendations.

ES-3.4 Hazardous Waste and Industrial Sites

Findings

Hazardous waste sites, old industrial and military sites, and industrial uses were very often cited for water quality concerns. Based on a September, 1996 listing from the Massachusetts Department of Environmental Protection, there are 93 confirmed hazardous waste sites in the nine towns.

The South Weymouth Naval Air Station is the only site in the project area listed on the federal National Priorities List of Superfund Sites. The Naval Air Station encompasses 1,442 acres in the towns of Weymouth, Rockland, Abington and Hingham and straddles the major basin divide separating the South Coastal and Weymouth & Weir basins. This site, and its redevelopment, has the potential for serious impacts on both major watersheds since it is located at the headwaters of two important tributaries.

The headwaters of the Old Swamp River and the headwaters of French Stream are located on Naval Air Station property. The Old Swamp River feeds Weymouth's drinking water supply at South Cove (Back River subbasin). French Stream is one of two tributaries to the Indian Head River which is the upstream, freshwater portion of the North River. There is no hydrologic separation between the Indian Head and North Rivers and thus water quality in French Stream has the potential to affect the entire North River System.

French Stream is a potentially degraded stream that receives pollution inputs from the Naval Air Station, the Rockland Wastewater Treatment Plant and the old Rockland landfill. Off-site pollution impacts from the Naval Air Station site have not yet been fully investigated. The Air Station is being decommissioned and is slated for major redevelopment, including a "mega-mall" (see "Planning for Growth, below).

Other hazardous waste sites of concern in the project area include:

- The old Fireworks Site on Factory Pond in Hanover (Indian Head River subbasin) where mercury contamination in sediments has led the state to issue a Public Health Advisory against the consumption of locally-caught fish. This site hosted industrial and military operations for about 80 years, during which time wastes laden with mercury, arsenic and other pollutants were directly disposed of in Factory Pond and adjacent land.
- Several other old military sites, including the Hingham Annex hazardous waste site and the old ammunitions bunkers in Wompatuck State Park, which include old bunkers in the Aaron River Reservoir (a drinking water supply for Cohasset). The Back River ACEC also hosted former military operations, and town and state officials disagree about the severity of potential problems at this location.
- Contaminated groundwater plumes from hazardous waste sites (gas stations) in the Queen Anne's Corner area are threatening public wells in Hingham and Norwell.
- Contaminated groundwater plumes from other former gas stations in Hingham are polluting groundwater, discharging to wetlands, and threatening private wells on Whiting Street.

There is a general concern about the lack of knowledge of the impacts of these, and other, hazardous waste sites. Not enough is known about groundwater elevations or bedrock fractures to accurately determine where contaminated groundwater plumes are going and what resources are threatened. In addition, many town officials voiced frustration over the slow pace of hazardous waste site cleanups. At least one town has found that cleanups progressed faster when the town became more involved and aggressive. One way of funding increased involvement is through the DEP Technical Assistance Grant program, which provides funding to communities to interpret and respond to technical information from site investigations and cleanups.

All of the nine towns have adopted zoning overlay districts for water supply protection. Some of these bylaws should be strengthened, as recommended in Chapter 5 and Appendix D. Furthermore, the recharge area ("Zone II") for many municipal wells has not yet been delineated or approved, which means that water supply protection districts may not be protecting the full extent of the recharge area. Delineation of Zone II's is important with regard to hazardous waste sites, because state regulations require more stringent cleanup standards for sites within DEP-approved Zone II's.

Commercial and industrial uses can pose a threat to drinking water quality even when towns have adopted Zone II's to protect their wells. For example, industrial uses along Route 53 pose a potential threat to drinking water wells in Hanover because these uses are "grandfathered" (i.e., they were in place before the town adopted its zoning overlay district for groundwater protection).

Recommendations: Hazardous Waste and Industrial Sites

- More thorough investigation into the nature and extent of on-site and off-site contamination is needed at several old military sites in the project area.
- More information is needed to understand the potential impacts of hazardous waste sites on public health and the environment, particularly drinking water resources. More information is needed to understand where plumes are moving, potential movement in bedrock, and what resources could be threatened.
- The results of the "2E site assessments" that are conducted for commercial and industrial property transaction, could be a useful source of information regarding the nature and extent of environmental contamination in a community. The DEP should investigate ways that this information could be provided, and make useful to communities.

Recommendations: Hazardous Waste and Industrial Sites (cont.)

- There should be better notification of local officials regarding site activities. Depending on the site, this may be the responsibility of the Licensed Site Professional (LSP), the DEP, or the EPA or other federal agency. In many cases, communities, and public health, would benefit from a more active role in the site investigation and cleanup process. For example, communities can identify whether there are areas near a hazardous waste site that are served by private wells even though they may have access to public drinking water.
- Communities should apply for Technical Assistance Grants to assist their active participation in the site investigation and cleanup process.
- Towns should adopt strong local hazardous materials management programs to ensure that existing commercial and industrial uses do not pose water quality or public health concerns. Priority should be given to uses within drinking water recharge areas. Towns can contact MAPC for more information, and model and example regulations.
- Towns should delineate Zone II's for their active drinking water wells and identify and develop protection areas for potential future supplies.

ES 3.5 Other Pollution Concerns

Findings

There are 4 active and 12 former landfills in the project study area. Leachate from some of these landfills is leaking into adjacent wetland and streams, causing degradation of water quality. The former Hingham and Weymouth landfills have been cited as a cause of water quality degradation in the Back River Area of Critical Environmental Concern. Some former landfills are known to have accepted industrial wastes and there is concern about the potential for groundwater contamination with industrial chemicals. According to town officials, monitoring wells around the old Rockland landfill have identified elevated levels of silver, a heavy metal which is extremely toxic to aquatic life.

Other water quality concerns include:

- Several animal waste containment areas in the Indian Head River and North River subbasins were cited as posing concerns for water quality, including potential threats to drinking water.
- There are many cranberry bogs in the project area, particularly in the southern-most communities. There is general concern about the impacts of these bogs, and the fact that not much is known about the extent or severity of these impacts. Concerns include pollutant loading (e.g., nutrients and herbicides) and hydrologic impacts due to the controlled storage and release of water.
- Several municipal wells are located in close proximity to state highways, and there is concern about potential sodium contamination of these wells. The Massachusetts Highway Department utilizes straight salt on these highways, at a rate of 300 pounds per lane mile per application.
- Discharge of sanitary boat wastes into local harbors and waterways. All of the coastal communities have adopted boat waste pumpout programs (see Chapter 5).

Recommendations: Other Pollution Concerns

- Routine water quality monitoring should be conducted at former landfills to identify potential groundwater and surface water impacts.
- Boards of Health and Conservation Commissions should review runoff of sediments and contaminants from active and closed landfills and require that such runoff into wetlands or other sensitive areas be reduced or eliminated.
- Former landfills should be capped, particularly those that are contributing pollutants to nearby waterways.
- Additional investigation is needed to determine the extent, and confirm the source, of silver contamination identified in monitoring wells around the old Rockland landfill.
- Towns should work with the Natural Resource Conservation Service to identify ways to address potential pollution from animal containment areas.
- More research and investigation is needed into the water quality and hydrologic impacts of cranberry bogs. Towns should try to gain the cooperation of growers to help protect water supplies and other critical resources.
- Towns should work with the Mass. Highway Department to designate low-salt areas around wells and reservoirs near state highways, particularly if sodium levels begin to approach the drinking water guideline level of 20 mg/l.

- Towns can apply for grant funds for boat waste pumpout programs through the MA Coastal Zone Management Office's Coastal Pollution Remediation (CPR) Program and the federal EPA's Clean Vessel Act program.

ES-3.6 Planning for Growth

Findings

Major growth is anticipated for the South Shore and Old Colony area. A Harvard University Study (A Region in Transition: The *New* Old Colony, 1996.) identified the Old Colony Region (of which most of the project towns are a part) as the fastest growing region in the northeastern United States. In part, this growth is being spurred by major transportation improvements, including the extension of the MBTA commuter rail and the widening of Route 3. The Harvard University report noted that many towns in the region have antiquated regulations that have proven ineffective at dealing with development pressures. The South Coastal Watersheds Team Leader for the Massachusetts Executive Office of Environmental Affairs (EOEA) has identified growth pressures as the major issue facing the South Coastal Watersheds.

A few of the nine towns in this study do not have full-time staff to support the Planning Board or Conservation Commission. These towns are hard-pressed to respond to the grinding timetable of development proposals, much less to undertake the time-consuming work of preparing planning documents (Master Plans, Open Space Plans), adopting growth control measures and revising regulations to bring them up to desired standards.

Some towns have done a good job of acquiring and setting aside sensitive environmental lands and open space, but other towns have not. Development pressures are strong now and are anticipated to increase. Some towns are finding that environmentally sensitive lands and remaining open space are being developed at a frightening rate.

The South Weymouth Naval Air Station is being decommissioned by the Navy and is now the subject of a major redevelopment proposal that includes over 500 units of housing, an 18-hole golf course and a "mega-mall" with over 200 stores. This project could have major water quality and quantity impacts, particularly given its location at the headwaters of two significant stream systems (French Stream in the Indian Head Basin and Old Swamp River in the Back River subbasin).

The towns are undertaking studies to identify future water sources for this proposed development, as there is not sufficient permitted capacity in the towns to provide the water needed at full project buildout. The fate of wastewater from the proposed development is also uncertain at this time, and may include a combination of discharge to the Weymouth/MWRA system, the Rockland wastewater treatment plant and a future on-site treatment facility. The Weymouth and MWRA systems are already overburdened, as evidenced by chronic sewer surcharging problems at some locations in Hingham and Weymouth.

Recommendations: Planning for Growth

- Planning Boards, Conservation Commissions, and Boards of Health need to be properly funded and professionally staffed.
- Towns should update their Master Plans and Open Space Plans, if they are outdated. Communities must have an up-to-date open space plan to be eligible for state open space acquisition funds.
- Planning Boards, Conservation Commissions and Boards of Health should take full advantage of their authority to hire consultants, at the developer's expense, to review development proposals.
- Towns need to prioritize their land acquisition "wish-list" and be prepared to acquire key properties when they become available. Towns should set aside funds for acquisition and apply for state open space funds.
- Planning Boards should conduct a build-out analysis to determine whether town resources and services (e.g., drinking water, wastewater, etc.) can sustain the growth implied by current zoning.
- Planning Boards should more aggressively encourage developments that are sensitive to environmental resources and preserve open space (e.g., cluster/open space/ conservation subdivisions).
- Weymouth, Rockland and Hingham should continue their active participation in the Restoration Advisory Board and Land Use Planning Committees for the South Weymouth Naval Air Station.

- State and federal agencies and the EOEA South Coastal Watersheds Team should work to ensure that redevelopment plans for the South Weymouth Naval Air Station support the goals of the Massachusetts Watershed Initiative, including restoring and protecting water quality and quantity, habitat, and open space.

Recommendations: Planning for Growth (cont.)

- Town boards should be informed about the location of all state-regulated public drinking water supplies and ensure that future development does not threaten these supplies. Towns should obtain public water supply locations (including non-municipal systems serving residential communities, schools and workplaces) from the state MassGIS office.
- Massachusetts State law limits the authority of communities to restrict access to sewers once they are constructed. The MAPC Legislative Committee and the other Massachusetts Regional Planning Agencies should study this issue and determine whether a revision of state law is appropriate.
- Zoning should require a minimum upland area for each zoning category.

ES-3.7 Inter-Community Coordination

Findings

The nine communities share many critical water resources, including drinking water aquifers and watersheds, shellfish bed growing areas, finfish habitat, Areas of Critical Environmental Concern, and swimming beaches. The communities should continue to coordinate to protect these joint resources.

The South Shore Coalition is a subregion of MAPC and is comprised of Selectmen and Planning Boards from ten South Shore communities. The Coalition can be a major force in the effort to protect and restore the region's water resources. The South Shore Water Resources Advisory Committee, which provided input and feedback for this plan, was established by MAPC and the communities with the intent of serving as a long-standing committee for inter-community cooperation on water resource issues.

Recommendations: Intercommunity Coordination

- The communities should continue the work of the South Shore Water Resources Advisory Committee. The South Shore Coalition and MAPC can provide direction on the form and direction that this committee should take. This committee should foster inter-community cooperation on drinking water resource and other resource issues. For example, Scituate and Norwell should keep the town of Cohasset apprised of development proposals that might have an adverse impact on the Aaron River Reservoir.
- The communities should have a strong and active link with the South Coastal and Boston Harbor Basin Teams formed by the Executive Office of Environmental Affairs (EOEA) under the Massachusetts Watershed Initiative. Participation in the EOEA Basin Teams can help bring priority projects to the attention of state agencies. The Basin Teams recommend projects for funding and are anticipated to have significant input into the expenditure of state funding resources for water quality-related projects. The South Shore Water Resources Advisory Committee and/or the South Shore Coalition can provide this link.
- The Coalition can be a major force in the effort to protect and restore the region's water resources. Two-way communication should be encouraged: agencies and organizations should bring information to the Coalition, and Coalition members should in turn provide information and direction to the relevant town boards and departments. Member towns should work together to resolve inter-community water resource and pollution issues.
- The Coalition has used MAPC subregional resources to conduct several useful projects that supplement this study, including regional zoning maps and regional water resource maps showing land use and zoning in Zone II areas. Town boards should be informed about the existence of these maps. The maps should be used, in conjunction with this plan, to develop priorities for resource protection.
- The communities should continue their involvement in the MassBays Local Governance Committee. This committee focuses on the protection of coastal resources, particularly the restoration of polluted shellfish beds.

Recommendations: Intercommunity Coordination (cont.)

- Towns should cooperate on joint purchasing and other projects. Examples of possible areas for cooperation include:

  - Joint purchase by the towns of an infrared camera that could be used to identify sewage leaks into adjacent waterways. This type of camera could also be used to identify cesspools and septic system leaching fields. In addition, the camera could be used to identify leaks from water supply pipes.

  - Joint purchasing of vacuum truck or regional contract for hiring vacuum truck for cleaning of hooded catch basins.

  - Joint training of DPW staff on the proper maintenance of stormwater infrastructure, cleaning and repair of hooded catch basins, etc.

- The MAPC can foster water resource protection and inter-community cooperation in several ways, including:

  - Publicizing this plan, including holding public meetings, and providing the plan to all relevant town departments and public libraries;

  - Providing staff resources to the South Shore Coalition and the South Shore Water Resources Advisory Committee (or its replacement);

  - Providing information on MAPC's World Wide Web site, including the Executive Summary and GIS maps from this, and other projects.

Chapter 1: Regional Overview of Land Use and Water Resources

1.1 Watersheds in the Project Study Area

The term watershed refers to a geographical area in which water and sediments drain to a common outlet such as a stream, river, lake, or estuary. Viewing water quality from a watershed perspective requires us to understand water in the context of land. One of the objectives of this project is to view water resources and nonpoint source issues in a watershed context. This is a good fit for a study of nonpoint source pollution, since nonpoint source pollution is caused by the impacts of land use on water quality. By viewing land use, water quality, pollution sources and management activities in a watershed context, we can more closely link water quality problems with their causes and potential solutions.

The Commonwealth of Massachusetts has launched the Watershed Initiative to ensure that state environmental programs view water-related environmental issues from a watershed perspective. The Watershed Initiative brings together state and federal agencies, community leaders, watershed associations and others to coordinate their work in each watershed. The Executive Office of Environmental Affairs is leading this effort, and has hired a "Team Leader" to coordinate activities and work on priority-setting for each of the state's 27 major watersheds. The EOEA Team Leader for the South Coastal Watershed(s), has reviewed and provided comments on this report.

Given our interest in developing a watershed perspective for this project, one of our first tasks was to delineate a manageable number of subwatersheds that would become our "project subbasins."

MassGIS, which provides Geographic Information System (GIS) services to the Commonwealth, has delineated "major" and "minor" drainage basin divides in Massachusetts. The project study area lies within two major drainage basins (the Boston Harbor and South Coastal basins) and 64 minor subbasins. It was clear to MAPC and the project committee that two subbasins were too few and 64 were too many. We needed a more reasonable number that would allow us to conduct a meaningful inventory and evaluation of land use, water quality, pollution sources and mitigation needs within each subbasin.

First, MAPC and MassBays identified the significant river systems and coastal embayments in the study area (such as the North River, the South River, Duxbury Bay, the Weir River and the Back River). Next, using the expert judgement of Bill Clark of MassBays and Martin Pillsbury of MAPC, we reviewed the MassGIS subbasin maps in conjunction with the USGS topographic maps to identify the drainage area for each of these significant river systems or coastal embayments. This effort, and review and comments by the regional project committee set up for local review of this project, resulted in dividing the study area into 12 “project subbasins.” These subbasins are listed in Table 1-1 and shown in Figure 1-1.

Figure 1-1 is a GIS map showing the 12 subbasins as well as hydrologic features and drinking water supplies. In most cases, the project subbasins are a combination of several of the minor MassGIS subbasins. Table 1-1 lists which of the GIS minor subbasins fall into each of the MAPC project subbasins. Table 1-1 also lists the major hydrologic resources (streams, ponds, embayments) in each subbasin.

While we have tried to view information from a watershed perspective, the study area is composed of nine towns and their political boundaries. Once we cross certain municipal boundaries (for example from Hanover into Pembroke in the North River watershed) we fall out of the study area. This project does not provide the complete picture for those watersheds which are located partially, or almost entirely, outside of the study area. In particular, the Fore River, Taunton River, and Jones River watersheds have only a small portion of their total land area located within the study area. Table 1-1 identifies whether the project subbasin includes all communities in the full subbasin.

1.2 Regional Land Use Assessment

1.2.1 Population and Employment

Table 1-2 shows how population has changed in the nine-town study area between 1940 and 1990. The region grew explosively during the 1940’s, 1950’s and 1960’s, with average growth rates over each decade ranging between 31 and 56 percent. Growth slowed considerably between 1970 and 1990, with a growth rate of less than one percent between 1980 and 1990.

Figure 1-1: Project Subbasins & Hydrologic Features

GIS Map

[back-side figure 1-1]

Table 1-1
Project Subbasins in the Study Area

MAJOR BASIN **Subbasins** GIS Minor Basin #'s	**Brooks**	**Waterbodies**	**Harbors**	**Town (s)**	**Acres**
SOUTH COASTAL BASINS					
1) Bound Brook/Gulf Basin					
21999, 21005, 21006, 21007, 21008	Aaron Rv. Bound Bk. Brass Kettle Bk Musquashcut Bk.	Aaron Rv. Res. Bound Bk. Pnd Lily Pond Musquashcut Pond	Cohasset Harbor Little Harbor The Gulf Scituate Harbor	Cohasset Hingham Norwell Scituate	14,549
2) Duxbury Bay Basin					
21042, 21048	Bluefish Rv. Cut Rv. Island Ck. West Bk.	Allen's Pond Island Ck. Pond Mill Pond	Duxbury Bay	Duxbury Marshfield	7,437
3) Green Harbor River Basin					
21047	Bass Ck. Green Harbor Rv Wharf Ck.		Green Harbor	Duxbury Marshfield	5,136
4) Indian Head River Basin					
[Does not include Hanson, Pembroke, Abington or Whitman] 21010, 21011, 21013 21021, 21022	Ben Man Bk. Cushing Bk. French Bk. Indian Head Rv. Shinglemill Bk.	Abington/ Rockland Res. Factory Pond Forge Pond Hackett Pond		Hanover Norwell Rockland	14,079
5) Jones River Basin					
[Does not include Pembroke or Kingston] 21057, 21060	Bassett Bk. Halls Bk. Mile Bk. Pine Bk. Tubbs Bk.	Lower Chandler Pond Silver Lake Upper Chandler Pond		Duxbury	2,298
6) North River Basin					
[Does not include Pembroke] 21028, 21031, 21031, 21033, 21035, 21036, 21037	Bares Bk. Cove Bk. Eams Bk. Herring Rv. 1st Herring Bk. 2nd Herring Bk 3rd Herring Bk. Iron Mine Bk. McFarlan Bk. North Rv. Pudding Bk. Little Pudding Robinson Ck. Silver Bk. Stony Bk. Swamp Bk. Wildcat Ck.	Old Oaken Bucket Pond Tack Factory Pond		Hanover Marshfield Norwell Scituate	26,106

MAJOR BASIN **Subbasins** GIS Minor Basin #'s	**Brooks**	**Waterbodies**	**Harbors**	**Town (s)**	**Acres**
SOUTH COASTAL BASINS (cont.)					
7) South River Basin					
21040, 21041, 21044	Furnace Ck. Kene Bk. Littles Ck. Phillips Bk. South Rv.	Chandlers Pond Keene Pond Pine Lake		Marshfield Duxbury	13,122
8) Back River Basin					
[Does not include Holbrook or Braintree] 19325, 19351, 19352, 19353, 19355, 19356, 19357, 19358, 19359, 19360, 19361, 19362, 19363	Fresh Rv. Mill Rv. Old Rv. Smelt Bk. Swamp Rv.	Cranberry Pond Elias Pond Whitman's Pond Weymouth Great Pond	Beal Cove Hewitt's Cove	Hingham Rockland Weymouth	10,700
9) Fore River Basin					
[Does not include Quincy, Braintree, Randolph, or Holbrook] 19322, 19323,19326	Fore Rv. Smelt Bk.		Mill Cove Town River Bay	Weymouth	2,341
10) Hingham Harbor Basin					
19999, 19365		Home Meadows	Hingham Harbor	Hingham	1,528
11) Weir River Basin					
19364, 19371, 19372, 19374, 19375	Accord Rv. Falling Bk. Mill Bk. Plymouth Rv. Weir Rv.	Accord Pond Cushings Pond Foundry Pond Fulling Mill Pond Straits Pond Triphammer Pond	Hingham Harbor	Cohasset Hingham Norwell Rockland Weymouth	11,814
TAUNTON RIVER BASIN					
12) Taunton River Basin					
[Includes only Weymouth portion of the basin]				Weymouth	193

Note: Towns and acreages listed above include only land within the nine study communities. If a subbasin extends outside of the 9 communities, it is not included in the study area.

Table 1-2
Historic Population Trends in the Study Area, 1940 - 1990

Year	Population	Population density per square mile (a)	% Population change from prior decade
1940	56,723	343.8	-
1950	74,377	450.8	31.1
1960	116,333	705.0	56.4
1970	153,818	932.2	32.2
1980	169,389	1026.6	10.1
1990	170,485	1033.2	0.6

Note: (a) Based on 165 square miles in the nine communities.
Sources: MAPC, U.S. Census.

Current population and employment density vary widely in the region. Table 1-3 shows 1990 population and employment density, by town, for the nine project communities. Weymouth has, by far, the highest concentration of residents (3,178 per square mile). Rockland, the second-most densely developed town, has half the population density of Weymouth. The least densely developed communities in the project area are Norwell (444 per sq. mi.) and Duxbury (585 per sq. mi.).

Weymouth also tops the list for employment density, at 861 employees per square mile. Rockland, Hingham, and Hanover also have large employment concentrations (663, 433 and 421 employees per sq. mi., respectively). Duxbury has a minimal commercial and industrial base, and has the lowest employment density in the study area (95 employees per sq. mi.).

The region is poised for another period of rapid and intensive growth. There is currently a high demand for high-priced housing, which makes development attractive to landowners, and some areas are experiencing significant growth pressures (e.g., the West End of Scituate). Major planned infrastructure projects, such as the Old Colony Rail Restoration Project and the Route 3 expansion are expected to fuel growth in the region.

Growth means more impervious surface, more runoff, less groundwater recharge, and more demand for clean drinking water. Communities need to plan for sustainable growth that will allow the town to provide safe drinking water and fishable and swimmable waters.

Table 1-3
Population and Employment Density in the Nine Project Communities, 1990[a]

Community	Land Area (Sq. Miles)	Population 1990	Population Density	Employment 1990	Employment Density
Cohasset	9.89	7,075	715.5	2,024	204.7
Duxbury	23.76	13,895	584.9	2,256	94.9
Hanover	15.61	11,912	763.1	6,569	420.8
Hingham	22.47	19,821	882.0	9,730	433.0
Marshfield	28.46	21,531	756.5	4,201	147.6
Norwell	20.88	9,279	444.5	5,511	263.9
Rockland	10.02	16,123	1,608.4	6,643	663.0
Scituate	17.18	16,786	976.8	2,906	169.2
Weymouth	17.01	54,063	3,177.8	14,653	861.4

Note: (a) Employment density does not include home businesses.
Sources: 1990 Population from U.S. Census. 1990 Employment from the Massachusetts Department of Employment and Training.

Table 1-4 provides MAPC's population projections for the nine-town study area, between 1990 and 2020. Hingham and Weymouth are not expected to grow significantly, with less than 1 percent growth predicted in this 20-year period. The predictions for other towns are quite different. Duxbury is expected to grow about 9 percent by 2020, and Hanover, Rockland, Norwell and Scituate are projected to grow between 11 and 16 percent. The highest projected growth rates are projected for Cohasset and Marshfield, which are projected to experience between 25 and 27 percent growth in this 20-year period.

Having reviewed these projections, several towns noted that current population, recent growth rates and their own projections provide much different numbers than the MAPC projections. While MAPC projects a population of 7,654 for Cohasset in the year 2000, Cohasset reports that their 1998 population is just about 7,125, and they therefore believe that the future projections are too high. The town is using its own projections for planning work. The MAPC projections for the town of Norwell may be too low. According to town officials, Norwell has already reached the population projected by the year 2010.

Table 1-4
MAPC Population Projections for the Project Communities, 1990 - 2020

Community	1990	2000	2010	2020	% Change 1990 - 2020
Cohasset	7,075	7,654	8,225	8,863	25.28
Duxbury	13,895	14,880	15,058	15,120	8.81
Hanover	11,912	12,886	13,138	13,245	11.19
Hingham	19,821	19,948	19,911	19,844	0.12
Marshfield	21,531	23,830	25,746	27,289	26.74
Norwell	9,279	9,825	10,289	10,732	15.66
Rockland	16,123	17,090	17,726	18,033	11.85
Scituate	16,786	17,747	18,564	19,352	15.28
Weymouth	54,063	54,547	54,553	54,427	0.67
TOTAL	**170,485**	**178,407**	**183,210**	**186,905**	**9.63**

Sources: 1990 Population from U.S. Census; projections from MAPC, March 1996.

1.2.2 Land Use

Table 1-5 provides a breakdown of developed land uses for each project subbasin. The table provides the percent of each basin in developed uses. Figure 1-2 depicts 1990/1991 MacConnell Land Use in the study area. These maps are developed through the interpretation of aerial photographs and are useful tools for analyzing current land uses and historic changes in land use. The MacConnell maps have a minimum parcel size of three acres and a resolution of one acre. It should be noted that because the maps are not field verified, inaccurate land use classifications are not uncommon. However, the data are useful as an indicator of general trends in regional land use change.

Table 1-5
1991 MacConnell Land Use by Project Subbasin

Subbasin	Total Acres	Resid.	Indust.	Commerc.	Transp.	Waste/ Mining	Recr'n	Total Developed Land Use	% Resid.	% Indust/ Comm.	% Subbasin Developed
South Coastal											
Bound Brook	14,549.4	4,746.1	43.7	171.1	0.0	7.7	286.4	5,255.0	32.6%	1.5%	36.1%
Duxbury Bay	7,437.2	2,785.0	0.0	59.2	7.2	28.2	301.5	3,181.1	37.4%	0.8%	42.7%
Green Harbor R.	5,135.7	1,797.9	0.0	44.2	63.9	29.1	228.1	2,163.2	35.0%	0.9%	42.1%
Indian Head R.	14079.04	4616.93	374.56	315.37	387.42	120.51	163.16	5977.95	32.8%	4.9%	42.5%
Jones River	2,298.2	47.0		9.5	36.6	3.2	2.2	98.4	2.0%	0.4%	4.3%
North River	26,106.0	6,804.6	106.2	687.8	316.5	146.6	183.9	8,245.5	26.1%	3.0%	31.6%
South River	13121.77	3803.29	0	152.77	158.77	207.94	195.81	4518.58	29.0%	1.2%	34.4%
Subtotal	**82,727.4**	**24,600.7**	**524.4**	**1,439.8**	**970.4**	**543.3**	**1,361.1**	**29,439.8**	**29.7%**	**2.4%**	**35.6%**
Weymouth/Weir											
Back River	10,699.6	3,978.2	383.4	507.9	235.8	103.9	192.8	5,401.9	37.2%	8.3%	50.5%
Fore River	2,341.4	1,507.7	59.9	113.9	2.8	32.7	81.7	1,798.8	64.4%	7.4%	76.8%
Hingham Harbor	1,527.8	887.0	0.0	47.0	0.0	0.0	67.8	1,001.9	58.1%	3.1%	65.6%
Weir River	11814.21	3649.23	122.76	240.15	80.99	281.16	357.85	4732.14	30.9%	3.1%	40.1%
Subtotal	**26,383.0**	**10,022.2**	**566.0**	**909.0**	**319.7**	**417.7**	**700.2**	**12,934.8**	**38.0%**	**5.6%**	**49.0%**
Taunton	193.1	42.6		1.6				44.2	22.0%	0.8%	22.9%
Project Total	**109,303.4**	**34,665.5**	**1,090.4**	**2,350.5**	**1,290.1**	**961.0**	**2,061.3**	**42,418.7**	**38.8%**	**3.1%**	**38.8%**

Figure 1-2: Land Use in Study Area

[36” x 48” maps will be reduced to fit on 11 x 17 paper and inserted into report]

Figure 1-2: land use (back page)

1.3 Drinking Water Supplies

The South Shore communities obtain their drinking water from private wells, municipal wells and municipal reservoirs. Table 1-6 lists the municipal wells and reservoirs that withdraw in excess of 100,000 gallons per day (gpd), by project subbasin. Ground water withdrawals are abbreviated in the table as “GW” and surface water withdrawals are abbreviated as “SW”.

Public water supply identification numbers assigned by the Massachusetts Department of Environmental Protection are abbreviated as “PWS ID. #” in Table 1-6 . Municipal water withdrawals are depicted in Figure 1-1, by PWS ID, and are shown on all of the subsequent project maps as well, with symbols only.

The Massachusetts Water Management Act requires that withdrawals in excess of 100,000 gpd, and cranberry bogs larger than a specified acreage must obtain Water Management Act permits from DEP. Table 1-7 shows the non-municipal water withdrawals in the nine communities that have Water Management Act Permits. Most of these withdrawals are for cranberry production. The Water Management Act requires that cranberry bogs with more than 4.6 acres in production must obtain a Water Management Act permit. New bogs can irrigate up to 9.2 acres without a Water Management Act permit if they use Soil Conservation Service Best Management Practices.

Table 1-6
Municipal Drinking Water Supplies by Project Subbasin

Town	Supply	PWS ID. #	GW Withdrawals	SW Withdrawals	Notes
BOUND BROOK/GULF BASIN					
Cohasset	Lily Pond	3065000-02S		x	
Cohasset	Sohier GP 1 & 2	3065000-01G 3065000-03G	XX		*Emergency source*
Cohasset	Ellms Meadow	3065000-02G	X		*Emergency source*
Cohasset	Aaron River Res.	3065000-01S		x	
Subtotal			**3**	**2**	
GREEN HARBOR RIVER BASIN					
Marshfield	Parsonage St. 1 & 2	4171000-02G 4171000-03G			*Inactive*
Marshfield	Webster 1 & 2	4171000-10G 4171000-12G	XX		
Subtotal			**2**		
DUXBURY BAY BASIN					
Duxbury	Tremont 1 & 2	4082000-05G	XX		
Duxbury	Millbrook Pond	4082000-01G	X		
Duxbury	Depot St.	4082000-03G	X		
Duxbury	Partridge Rd.	4082000-02G	X		
Duxbury	Evergreen St. 1& 2	4082000-07G 4082000-08G	XX		
Duxbury	Mayflower St.1 & 2	4082000-08G	XX		
Subtotal			**9**		
JONES RIVER BASIN					
Duxbury	Lake Shore Dr.	4082000-04G	X		
Subtotal			**1**		
INDIAN HEAD RIVER BASIN					
Rockland	Hingham St. Res.	4001000-02S		x	
Subtotal				**1**	
NORTH RIVER BASIN					
Norwell	Washington St. 7-8	4219000-08G 4219000-09G	Xx		
Norwell	Ridge Hill Rd 4	4219000-04G	X		
Norwell	South St. 1 & 6	4219000-01G 4219000-06G	xx		
Norwell	GP 10	4219000-11G	x		
Hanover	Pond St. 1,2,3,4	4122000-01G 4122000-05G 4122000-08G	xxx		*Well #4 inactive*
Hanover	Hanover St. 1 & 2	4122000-03G 4122000-04G	xx		
Hanover	Tindale 1 & 2	4122000-06G 4122000-07G	xx		*a.k.a Broadway Wells*
Hanover	Beal Wellfield	4212000-09G 4212000-10G			

Table 1-6 (cont'd)
Municipal Drinking Water Supplies by Project Subbasin

Town	Supply	PWS ID. #	GW Withdrawals	SW Withdrawals	Notes
North River Subbasin (Cont.)					
Scituate	Webster Meadow 10&11	4264000-01G 4264000-02G	xx		
Scituate	Old Oaken Bucket	4264000-01S		x	
Scituate	Edison Sta. (19)	4264000-05G	x		
Scituate	Sand & Gravel (18A)	4264000-04G	x		
Scituate	Kent St. 2	4264000-08G			*Inactive*
Scituate	Auxiliary 20	4264000-06G			*Inactive*
Scituate	Barnes Meadow (22)	4264000-11G	x		
Scituate	Stearns Meadow (17A)	426400003G	x		
Subtotal			**21**	**1**	
SOUTH RIVER BASIIN					
Marshfield	Webster 2	4171000-12G	x		
Marshfield	Church St. Well	4171000-13G	x		
Marshfield	Ferry St. Well	4171000-11G	x		
Marshfield	School St. Well	4171000-09G	x		
Marshfield	Furnace Brook 1,2,3,4	4171000-04G 4171000-05G 4171000-06G 4171000-07G	xxxx		
Marshfield	South River Well	4171000-08G	x		
Marshfield	Mt Skirgo Wellfield	4171000-01G	x		
Subtotal			**10**		
WEIR RIVER BASIN					
Hingham	Accord Pond	3131000-01S		x	
Hingham	Scotland St. GP	3131000-03S	x		
Hingham	Prospect St. GP	3131000-06S	x		
Hingham	Accord Brook	3131000-02S		x	
Hingham	Free St. 1,2,3	3131000-01G 3131000-02G 3131000-05G	xx		*Well #1 inactive*
Hingham	Downing St. GP	3131000-04G	x		
Hingham	Old Boston Pump				*Inactive*
Norwell	Grove St. 2,3,5	4219000-02G 4219000-03G 4219000-04G	xxx		
Norwell	Bowker 9	4219000-10G	x		
Subtotal			**9**	**2**	
BACK RIVER BASIN					
Weymouth	Whitman's Pond – Libbey Park Well	3336000-03G	x		
Weymouth	Whitman's Pond/Old Swamp River	3336000-02S		x	
Weymouth	Winter St. 1 & 2	3336000-04G 3336000-05G	xx		
Weymouth	Circuit Ave well	3336000-01G	x		
Weymouth	Main St. well	3336000-02G	x		
Weymouth	Great Pond	3336000-01S		x	
Subtotal			**5**	**2**	

Table 1-7
Non-Municipal Water Withdrawals Over 100,000 GPD

Water User / Source	Total Registered Volume (MGD)	Total Registered Cranberry Acreage
Bayside Agricultural	0.16	18
Island Creek Well #1, Tremont St., Duxbury		
Island Creek Reservoir		
Cedar Tree Farm/dba J&D Anderson	0.13	15
Phillips Brook #1, Congress St., Duxbury		
Phillips Brook #2, Congress St.		
Crowell Cranberry Company	0.27	30
C – 1, Lincoln St., Duxbury		
C – 2 , Old Toby Garden St.		
Well #1, Lincoln St.		
Duxbury Bogs	.029	33
Wright Reservoir, Tremont St., Duxbury		
Duxbury Yacht Club	0.10	0
Duxbury Yacht Club, Duxbury		
Duxbury Yacht Club Well #1		
Earle Ricker	0.17	14
239 Mayflower St., Duxbury		
Edgar W. Loring	0.28	32
Mayflower St. #6, Duxbury		
East St. #3		
East St. #4		
East St. #5		
Elm St. #7		
Garretson Cranberry Company	0.36	40
Garretson Bog Reservoir 214 Moraine St. Marshfield		
Geldmacher Cranberry Company	0.04	5
C – 1, 350 Temple St., Duxbury		
Marshfield Country Club	0.10	0
Well #1, Acorn St., Duxbury		
Well #2, Acorn St., Marshfield		
Well #3, Acorn St. Marshfield		
Marshfield Cranberry Corp.	0.22	25
S. River St. Reservoir, 317 S. River St., Marshfield		
Merryland Cranberries Inc.	0.49	56
C – 1, Hatches Bar Rd., Duxbury		
C – 2, West St., Route 14		
C – 3, Church St.		
C – 4, Franklin St.		
C – 5, Temple St.		
C – 6, Temple St.		
C – 7, Temple St.		
Well #1, Franklin St.		
Well #2, Franklin St.		
Noemi Rugani (Estate of)	0.05	6
Route 3A Reservoir, RT 3A, Marshfield		
Old Mt. Skirgo Cranberry Corp.	0.04	5
Mt. Skiran Reservoir, Marshfield		
R.H.Benea	0.16	18
Bebea Bog, Kingstown Way, Duxbury		
Town of Duxbury – Conservation Commission	0.41	46
Old Bog Reservoir, East St., Duxbury		
Lorings Bog Reservoir, East St.		
Island Creek Pond, Toby Garden Rd.		
Webster Cranberry Co., Inc.	0.20	22
Cross St. Reservoir, 292 Cross St., Norwell		

1.4 Shellfish Beds

Shellfish have historically been one of the most abundant and heavily utilized resources along the coast of Massachusetts. Shellfish beds represent significant economic value for harvesters and for the towns which sell shellfish licenses.

Unfortunately, shellfish beds up and down the coast are threatened by disease-causing viruses and bacteria. These pathogens enter the bays from a variety of sources, both point and nonpoint and both natural and anthropogenic. Anthropogenic sources include sewage treatment plants, combined sewer overflows, failing septic systems, stormwater runoff, and boat waste. Natural sources originate from the feces of warm-blooded animals. Waterfowl such as geese and ducks can contribute significant fecal coliform loadings and in many areas must be managed along with anthropogenic sources if shellfish beds are to remain open.

The Shellfish Sanitation Program of the Massachusetts Department of Marine Fisheries (DMF) is responsible for overseeing shellfish growing areas in the state. To remain open and unrestricted for shellfishing, a growing area must have very low levels of fecal coliform (geometric mean of 14 col/100 ml, with no more than 10 percent of samples having levels above 43 col/100 ml). To ensure that growing areas meet or exceed water quality standards, the DMF conducts an extensive monitoring and reporting program. DMF routinely monitors water quality in shellfish growing areas and also investigates and monitors potential and actual pollution sources that could have an impact on shellfish. DMF summarizes its information for each growing area in Triennial Reports (prepared every three years) and Sanitary Surveys (prepared every ten years) which are required by the national Shellfish Sanitation Program for the proper classification of shellfish growing areas.

MAPC has reviewed the current reports for the shellfish growing areas in the project study area. The conclusions of these reports are discussed in Sections 1.4, 2.3 and 3.2 of this report.

DMF classifies shellfish beds as follows:

> Approved: The shellfish are suitable for human consumption.
> Conditionally approved: approved except during intermittent or unpredictable pollution events, such as rainfall or combined sewer overflows.
> Conditionally restricted: shellfish harvested in these areas must be relayed to either a clean site or to a depuration plant to remove pathogens.
> Prohibited: closed due to fecal coliform levels consistently exceeding 88 fecal coliform per 100 ml. of seawater.
> Management Closure: closed because DMF lacked the manpower to survey and monitor what is assumed to be an unproductive or heavily-contaminated area.

According to the Massachusetts Bays Program Comprehensive Conservation and Management Plan (CCMP), about 60 percent of the State's shellfish beds are permanently open. Between 1970 and 1990 the total area of closed shellfish beds on the South Shore increased roughly threefold. (MassBays, 1996)

The following sections describe the status of shellfish resources in the study area subbasins.

1.4.1 South Coastal Subbasins

Bound Brook/Gulf Subbasin

All shellfish beds in Cohasset Harbor are closed due to high fecal coliform counts. Approximately 400 acres of shellfish beds located from Bassing Beach east are "Approved". The town of Cohasset and the DMF have a shellfish bed restoration project funded by the Massachusetts Bays Program in the Whale Meadow area of the Harbor. The preliminary data from monitoring efforts show that the contamination problem stems from non-point sources such as individual sewage disposal systems, stormwater runoff and boats.

Duxbury Bay Subbasin

Approximately 4,585 acres of Duxbury Bay are currently classified as "Approved" with an open status for the direct harvest of shellfish. Thirty one acres of the Eagles Nest Bay are seasonally classified as "Conditionally Approved" with an open status from

November 1 to April 30. The western portion of Eagles Nest Bay and Eagles Nest Creek, as well as a small area of Bayside Marine in Snug Harbor are currently classified as "Prohibited" due to unacceptable water quality.

There are two classified shellfish growing areas in the Duxbury Bay project subbasin: the Bluefish River shellfish growing area and the Back River shellfish growing area.

The Bluefish River is a small tidal river located in the northwest corner of Duxbury Bay. The shellfish growing area comprises nearly 94 acres. As reported in DMF's December 1996 Triennial Report for the Bluefish River shellfish growing area, approximately one-third of the beds are classified as "Prohibited" and the remaining two-thirds are classified as either "Approved" or "Conditionally Approved." The Bluefish River subbasin was selected as one of three subbasins for detailed assessment and stormwater modeling under this project. See Chapter 4 for this assessment and more background information on the Bluefish River.

A pollution source shoreline survey was conducted in the fall of 1996 that identified twenty-eight potential pollution sources. These sources were previously identified a 1993 shoreline survey and remain unchanged. The potential pollution sources observed included, individual sewage disposal systems, stormdrains, municipal pipes, and boats. Rain events and stormwater runoff do not appear to adversely impact most of the bays' water quality. Those areas effected by stormwater runoff, (Bayside Marine and Eagles Nest Creek) are currently classified as prohibited.

The season of the year appears to have an adverse influence on water quality in Eagles Nest Bay. The bay is currently classified as "Conditionally Approved" with a closed status during summer months and an open status from November until May each year. The cause of the seasonal poor water quality is unknown.

The majority of Duxbury Bay does have excellent water quality that is likely do to the magnitude of the tidal exchange in the shellfish growing area. Duxbury Bay has ten-foot tides and experiences a seventy percent exchange of water each tide. The Bay also supports large numbers of ducks, geese and other waterfowl which, based upon monitoring programs, do not appear to effect water quality.

In 1993, Kingston, Plymouth and Duxbury began a multi-town initiative with the goal of improving near shore water quality and opening shellfish beds for commercial and recreational harvest. The Mass Bays Program awarded the tri-town Baywide Committee a grant to assist the DMF in the development of a conditional rainfall opening for the Bluefish River.

The Baywide Committee, the Mass Bays Program, and the Town of Duxbury were instrumental in developing an innovative shared system to repair failing septic systems in the Washington Street area of Duxbury that was directly contributing to the closure of the Bluefish River shellfish growing area. Following the success of the Bluefish Project, the town of Duxbury embarked on a second innovative shared project to replace failing septic systems in the Snug Harbor business district which were contributing pollution to Duxbury Bay. However, if the Snug Harbor sewer project fails to correct the sources of the pollution, the Bayside Marine shellfishing closure may have to be enlarged. See Section 6.1 and Appendix E for a more detailed description of these shared septic system projects.

Eagles Nest Creek and Bayside Marine are the two small areas that have continually experienced fecal pollution in the region. The Duxbury Bay in general area has a history of excellent water quality and has thus long been known for its exceptional shellfish that have been important to the local economies. The Town of Duxbury has been working aggressively to correct the pollution in Bayside Marine which likely has it's source in Snug Harbor, and all the towns in the region have taken steps to correct sources of pollution before it enters the bay.

North River Subbasin

The shellfish beds in a portion of the North River where reclassified by the DMF from "Prohibited/Closed" to "Conditionally Approved/Open" in March, 1996 on a seasonal basis between December 1 and April 30. However, the North River continues to be classified as "Prohibited/Closed" to shellfishing on the North River west of Damon's Point. As reported in DMF's March 1996 Sanitary Survey Report on the North River area, the Herring River, Macomber's Creek and an unnamed Scituate Stream also do not meet the NSSP criteria for "Conditionally Approved" classification.

A Memorandum of Understanding between the DFM, the DEP and the Town of Scituate will notify the respective shellfish constables of any problems at the local wastewater treatment plant within a reasonable time period to ensure public safety in the growing area.

The current wastewater treatment facility in Scituate was built in 1967 and was expanded in 1984. Six water samples were taken from the treatment facility over a five-month period in 1996 that revealed no water quality problems. A new plant is planned to become operational in December 1999 which may relieve current pressures on the existing treatment facility in Scituate.

A stormwater treatment system has been installed on the Marshfield side of the North River. A "flapper valve" has been installed on a stormwater pipe on the Scituate side of the river to prevent animals and birds from nesting in the pipe which may prevent past problems with stormwater pipe blockage.

South River Subbasin

The shellfish beds in the New Inlet area are seasonally approved however, none of the estimated 543 acres in the creeks or inlets in the subbasin are open to harvesting shellfish due to septic contamination. The South River has remained closed to shellfishing and classified as "Prohibited" due to poor water quality and the lack of a current sanitary survey. An updated sanitary survey was conducted in 1994 in which the DMF recommended that the South River remain classified as "Prohibited".

Pollution source surveys were conducted for both sides of the South River in 1994 that identified a total of 293 potential pollution sources in the area. Potential pollution sources observed included, stormdrains, individual sewage disposal systems, municipal pipes, the U.S. Air Force Base and U.S. Coast Guard Radio Station, boats and marinas, and stormwater runoff.

The last shoreline survey was conducted in the dry conditions of July so many of the storm drains in the region were not flowing and could not be sampled. However, even under less than worse case conditions, the South River fails to mean any NSSP classification other than "Prohibited". According to the MDF, the River contains numerous potential pollution sources and should remain closed to the harvest of shellfish until all sources can be tested under worst case conditions and corrected.

1.4.2 Weymouth & Weir Subbasins

Fore River

The shellfish beds in the upper Fore River are open. The areas from the Route 3A bridge downstream as well as the section of the Fore River from Wompatuck Road to Fort Point are conditionally restricted due to contamination from stormwater runoff.

Back River Subbasin

Shellfish beds east of Route 3A, in the Stodders Neck area of the Back River, are classified as "Conditionally Restricted," reflecting the fact that wet weather events are a main contributor to elevated fecal counts in the Back River. Potentially harvestable shellfish beds upstream of Route 3A are closed due to pollution. In Conditionally Restricted areas, if there is between 0.5 and 0.99 inches of rainfall, the shellfish beds are automatically closed for three days. If it rains between 1.0 and 1.9 inches, there is a five-day closure. If it rains more than two inches, the shellfish beds are closed until further notice or sampling can be done.

In its 1995 Triennial Report for Hingham Bay (which includes the Back River shellfish beds), the DMF noted that the shellfish take longer to recover from pollution events from snow melts, and recommended a longer closure period following these events. Additionally, the report confirms a relationship between treatment plant upsets at the MWRA's Nut Island plant in Quincy and contamination of shellfish in the Back River. The DMF has established a Memorandum of Understanding with the MWRA to ensure notification of potential pollution problems.

Hingham Harbor Subbasin

The majority of the shellfish beds in Hingham Harbor are conditionally restricted or closed due to high fecal coliform counts. Sources of the contamination include stormwater runoff and effluent from the Nut Island Treatment Plant in Quincy.

Shellfish harvesting is prohibited in Hingham Harbor from the Hingham Bathing Beach to the rotary on Route 3. The source of contamination for this area is fecal loading in Town Brook due to stormwater runoff and dry weather flow problems.

The shellfish beds around the islands in Hingham Bay (Grape, Sheep, Bumkin and Slate) are closed due to contamination from the MWRA's Nut Island Treatment Plant in Quincy. Shellfish beds around the Central Islands in Hingham Harbor (Ragged, Sarah and Langlee) are closed, with fecal contamination attributed to the abundance of birds residing in the area.

Another source of contamination contributing to shellfish bed closures in this subbasin is the area upstream of the Borland Bridge on the Weir River. This area is not sewered and was grossly contaminated by failing subsurface sewage disposal systems when surveyed in 1995. The communities of Cohasset, Hingham and Hull have recently been engaged in discussions to sewer the upper Weir River with treatment to occur at the Hull Sewage Treatment Plant (secondary treatment).

1.5 Areas of Critical Environmental Concern (ACECs)

Two areas of Areas of Critical Environmental Concern (ACEC) have been designated in the project area: the Weir River ACEC and the Weymouth Back River ACEC. The purpose of the ACEC program is to preserve, restore and enhance critical environmental resources and resource areas of the Commonwealth. An ACEC is an area containing concentrations of highly significant environmental resources that has been formally designated by the Commonwealth's Secretary of Environmental Affairs following a public nomination process. The enabling legislation and the regulations for ACECs list several kinds of environmental features and critical areas an ACEC may include, ranging from wetlands and water supply areas to rare species habitats and agricultural areas. To be eligible for designation, an area must contain at least four of these resource categories or features, and the resource and area must be of regional and/or statewide significance.

Weir River ACEC

Approximately 950 acres, the Weir River ACEC contains one of the most extensive salt marsh systems in the greater Boston metropolitan area. The water bodies included (partially or entirely) in the ACEC are the Weir River (Hingham) and Straits Pond (Cohasset and Hull). The area is subject to intense development pressure.

Because of its size, the ACEC, unlike the many small pockets of marshland that dot the urban landscape, is able to support over 100 migratory resident bird species, as well as numerous small mammals. An abundance of shellfish have been harvested historically and continue to feed the bird populations. The marsh and flats are also nursery and feeding areas for a wide variety of finfish, including alewives, smelt, flounder, bluefish and striped bass. Flood protection is provided by the floodplains of this estuarine system.

Weymouth Back River ACEC

The Weymouth Back River ACEC comprises approximately 950 acres in Hingham and Weymouth. The significant resource areas within the ACEC include anadromous and catadromous fish runs, fish spawning and nursery areas, an estuary with over 200 acres of open water, flood plains, over 100 acres of salt marsh, several salt ponds and 180 acres of open clam flats. Within the ACEC, habitat is available for many forms of wildlife, particularly birds.

The Weymouth ACEC is an unusual natural area in the midst of an urban/suburban environment, uniquely preserved considering its proximity to Boston. Approximately 180 acres are tidal waters flushing into Hingham Bay. There are productive clam flats and nursery and feeding areas for a wide variety of finfish. Herring Brook in Weymouth provides annual passage to Whitman's Pond for thousands of alewives, locally referred to as herring. The lower portion of Herring Brook, Hingham's Fresh River, and several unnamed tributaries provide spawning sites for an annual smelt run. The more than 100 acres of salt marsh and several salt ponds are vital links in the marine food web. Also included in the ACEC are ponds and swamps that form the headwaters of various tributaries to the Weymouth Back River.

The ACEC boundary generally follows the boundaries of several open space and marine areas: the Weymouth Back River estuary, Bare Cove Park, Great Esker Park, More-Brewer Park, Bouve Pond and Herring Brook.

In addition to the ACEC designation, the Commonwealth of Massachusetts has awarded the Back River status as a State Scenic River and as a Special Place.

Chapter 2: Water Quality Data

2.1 305(b) Water Quality Assessment

To evaluate the quality of a water resource it is helpful to know its use. Will the water be used for drinking? Shellfishing? Swimming? The Clean Water Act (CWA) established a process wherein the principal uses for the nation's waters were to be designated, and then the waters were to be assessed periodically to determine whether or not they are clean enough to be used as designated. Each state is required to monitor the quality of its surface and groundwater and prepare a report every two years describing the status of the water quality. This process, referred to as the 305(b) Water Quality Assessment process, is the principal means by which the EPA, Congress, and the public evaluate water quality, the progress made in maintaining and restoring water quality, and the extent to which problems remain.

The Massachusetts Surface Water Quality Standards define six water use classes for surface waters: A, B, and C for inland waters and SA, SB and SC for coastal and marine waters. Each class designates multiple water uses for which the water quality should be suitable. These uses are considered to be the most stringent or governing water uses. Waters may be suitable for other beneficial uses to the extent they are compatible with the designated uses. For example, the governing use for class A waters is public water supply and the governing use for Class B waters is primary contact recreation (swimming). Beneficial uses for Class C waters, as well as for Class A and B, include fish consumption, secondary contact recreation (e.g., boating), preservation of aquatic life and aesthetics. State regulations include the water quality standards that each water use class must meet (e.g., dissolved oxygen, temperature, fecal coliform, etc).

The 305(b) Water Quality Assessment determines whether a given stretch of a water body supports, partially supports, or does not support its designated uses and provides information on pollutants and suspected causes for areas not supporting or only partially supporting their designated uses. The Massachusetts Department of Environmental Protection (DEP) conducted a 305(b) Water Quality Assessment in 1992, including a basin-by-basin assessment of water quality. The DEP just recently published its 1998 assessment, but this does not include a basin-by-basin assessment.

An overview of the results of the 1992 assessment is listed in Table 2-1, for the South Coastal and Weymouth & Weir Basins. Note that the assessment only includes a partial list of the streams, ponds or harbors in each basin. It also focuses on ambient water quality, rather than drinking water quality (i.e., drinking water reservoirs are not included in the assessment). Maps from the 305(b) report are attached as Figure 2-1 (South Coastal Basin) and Figure 2-2 (Weymouth & Weir Basin). These figures present the information in Table 2-1 in a graphic format.

Table 2-1 and Figures 2-1 and 2-2 show whether an assessed segment supports (S), partially supports (PS) or does not support (NS) its designated uses. Table 2-1 lists the suspected pollution sources for segments that only partially support or do not support their designated uses.

As can be seen from Table 2-1 and Figures 2-1 and 2-2, only a few of the assessed waters in the study area fully support their designated uses. In the South Coastal basin, Duxbury Bay, a segment of Bound Brook and a segment of the South River fully support their designated uses. None of the assessed segments in the study area in the Weymouth and Weir basins fully support their designated uses.

The 305(b) assessment does not assess drinking water quality of reservoirs, although some Class A tributaries to reservoirs are assessed. As Table 2-1 shows, the Mill River and Old Swamp River in Weymouth are designated Class A waters but they do not meet the Class A standards. Water quality improvements in these waters should be a priority. Future development (such as the redevelopment of the South Weymouth Naval Air Station, which is located in the headwaters of the Old Swamp River), should strive to restore, rather than degrade, water quality.

2.2 MAPC Water Quality Database

One of the major tasks of this plan is the review, evaluation and mapping of available water quality monitoring data with the purpose of gaining an understanding of the nature and extent of water quality problems in the study area.

MAPC developed a database of recent water quality monitoring data. The database includes 822 fecal coliform samples and 220 nitrate-nitrogen samples collected from 56 locations within the project study area, between 1990 and 1997. (There are 56 stations in

Table 2-1: DEP Water Quality Ratings For South Shore Rivers And Harbors South Coastal Basins

River Segment	Use Class	Status	Cause of Partial or Non-Support Status
DUXBURY BAY BASIN			
Duxbury Bay	SA	S	
BOUND BROOK/GULF BASIN			
Bound Brook	B	S	
Cohasset Harbor	SA	NS	Pathogens (septic tanks, municipal point sources, non-urban runoff)
The Gulf	SB	NS	Pathogens (septic tanks, non-urban runoff)
Scituate Harbor	SA	PS	Pathogens (source unknown)
GREEN HARBOR RIVER BASIN			
Green Harbor	SA	NS	Pathogens (septic tanks)
Green Harbor River	B	PS	Pathogens (septic tanks)
INDIAN HEAD RIVER BASIN			
French Stream	B	PS	Nutrients, organic enrichment/DO, pathogens (municipal point sources, natural sources, non-urban runoff)
Indian Head River	B	PS	Nutrients, organic enrichment/DO (municipal point sources, natural sources)
NORTH RIVER BASIN			
Herring River	SA	PS	Pathogens (septic tanks, non-urban runoff, recreational activities, marinas)
North River (3A to mouth)	SA	PS	Pathogens (septic tanks, non-urban runoff)
North River (Curtis Crossing Dam to 3A)	SA	NS	Organic enrichment/DO, pathogens (septic tanks, non-urban runoff, septic disposal, natural sources)
SOUTH RIVER BASIN			
South River (outlet South Reserv., Duxbury to Main St., Marshfield)	B	S	
South River (Main St., Marshfield to North River)	SA	NS	Unionized ammonia, pathogens, organic enrichment/DO (non-urban runoff, septic tanks, natural sources)

Table 2-2: DEP Water Quality Ratings For South Shore Rivers And Harbors Weymouth & Weir Basins

River Segment	Use Class	Status	Cause of Partial or Non-Support Status
WEIR RIVER BASIN			
Weir River (Rockland St. and Straits Pond to mouth at World's End)	SA	NS	Pathogens (urban runoff/ storm sewers)
Weir River (confluence w/ Crooked Meadow R. Fulling Meadow Bk. to tidal area)	B	PS	Nutrients, pathogens (source unknown)
Crooked Meadow River (Cushing Pond to Weir R.)	B	NS	Organic enrichment/DO, nutrients, noxious aquatic plants (urban runoff/strm sewers, septic tanks)
WEYMOUTH/FORE RIVER BASIN			
Weymouth Fore River (Rte.53 to mouth)	SB	NS	Pathogens (urban runoff/ storm sewers, unknown)
WEYMOUTH/BACK RIVER BASIN			
Weymouth Back River (outlet Whitmans Pond to tidal area)	B	NS	Organic enrichment/DO, pathogens (septic tanks, urban runoff/strm sewers)
Weymouth Back River (RR tracks to mouth)	SA	NS	Pathogens (combined sewer overflow, urban runoff/storm sewers)
Mill River (outlet Great Pond to inlet Whitmans Pond)	A	NS	Noxious aquatic plants, pathogens, nutrients (urban runoff/storm sewers, septic tanks)
Old Swamp River (headwaters to inlet Whitmans Pond)	A	NS	Pathogens, organic enrichment/DO (urban runoff/storm sewers, septic tanks)

Legend:

Class (water use classification):

A=public water supply — SA = marine water, designated for shellfishing
B=fishable, swimmable — SB = marine water, designated for swimming & fishing
C=fishable — SC = marine water, fishable

Status (An indication of an individual segment's level of designated use support):

S= All designated uses supported
PS= Partially supporting one or more designated uses
NS= Not supporting one or more designated uses

Source: Massachusetts Department of Environmental Protection. Division of Water Pollution Control. Summary of Water Quality. 1992.

Figure 2-1: Water Quality Assessment for South Coastal Basins

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Figure 2-2: Water Quality Assessment for Weymouth & Weir River Basins

the database, but station numbers extend to 61 since numbers 25 through 29 were reserved but never utilized.)

2.2.1 Fecal Coliform

<u>*Bacteriological Contamination*</u>

The 1992 Water Quality Assessment shows pathogens to be one of the primary causes of non-attainment of water quality. Pathogens are disease-causing organisms, and include harmful classes of bacteria (such as those that cause gastroenteritis, dysentery and cholera), viruses (e.g., hepatitis A) and protozoans (such as *Giardia lamblia* and *Cryptosporidium*). These disease-causing organisms can enter water resources if the water is contaminated with fecal matter. Faulty septic tanks, improperly treated wastewater, combined sewer overflows (CSOs), surcharging storm sewers and cross-connections (sewage flowing into water pipes) can all be sources of pathogen contamination. Bacteria from warm-blooded animals, particularly waterfowl, are another common, and natural, source of elevated fecal coliform counts.

Because it is not feasible to test for all of the specific disease-causing pathogens, coliform bacteria, which are prevalent in fecal matter, are used as an "indicator organism" to warn of possible fecal contamination. Coliform bacteria that reside in the human intestinal tract are excreted in large amounts in feces, averaging about 50 million coliforms per gram. Untreated domestic wastewater generally contains more than 3 million coliforms per 100 ml.[1] There is therefore a strong association between the presence of coliform bacteria and the presence of fecal matter.

The fecal coliform test is used to identify coliforms from the feces of humans and other warm-blooded animals, rather than from non-fecal sources. Fecal coliform results are typically discussed as the number of colonies present per 100 ml. of water sample. Table 2-2 provides the coliform standards for various water uses.

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[1] Viessman, Warren Jr. and Hammer, Mark J. Water Supply and Pollution Control. 4th Edition. Harper & Row. 1985.

Table 2-3
Fecal Coliform Standards by Designated Use

Designated Use	Classification	Standards
Drinking water supply	A	Any positive repeat sample at the tap (after treatment) is a violation.
Fresh water, open for swimming (primary contact recreation)	B	Geometric mean ≤ 200 col/100 ml. 90% of samples ≤ 400 col/100 ml
Fresh water, safe for boating and other non-contact recreation (secondary contact recreation)	C	Geometric mean ≤1000 col/100 ml 90% of samples ≤ 2000 col/100 ml
Marine water open, for shellfishing	SA	Geometric mean ≤ 14 col/100 ml. 90% of samples ≤ 43 col/100 ml
Marine water, closed for shellfishing	SB	Geometric mean ≤ 88/100 ml 90% of samples ≤ 260/100 ml

Fecal coliform results can have a huge range. Whereas water free from fecal matter may not detect any fecal bacteria, a sample contaminated with sewage or animal waste may have thousands of col/100 ml, or even be classified as "too-numerous-to-count." Because of this huge range, fecal coliform results are typically expressed in terms of the geometric mean. The geometric mean prevents the distortion that occurs from the arithmetic average. For example, if a simple arithmetic average of several samples is calculated, one very high level can create a high average, masking the fact that all other samples were low. The geometric mean is based on the average of the natural logarithm of the samples.

The geometric mean cannot be calculated for samples with a result of zero (0), because the logarithm of zero cannot be calculated. In order to calculate the geometric mean for data sets with results of zero, MAPC changed all "0" fecal coliform results from 0 to 0.01 col/100 ml. The "notes" column in the database identifies each sample that was altered in this way.

2.2.2 Nitrate-Nitrogen

Nutrients such as nitrogen and phosphorus are essential for plant growth, but an excessive amount of these nutrients leads to eutrophication. Nitrogen is considered the limiting nutrient for salt-water systems and phosphorus for fresh water systems. Thus, excess nitrogen inputs will cause algal blooms and excessive aquatic weed growth in marine environments and excess phosphorus inputs will cause algal blooms and excessive aquatic weed growth in lakes, rivers and streams. Algal blooms contribute to the decline of submerged aquatic vegetation by reducing light available for photosynthesis. Dissolved oxygen levels are depleted as dead plant material decomposes, thus killing fish and other fauna.

Sources of nitrogen include heavily fertilized lawns, golf courses and other intensively-managed turf areas, septic systems, agriculture and municipal wastewater treatment plants. For coastal embayments, the relative impact of nitrogen sources depends on land use patterns and the characteristics of the embayment including depth, volume, and flushing time. Because of the site-specific nature of nutrient impacts, there is no quantitative nitrogen standard for water quality, as there is for fecal coliform. Massachusetts' ambient water quality standards are a qualitative standard that require that the level of nutrients remain below that which will cause eutrophication. Nitrate standards for drinking water are 10 mg/l.

2.3 Water Quality Data by Subbasin

The primary source of water quality monitoring data in the MAPC database are data collected by and for three area watershed associations: the North and South Rivers Watershed Association (NSRWA), the Fore River Watershed Association (FRWA), and the Weymouth Back River Committee. The database also includes some limited sampling conducted by the DEP in 1996.

The MAPC database does not include fecal coliform data from the Division of Marine Fisheries (DMF), except for some monitoring that the DMF conducted for the Back River Committee in 1995**.** After much consideration, MAPC decided not to use the DMF data, for two reasons. First, it was decided that inclusion of the data would require a great deal of time, but would not add much benefit, since the results of the data, and the conclusions to be drawn from them, are well summarized in DMF's Triennial Reports and Sanitary Surveys. By focusing on these reports, we could understand and relay what is known about water quality, without spending limited project resources on incorporating the data into the database. Summaries of the DMF reports are included in Section 1.4. Second, much of the DMF data focuses on potential or actual pollution sources (e.g., breakouts from failing septic systems). The MAPC database focuses on water quality in the rivers and tributaries, not on direct pollution sources.

This chapter describes the water quality monitoring data contained in MAPC's database, by subbasin. Table 2-4 shows the number of water quality monitoring stations in each subbasin. The MAPC database includes fecal coliform data collected in seven subbasins and nitrate-nitrogen data from two subbasins (the South River and Weir River).

The MAPC database does not include any data from the Bound Brook, Duxbury Bay, or Indian Head River subbasins. A substantial amount of fecal coliform data (from DMF) exists for shellfish growing areas in Duxbury Bay and the Gulf (Bound Brook subbasin). MAPC was unable to identify any recent fecal coliform or nitrate-nitrogen data for the Indian Head River subbasin. Water quality monitoring for this basin would be useful, considering the large number of pollution concerns (see Section 2.3).

The MAPC database also does not include any data from the Jones River or Taunton River basins, however, the project study area includes only a slight percentage of the total land area of these two basins.

Figure 2-3 is a GIS map showing water quality monitoring stations in the project area. Only stations used in the MAPC database are shown on the map. Fecal coliform monitoring stations are color coded to show the station's overall compatibility with ambient water quality standards, using an approach borrowed from the DEP's 1994 Resource Assessment for the Neponset River Basin.

Table 2-4
MAPC Database: Water Quality Monitoring Stations by Subbasin

Subbasin	Fecal Coliform	Nitrates	Total # Stations	# Samples Collected
South Coastal Basins	Number of Water Quality Monitoring Stations			
North River	8	-	8	214
South River	11	15	15	Fecal 318 Nitrates 213
Green Harbor	1	-	1	4
Weymouth & Weir Basin				
Back River	6	-	6	61
Fore River	16	-	16	111
Hingham Harbor	2	-	2	97
Weir River	8	7	8	Fecal 17 Nitrates 7
TOTAL	***52***	***22***	***56***	***1,042***

If the geometric mean of samples collected at the site is above 1,000 col/100 ml (the standard for class C water), the monitoring station symbol on Figure 2-3 is a red circle. If the geometric mean is above 200 col/100 ml (the standard for Class B water), but below 1,000 col/100 ml, the monitoring station symbol is a yellow circle. If the geometric mean is below 200 col/100, then the monitoring station symbol is a green circle. A green circle does not imply that the water is clean enough for all uses. The fecal coliform standard for shellfishing is only 14 col/100 ml. If contaminated shellfish beds are to be reopened, fecal coliform levels must be reduced far below the 200 col/100 ml Class B standard.

Figure 2-3: Water Quality Monitoring Stations

(GIS Map)

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Summary tables are provided below in the subbasin-by-subbasin discussion. These tables include the following information for each monitoring station: MAPC ID number, monitoring location and potential pollution source (if any), parameter monitored for, the time period in which samples were taken, the number of samples collected, and the geometric mean (for fecal coliform) or arithmetic mean (for nitrate-nitrogen) of the sample results.

Appendix A provides two additional summary reports from the MAPC database, one for fecal coliform results and the other for nitrate-nitrogen results. Appendix A-1, Fecal Coliform Data: Summary by Site Location, provides: the number and percent of samples with fecal coliform levels above 200 col/100 ml; the number and percent of samples with fecal coliform levels above 1,000 col/100 ml; and the minimum and maximum values reported for each monitoring station. Appendix A-2, Nitrate Data: Summary by Site Location, provides the minimum, maximum and average value for each monitoring station.

2.3.1 South Coastal Basins

The MAPC database includes fecal coliform and nitrate-nitrogen samples collected in the North and South River basins by the North and South Rivers Watershed Association (NSRWA). NSRWA's December 1993 report, titled Stormwater Investigations Relating to the South River, states that loading of fecal bacteria and nutrients is of particular concern in the North and South River watersheds. The report states that wet and dry weather sampling conducted over a period of several years indicates a relationship between high fecal coliform values and wet weather.[*]

The North and South Rivers Watershed Association has sponsored on-going citizens monitoring efforts in the North and South rivers and their tributaries for over five years. Approximately every six months, the rivers are tested for fecal coliform, pH, dissolved oxygen and nitrate-nitrogen. Since 1995, NSRWA has conducted intensive summertime monitoring. For a nine-week period during the summer, ten sites on the North and South rivers and their tributaries are monitored weekly for fecal coliform. The MAPC database

[*] North and South River Watershed Association. Stormwater Investigations Relating to the South River. December 1993. Page 4.

includes this summertime monitoring from these ten stations for the years 1995 through 1997.

North River Subbasin

The MAPC database includes 214 samples collected from eight stations on the North River and its tributaries during the summers of 1995, 1996, and 1997. These data were collected as part of the North and South Rivers Watershed Association's (NSRWA's) volunteer monitoring program.

As shown in Table 2-5, fecal coliform levels were elevated at several of the monitoring stations. Station #3 is the town of Scituate's wastewater treatment plant discharge, so elevated levels are not surprising here. Station #7, at the Washington Street (Route 53) bridge in Hanover had a geometric mean of 202, with a maximum value of 4,500 (see Appendix A-1. According to NSRWA, failing septic systems along the river are believed to be the source of these elevated counts.

Station #10, at Corn Hill Lane, had a geometric mean of 104, with a maximum value of 1,200. The source of these elevated counts is not confirmed. The Corn Hill drainage area includes portions of Norwell and Marshfield upstream and downstream of the confluence of Second Herring Brook with the North River. A 1991 study of the North River by Baystate Environmental Consultants, Inc. concluded the following with regard to the Corn Hill drainage area:

> "[A]lthough lightly developed and containing much wetland, this area is a growing concern as a source of fecal bacteria. Natural sources may be substantial, but at least two illegal discharges from residential areas have been located along Corn Hill Lane….Fecal coliform values in the North River in this area average well above the desirable limit, and it is not completely clear whether this is due to localized inputs or an accumulation of fecal bacteria as a function of tidal activity." (BEC, 1991)

Norwell officials did not identify any septic system problem areas in the Corn Hill area. The Till Rock Lane development on Barque Hill, about 2-1/2 miles upstream of the Corn Hill monitoring station, is the nearest septic system problem area identified for this study.

Table 2-5
Water Quality Data in the North River Subbasin
Geographical Distribution of Fecal Coliform

MAPC ID #	Address (Pollution Source)	Min Date	Max Date	Samples Collected	Geom. Mean
NORTH RIVER SUBBASIN – Headwaters to Mouth of River					
7	No. River, Washington St. Bridge, Hanover (failing systems along river)	6/29/95	8/26/97	27	202
10	No. River, Corn Hill Lane, Marshfield	6/29/95	8/26/97	26	104
6	No. River at Bridge St./Union St. bridge (Norwell/Marshfield)	6/5/95	8/26/97	27	37
1	North River Marine, Scituate	6/29/95	8/26/97	27	8
2	Damon's Point, Marshfield	6/29/95	8/26/97	26	4
4	James Landing, Scituate	6/29/95	8/26/97	27	19
3	Scituate Treatment Plant, Scituate (wastewater treatment plant discharge)	6/29/95	8/26/97	27	365
5	Mouth of North River, Scituate	6/29/95	8/26/97	27	1
Subbasin Totals		***6/29/95***	***8/26/97***	***214***	***26***

The 1991 study by Baystate Environmental entailed the collection of over 400 samples from over 200 stations on the North River. They concluded that the data “suggests significant inputs all along the river.” They confirmed a link between stormwater and elevated fecal coliform counts in the river, stating that “it is apparent that stormwater drainage pipes yield the highest concentrations of fecal coliform bacteria, often greater than 1,000 col/100 ml.” They added, however, that with regard to overall fecal coliform loading in the river, loads from stormwater were roughly equivalent loads from the larger tributaries since stormwater concentrations are about a magnitude higher than the larger tributaries, but flows are about an order of magnitude lower.

Figure 2-4 graphs the geographical distribution of fecal coliform along the North River. Fecal coliform levels are represented from the headwaters, to the mouth of the North River.

South River Subbasin

The MAPC database includes 318 fecal coliform samples collected from eleven stations and 213 nitrate samples collected from 15 stations in the South River subbasin. With the exception of five nitrate samples collected by the DEP in 1996, all of the samples were collected by the North and South Rivers Watershed Association (NSRWA). Except for the 1996 DEP data and NSRWA data collected from stations #8 and #9, all samples were collected between 1990 and 1993 and are reported in NSRWA's December 1993 report to the DEP titled Stormwater Investigations Relating to the South River. In addition to the 1990 to 1993 data, stations #8 and #9 include fecal coliform samples collected as part of NSRWA's weekly summertime sampling program in 1995, 1996 and 1997.

As shown in Table 2-6 and Figure 2-5a, the geometric mean of fecal coliform results from two stations were above 200 col/100 ml: station #8 (geometric mean of 482, based on 43 samples) and station #61 (geometric mean of 274, based on 10 samples). Station #8 is located on the South River at the Willow Street Bridge in Marshfield. Seventy-four percent of the samples collected at this station exceeded 200 col/100 ml and 47 percent exceeded 1,000 col/100 ml. Station #61 is located 0.3 miles downstream of station #8. Although it had a higher maximum count (20,000 col/100 ml), it had lower values overall, with 40 percent of samples exceeding 200 col/100 ml and 20 percent of samples exceeding 1,000 col/100 ml.

The higher values for station #8 may be explained in part by the fact that the river is culverted at this location and there is less flushing (and less exposure to sunlight) than at station #61, where the river is in its natural channel. Also, there are businesses close to the river around station #8. Bacteria levels at station #8 should improve because the town has reconstructed the septic system for the South River School, west of Willow Street.

The portion of the South River where stations #8 and #61 are located runs along Route 139 in the commercially developed center of Marshfield. This area is unsewered and is a known septic system problem area. Elevated fecal coliform counts in this area were also identified in a 1987 study conducted by the North River Commission. Stormwater infrastructure, including an extended detention basin upstream of station #8, may be contributing pollutants at these locations. Finally, station #8 may also be affected by a

Figure 2-4: Geographical Distribution of Fecal Coliform Along North River

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colony of waterfowl at Veterans Memorial Park. Follow-up monitoring could be conducted to identify whether the fecal coliform is of human or animal origin.

Nitrate monitoring conducted by NSRWA between 1990 and 1993 also showed some elevated nitrate levels at station #8. Of 13 samples, the maximum level was 3.08 mg/l.

High maximum counts (exceeding 1,000 col/100 ml) were observed at all but three of the eleven stations. At least some of the peak values may be attributable to stormwater runoff and/or natural sources (i.e., waterfowl). NSRWA's 1993 report notes that high values were obtained at each of the sampling locations, particularly after a wet weather event. With regard to natural sources, a colony of geese is known to frequent site #49 (Little's Creek at the Keene's Pond outlet). A sample collected from station #49 also had the highest nitrate level (6.6 mg/l) of all 213 samples collected in the South River Basin. The average nitrate level of the 26 samples taken at station #49 was 0.73 mg/l.

The location with the highest average nitrate level was Furnace Brook at Parson's Pond (station #46). The average value of 27 samples collected between 1990 and 1993 was 2.00 mg/l, with a maximum value of 4.4 mg/l. The DEP collected five nitrate samples at four stations in Furnace Brook in August 1996. Two of the stations were near the town of Marshfield's Furnace Brook well. The highest value recorded was 1.04 mg/l.

Figures 2-5a and 2-5b graph the geographical distribution of fecal coliform and nitrates, respectively, along the South River. Both fecal coliform and nitrate levels are represented from the headwaters, to the mouth of the South River.

Table 2-6
Water Quality Data in the South River Subbasin

MAPC ID #	Address (Pollution Source)	F-Fecal Coliform N-Nitrate	Min Date	Max Date	Samples Collected	Geo. Mean- Fecal Coliform Samples	Mean- Nitrate Samples
SOUTH RIVER SUBBASIN – Headwater to Mouth of River							
45	Chandler's Pond Outlet, Marshfield	F	6/9/90	9/11/93	30	23	
		N	6/9/90	9/11/93	26		0.28
48	Clapp's Creek, Marshfield	F	6/9/90	9/11/93	30	69	
		N	6/9/90	9/11/93	28		0.23
21	Furnace Brook @ School St	N	8/29/96	-	1		0.17
22	Furnace Bk @ pump. sta.	N	8/29/96	-	1		0.61
23	Furnace Bk @ Furnace St	N	8/29/96	-	1		1.04
24	Furnace Pond opposite well	N	8/29/96	-	2		0.98
46	Furnace Brook/Parson's Pond Outlet, Marshfield	F	6/9/90	9/11/93	30	64	
		N	6/9/90	9/11/93	27		2.00
52	Below Memorial Park & Rt. 3A, Marshfield	F	8/10/91	9/11/93	16	129	
		N	9/19/92	6/12/93	2		0.33
8	So. River, Willow St. Bridge, Marshfield	F	10/13/90	8/26/97	43	482	
		N	10/13/90	9/11/93	13		0.96
61	So. River at abandoned RR	F	3/9/91	12/14/91	10	274	
	trestle, Marshfield	N	3/9/91	12/14/91	10		0.59
47	Howe's Brook, Marshfield	F	6/9/90	9/11/93	30	64	
		N	6/9/90	9/11/93	27		1.28
48	Clapp's Creek , Marshfield	F	6/9/90	9/11/93	30	69	
		N	6/9/90	9/11/93	28		0.23
9	So. River, Julian St. Bridge	F	1/19/91	8/26/97	50	34	
		N	2/9/91	9/11/93	19		0.27
49	Little's Creek/Keene's Pond Outlet, Marshfield	F	6/9/90	9/11/93	30	39	
		N	6/9/90	9/11/93	26		0.73
51	South River Mouth at Trouant Island	F	8/11/90	9/11/93	19	5	
		N	11/10/90	11/9/91	3		0.51
50	Murdock's Pond, above Macomber's Ck, Marshfield	F	6/9/90	9/11/93	30	13	
		N	6/9/90	9/11/93	27		0.36
Subbasin Total		F	6/9/90	8/26/97	318	52.9	
		N	6/9/90	9/11/93	213		0.75

Figure 2-5a: Geographical Distribution of Fecal Coliform in South River Subbasin

Figure 2-5b: Geographical Distribution of Nitrates in South River Subbasin

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Figure 2-6a, 2-6b, 2-7: Fecal Coliform Results Stations - Station #8, #52

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Green Harbor River Subbasin

The MAPC database contains 4 fecal coliform samples from one monitoring station in the Green Harbor River Subbasin. Samples were collected by the Massachusetts Department of Environmental Protection in the summer of 1996, just upstream of the Route 139 Bridge near the mouth of the Green Harbor River. Results ranged from 20 col/100 ml to 180 col./100 ml, with a geometric mean of 62.

Table 2-7
Water Quality Data in the Green Harbor River Subbasin

MAPC ID #	Address (Pollution Source)	F-Fecal Coliform	Min Date	Max Date	Samples Collected	Geo. Mean
GREEN HARBOR RIVER BASIN						
44	Green Harbor River, upstream of Rt. 139 Bridge	F	7/9/96	8/29/96	4	62

Bound Brook/Gulf Subbasin

The MAPC database does not include any water quality samples collected from the Bound Brook/Gulf subbasin. The Gulf Association does have a sampling program that it has been conducting in conjunction with the Town of Scituate and the Cohasset High School, but data was not provided to MAPC. Since the fall of 1996 seven sites have been monitored for dissolved oxygen, fecal coliform, pH, total suspended solids, biological oxygen demand, temperature, and turbidity. According to an interview with the Gulf Association the results of the testing were tabulated into a Water Quality Index, which ranked water quality at the low end of the “good” range.

The Association has also collected fecal coliform data for about the past eight years from various sites along the Gulf. This information has been useful to identify potential and actual pollution sources. Elevated levels of fecal coliform were reportedly detected at the monitoring station near the Hatherly Country Club in Scituate (due to the abundant geese population) and around three house sites, but in general fecal coliform levels have not been elevated.

Indian Head River Subbasin (tributary to the North River Basin)

The Indian Head River subbasin is tributary to the North River Subbasin. The Indian Head River is the upstream, freshwater portion of the North River. The major tributaries to the Indian Head River are French Stream and the Drinkwater River.

MAPC could not identify any sources of recent fecal coliform or nitrate data in the Indian Head River subbasin. This is a significant data gap, given that this subbasin has numerous potential and confirmed pollution sources, including old industrial and military sites, several old landfills, the Rockland wastewater treatment plant, and the South Weymouth Naval Air Station, which sits at the headwaters of French Stream.

Greg Thomson of the Rockland Sewer Commission noted that he conducted metals testing in French Stream in 1997. He stated that he tested for 13 metals and did not find any levels above state standards.

A Masters Candidate at UMass Boston, Frederick SaintOurs, is conducting a comparison study of macroinvertebrate fauna in tributary streams for the North River watershed. His preliminary research and observation of French Stream identified it as a degraded tributary. Sampling for this thesis research will begin in the late summer or fall of 1998.

2.3.2 Weymouth & Weir Subbasins

Back River Subbasin

The database includes 61 fecal coliform samples collected from six monitoring stations between January 30 and December 5, 1995. Samples were collected by the Division of Marine Fisheries for the Back River Committee. These monitoring stations are located upstream of the open shellfish growing areas (see Section 1.4.2).

Table 2-8
Water Quality Data in the Back River Subbasin

MAPC ID #	Address (Pollution Source)	F-Fecal Coliform	Min Date	Max Date	Samples Collected	Geo. Mean
BACK RIVER SUBBASIN						
42	Herring Run	F	5/22/95	12/5/95	6	649
43	Wharf St. drain, Weymouth (storm drain adjacent to pump station)	F	9/20/95	12/5/95	4	692
41	Fresh River @ South St. Hingham	F	5/25/95	12/5/95	12	212
38	Puritan St. Drain, Weymouth (storm drain)	F	1/30/95	12/5/95	19	139
39	Beal Cove Creek, Hingham	F	1/30/95	12/5/95	17	88
40	Bare Cove Crest, Hingham	F	1/30/95	11/28/95	3	2
Subbasin Totals			**1/30/95**	**1/25/95**	**61**	**140**

Results from three of the six locations have a geometric mean above 200 col/100 ml: Wharf Street drain (692 col/100 ml), Herring Run Brook (649 col/100 ml), and Fresh River at South Street (212 col/100 ml). Except for the Bare Cove Crest location (station #40), results from all six stations had maximum values exceeding 1,000 col/ml, with a range of 2,401 to 3,500 col/100 ml (see Appendix A-1).

The Fresh River drains from the wetlands bordering Bouve and Brewer Ponds. A draft 1996 report prepared for the Weymouth Back River Committee* cites leachate from the Hingham landfill as a possible, but unconfirmed, source of pollution to the Fresh River. Other possible pollution sources, according to this report, are an illegal sewer connection or septic hauler properties which abut the marsh and the Fresh River.

The storm drain at Puritan Road (station #38) has been confirmed by DMF as a pollution source, due to cesspools and stormwater runoff. The town of Weymouth obtained a grant to install a StormTreat stormwater treatment system at Puritan Road to remove bacteria, however it now appears that the high groundwater table and tidal influence at this location will make the system unworkable. The project is on hold for the time being.

Illicit sewer connections to the storm drain may be the cause of elevated fecal counts in the Wharf Street station, according to the 1996 Back River Committee report. The report

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* Myers, Jennifer. Inventory of Natural Resources and Land Use in the Weymouth Back River ACEC. Submitted to the Weymouth Back River Committee. Final Draft. October 1996.

notes that the outfall area had been used historically by factories and businesses for sewage disposal. There is also a former landfill on Wharf Street. The landfill was closed in 1984 and the town is currently in the process of capping the landfill.

Herring Run Brook is an anadromous fish run that flows from the northeast corner of Whitman's Pond and runs approximately one-half mile before entering the southern tip of the salt marsh located at the head of the Back River. The Back River is an Area of Critical Environmental Concern (ACEC), designated for its important environmental resources (see Section 1.5).

Herring Run Brook passes through Jackson Square in Weymouth. Jackson Square is a heavily developed commercial area and Herring Run Brook is culverted through part of its passage through this area. The Weymouth Conservation Agent specifically mentioned Jackson Square as a concern for its impact on the Herring Run due to oil, grease and sediments in stormwater runoff. The culverted portion of Herring Run Brook runs through some unsewered areas. Also, the project committee noted that there is an area where horses are kept adjacent to Herring Run Brook

Figure 2-8, 2-9: Fecal Coliform Results – Station #41, #42

back of Figure 2-8

Fore River Basin

The database includes 111 fecal coliform samples taken from 16 monitoring stations between September 1, 1994 and January 27, 1997. These samples were collected by the Tellus Institute and the Fore River Watershed Association (FRWA). Samples collected before February 1996 were collected by Tellus, and samples collected after this date were collected by FRWA and analyzed by the MWRA.

The Tellus Institute samples were collected as part of the Fore River Embayment Project, which was funded by a MassBays grant. The project included sediment and water quality sampling throughout the Fore River and its tributaries in Braintree, Quincy and Weymouth. Because the MAPC study area does not include Braintree and Quincy, only samples from the Weymouth stations are included in the MAPC database.

The MAPC database includes samples from the following areas in the Fore River basin:

- Smelt Brook at the Quirk car dealership at the Braintree/Weymouth town line (station 37);
- Lower Mill Cove at Montcalm Street (station 35);
- An unnamed stream that runs from the Cranberry Pond outlet to the Fore River (station 36);
- An unnamed tributary that discharges to Lower Mill Cove (station 34)
- Phillips Creek where it empties into Mill Cove (station 32) and at several upstream locations (stations 30, 31, 33 and 53-60).

Fecal coliform monitoring results for stations 34-37 along the Fore River Subbasin are graphed in Figure 2-12, 2-11, and 2-12.

Tellus Institute concluded that there is significant bacterial contamination at various locations in the Fore River on a periodic basis. Indeed, of the 16 locations in the MAPC database, only four had a geometric mean below 200. The report further concluded that "[I]nteresting, the locations of highest bacterial contamination were at the points of freshwater inflows…", including Phillips Creek in Weymouth.[*]

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[*] Tellus Institute. Fore River Embayment Project, Interim Final Project Report. Submitted to Massachusetts Bays Program. March 1996.

Phillips Creek experienced the highest bacterial counts identified in the entire MAPC database. Samples from eight stations along Phillips Creek had a geometric mean above 800 col/100 ml, and four of these stations had a geometric mean above 1,000 col/100 ml. Phillips Creek empties into Mill Cove, the site of substantial shellfish resources that have been closed for harvesting for more than a decade.

Although Weymouth is about 92 percent sewered, the Weymouth DPW informed Tellus of several properties along Phillips Creek that had on-site sewage treatment, including two cesspools very close to the streambed. Tellus collected five samples at a location downstream of the two cesspools (MAPC site 53) and at a location a few hundred feet upstream of the cesspools (MAPC site 54). The geometric mean of the fecal coliform results from the downstream site was about 72 percent higher than the geometric mean of results from the upstream site, however the geometric mean of samples from both locations was above 1,000 col/100 ml. This led Tellus to conclude that sources in addition to the cesspools were contributing bacteria to the brook. These cesspools have not yet been connected to sewer. Monitoring is continuing to determine if water quality is being impaired by these cesspools.

Tellus conducted additional upstream sampling, but concluded that the source remained elusive. Possible sources included leakage from the sewer line (that parallels and crosses Phillips Creek) into the stormdrain near Katherine Street. A television inspection of the sewer line was inconclusive. Tellus reported that the sewer line appeared to be in good condition overall, with a few areas where infiltration was noticed.

In sum, Tellus concluded that “[I]n light of the elusive and likely non-point nature of the sources of bacterial contamination to Phillips Creek, the best intervention to decrease contaminant inputs to Mill Cove may be Stormwater Best Management Practices.”

Lower Mill Cove at Montcalm Street (station 35) was another location with elevated fecal coliform levels (geometric mean of nine samples was 724 col/100 ml). Eight of the nine samples collected at station 35 between July 1996 and July 1997 had fecal coliform levels

Figures 2-10, 2-11, 2-12: Fecal Coliform Results – Stations #34-#37

back of Figure 2-10, 2-12

greater than 200 col/100 ml, with a maximum level of 3600 col/100 ml. A sewer manhole on Montcalm Street is subject to surcharging during wet weather, and is shown as site 96 in the potential pollution sources database (see Fore River Subbasin discussion in Section 3.2.2).

The Smelt Brook monitoring station (station 37) also showed elevated fecal coliform levels. The geometric mean of the ten samples collected at this location between April 1996 and January 1997 was 340 col/100 ml, with a maximum level of 104,000. As discussed in Section 3.2.2 (Fore River Subbasin section), Smelt Brook is adversely affected by sewage overflows from a sewage siphon that drops below Smelt Brook shortly before it feeds the Fore River. FRWA continues to monitor station 37 on a monthly basis. A sample collected by FRWA at station 37 during a surcharging event in April 1997, contained a fecal coliform level of 436,000 col/100 ml.

Table 2-9
Water Quality Data in the Fore River Subbasin

MAPC ID #	Address (Pollution Source)	F-Fecal Coliform	Min Date	Max Date	Samples Collected	Geo. Mean
FORE RIVER SUBBASIN – Headwaters to Mouth of River						
37	Smelt Brook at Quirk, Weymouth	F	4/23/96	1/27/97	10	340
36	Cranberry Pond outlet @ Commercial St., Weymouth	F	4/23/96	1/27/97	9	143
34	Lower Mill Cove at Commercial St., Weymouth	F	4/23/96	1/27/97	9	198
35	Lower Mill Cove at Montcalm St., Weymouth	F	7/15/96	1/27/97	9	724
60	Phillips Creek, btwn Katherine & Green Streets (near culvert)	F	5/25/95	11/28/95	4	150
59	Phillips Creek, btwn Katherine & Green Streets (near cans)	F	5/25/95	11/28/95	4	229
30	Phillips Ck, approx. 100 yds. Downstream from # 59	F	8/1/95	11/28/95	3	541
31	Phillips Creek, right side storm drain tributary (storm drain)	F	11/28/95	11/28/95	1	29
58	Phillips Creek, path behind 27 Donnellan Circle	F	5/25/95	11/28/95	4	2733
57	Phillips Creek, path behind 28 Donnellan Circle	F	5/25/95	11/28/95	4	1470
56	Phillips Creek at 52 Moreland Rd.	F	5/25/95	8/1/95	2	807
55	Phillips Creek at 46 Moreland Rd.	F	5/25/95	11/28/95	4	1245
54	Phillips Creek at 34 Moreland Rd. (upstream of septic system)	F	3/1/95	11/28/95	5	1223
53	Phillips Creek at North St. (downstream of septic system)	F	3/1/95	11/28/95	5	2106
33	Phillips Creek at North St., downstream side	F	9/1/94	1/27/97	19	998
32	Phillips Creek at Pearl St., upstream side	F	9/1/94	1/27/97	19	910
Subbasin Totals		**F**	**9/1/94**	**1/27/97**	**111**	**605.1**

Hingham Harbor Subbasin

The MAPC database includes a total of 97 fecal coliform samples collected from two sites at Town Beach in Hingham between June 1992 and August 1996. These samples were collected by the Hingham Board of Health as part of its beach monitoring program. Town Beach is a bathing beach and must meet Class B water quality standards for fecal coliform bacteria (geometric mean below 200 col/100 ml and no more than 10 percent of samples above 400 col/100 ml).

The samples collected were well within the Class B standard. Table 2-10 shows the geometric mean for the two sites. As shown in Appendix A, only one of the 97 samples was above 200 col/100 ml and none of the samples were above 400 col/100 ml.

Table 2-10
Water Quality Data in the Hingham Harbor Subbasin

MAPC ID #	Address (Pollution Source)	F-Fecal Coliform	Min Date	Max Date	Samples Collected	Geo. Mean
HINGHAM HARBOR SUBBASIN						
11	Town Beach-North, Hingham	F	6/30/92	8/26/96	66	17
12	Town Beach-South, Hingham	F	12/21/93	8/26/96	31	18
Subbasin Totals		**F**	**6/30/92**	**8/26/96**	**97**	**17.5**

Weir River Subbasin

The MAPC database includes 17 fecal coliform samples and seven nitrate-nitrogen samples collected at eight locations by the Hingham Board of Health. Samples of fecal coliform were collected between June 1993 and June 1996, and there are generally two samples collected at each of the eight locations. The nitrate-nitrogen data consist of one sample from each of seven locations in June 1993. The highest nitrate result collected was 1.83 mg/l.

Of the 17 fecal coliform samples, only one had a result above 200 col/100 ml. This sample, collected from Tower Brook in Hingham (station 14), had a result of 2,000 col/100 ml. The other sample collected at this location had a result of 160 col/100 ml. Another location with somewhat elevated fecal counts was Plymouth River (site 16), with results of 180 and 190 col/100 ml. The Hingham Conservation Agent noted that elevated counts in the subbasin are most likely related to septic system problems. She noted that the town has identified some stormwater pipes and storm drains that pass through septic system leaching fields.

Table 2-11
Water Quality Data in the Weir River Subbasin

MAPC ID #	Address (Pollution Source)	F-Fecal Coliform N-Nitrate	Min Date	Max Date	Samples Collected	Mean Of Nitrate Samples	Geo. Mean- Fecal Coliform Samples
WEIR RIVER SUBBASIN – Headwater to Mouth of River							
16	Plymouth River, Hingham	F	6/15/93	6/2/95	2		185
		N	6/15/93	6/15/93	1	0.50	
15	Eel River, Hingham	F	6/15/93	6/2/95	2		22
		N	6/15/93	6/15/93	1	1.83	
13	Cushing Pond, Hingham	F	6/15/93	6/2/95	2		30
		N	6/15/93	6/15/93	1	1.19	
18	Crooked Meadow, Hingham	F	6/15/93	6/2/95	2		63
		N	6/15/93	6/15/93	1	0.5	
19	Fulling Mill Pond, Hingham	F	6/15/93	6/2/95	3		7
14	Tower Brook, Hingham	F	6/15/93	6/2/95	2		566
		N	6/15/93	6/15/93	1	1.60	
20	Weir River, upstream of Union St., Hingham	F	6/2/93	6/15/93	2		66
		N	6/15/93	6/15/93	1	0.55	
17	Triphammer Pond, Hingham	F	6/15/93	6/2/95	2		10
		N	6/15/93	6/15/93	1	0.50	
Subbasin Totals		**F**	**6/2/93**	**6/2/95**	**17**		**41.6**
		N	**6/15/93**	**6/15/93**	**7**	**0.95**	

Chapter 3: Potential Pollution Sources

3.1 Potential Pollution Sources Database

MAPC constructed a GIS map and related Microsoft ACCESS database of potential pollution sources in the nine communities. Appendix B is a printout of the potential pollution sources database, by town. The GIS map is shown on Figures 3-1A and 3-1B. A set of the potential pollution sources maps at a scale of 1:25,000 have been provided to each project community.

The database includes the following categories of potential pollution sources: septic system problem areas, active and closed landfills, junkyards, confirmed hazardous waste sites, stormwater and wastewater discharge permits, golf courses, mining, road salt storage, and other sites of concern that do not fall into the above categories (e.g., sites of chronic sewer surcharging, animal containment areas). In addition, the map shows cranberry bogs and areas of (predominantly) impervious surface greater than 5 acres. These two categories are not included in the database. Table 3-1 provides the source of data and mapped locations for each pollution source category.

3.2 Potential Pollution Sources by Subbasin

Table 3-2 is a matrix showing the number of each type of potential pollution source in each project subbasin. The table does not include septic system problem areas or golf courses, since these often extend across subbasins.

The remainder of Section 3.2 discusses potential pollution sources by subbasin. Project subbasins within the South Coastal major basin are discussed in Section 3.2.1, and project subbasins within the Weymouth & Weir major basin are discussed in Section 3.2.1.

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Table 3-1: Data and Map Sources, MAPC Potential Pollution Sources Database

Hazard Type & Data Base Code	Source of Data	Source of Mapped Location	Potential Pollutants/Concerns
Active Landfills (A) ***Closed Landfills (L)*** ***Junkyards (J)***	Massachusetts Department of Environmental Protection (DEP), Division of Water Supply, 1982 Waste Sources Overlay; town officials	Same	Heavy metals, organic chemicals, etc. in landfill leachate, and sedimentation from erosion of side slopes. Wind blown litter.
Septic System Problem Areas (F)	Town Health Agents, Planning Boards and Boards of Health; town wastewater facility plans	Same	Pathogens, nitrates, phosphorus, and household chemicals, or hazardous materials disposed of by residents and businesses.
Golf Courses (G)	Town officials; 1990/1991 MacConnell Land Use Data.	Same	Herbicides, fertilizers (nutrients), bacterial loading from waterfowl
Hazardous Waste Sites (H)	Massachusetts DEP, Bureau of Waste Site Prevention, List of Transition and Tier-Classified Sites, September 13, 1996 (confirmed sites only).	Project committee (town officials).	Hazardous materials, including petroleum products, in groundwater, surface water and soils. Contaminated groundwater plumes threatening drinking water, and discharging to wetlands and surface water.
Sand and gravel mining; rock quarrying (M)	1990/1991 MacConnell Land Use Data; town officials.	Same	Erosion and sedimentation; groundwater quality impacts due to removal of aquifer material; use of fuel, oil and other hazardous materials in aquifer areas
Road Salt Storage (R)	DEP's 1982 Waste Sources Overlay (division of Water Supply); town officials	Same	Sodium chloride, sand
Stormwater Discharge Permits (S)	U.S. EPA, Region I, List of general stormwater permits, July 1996	Project committee (town officials)	Total suspended solids (sediments), heavy metals, hydrocarbons, pathogens
Wastewater Discharge permits (W)	U.S. EPA, Region I, Printout of selected cities with active NPDES Permits, 7/24/96	Project committee (town officials)	Pathogens, nutrients, hazardous chemicals from household and business use
Other (O)	Town officials	Same	Database category includes locations of chronic sewer surcharging, animal containment areas and past industrial sites.
Cranberry Bogs (mapped but not in database)	1990/1991 MacConnell Land Use	Same	Nutrients, fungicides, herbicides. Alteration of natural hydrology
Impervious Surfaces >5 acres (mapped but not in database)	1990/1991 MacConnell Land Use: where commercial, industrial, transportation, or multifamily residential uses exceeded 5 acres.	Same	Polluted stormwater runoff (pathogens, hydrocarbons, heavy metals); changes to natural hydrology (peak flow rates, groundwater recharge, time of concentration, etc.)

Table 3-2: Summary of Potential Pollution Sources by Subbasin

Subbasin	Active Landfill	Closed Landfill	Junkyard	Hazardous Waste Site	Stormwater Permit	NPDES Permit	Mining	Salt Storage	Other
Back River	1	1		23	8				5
Bound Brook				5		3		2	
Duxbury Bay		2		1	2	1		2	
Fore River				6					3
Green Harbor				4	1	1	1		
Hingham Harbor				6				1	
Indian Head River		2	3	18	1	2		3	4
Jones River					1				
North River	1	3	2	13	2	3		2	2
South River	1	2		6	1	1		1	1
Weir River	1	1		9	1	2	4	2	
Totals	4	11	5	91	17	13	5	13	15

Figure 3-1a, Potential Pollution Sources, North Section

[back of Figure 3-1A]

Figure 3-1b, Potential Pollution Sources, South Section

[back of Figure 3-1B]

3.2.1 South Coastal Subbasins

Bound Brook/Gulf Basin

Wastewater Issues

Both Cohasset and Scituate have severe septic system problems due to poor soils, abundant ledge at the surface, shallow depth to groundwater and inadequate and aging systems. In places, these problems are exacerbated by small lot size. Soil conditions can be extremely variable, even from lot to lot. Some systems in a mapped "problem area" may be failing and cannot be repaired, others may be failing and can be repaired, while others may not have any problems.

Cohasset has developed a wastewater facility plan and is proceeding with an upgrade of its wastewater treatment plant to an advanced tertiary treatment system, and is expanding its sewer system to serve several septic system problem areas. The Cohasset Board of Health will be proposing a septic management district to provide improved management of private septic systems throughout the unsewered areas of town.

Septic system problem areas in Cohasset in the Bound Brook/Gulf basin include the Atlantic Avenue/Little Harbor area (site 19), the Pond St. area (site 112), and some streets near Lily Pond, the town's primary drinking water supply (site 146). Sewer extensions are planned for the latter two areas. The Pond Street area includes the Hillside and Veterans residential developments. There are illicit connections to the stormdrain system in these developments which will be eliminated once these areas are sewered. In addition, James Brook, which drains Cohasset center and discharges to Cohasset Harbor, is subject to flooding and may become contaminated from failing septic systems during flood events. The sewer extension project includes this area and should alleviate this problem.

The Atlantic Avenue/Little Harbor area (site 19) may or may not be sewered, pending the results of a water quality study of Little Harbor. If the area is not sewered, the Board of Health is likely to create a septic management district for this area.

Within the Scituate portion of the Bound Brook subbasin, several septic system problem areas have been prioritized for sewering. These are: Hatherly Rd. and Egypt Beach (site 102), Indian Trail (site 66), the Minot area (site 93), North Scituate Village (site 103), Sedgewick Drive area (site 104), Harbor Heights (site 120), and Second Cliff (site 25). The Creelman Drive/Arborway (site 105) is located in both the Bound Brook and North River project subbasins. Some homes around Musquashcut Pond in Scituate (sites 102 and 93, above) have their cesspools located in groundwater. Other homes within these mapped areas do not have problems or have problems that can be repaired.

Industrial Development/Hazardous Waste

There are several old or existing commercial and industrial areas in the Bound Brook project subbasin which are of concern to the town of Cohasset regarding potential impacts on drinking water supply. The former Army site known as the Hingham Annex hazardous waste site (site 23) is located off Leavitt Street in Hingham and is within Cohasset's Lily Pond watershed. This site is listed as a Tier 1A priority confirmed site, which is the highest priority ranking for a 21E site.

Munitions and hazardous waste were historically stored in bunkers throughout Wompatuck State Park, including adjacent to, and even within, the Aaron River Reservoir, a drinking water supply for the town of Cohasset. The former munitions dump at Wompatuck State Park is a confirmed hazardous waste site (site 101, listed under Hingham). The Army Corps of Engineers is in the process of closing the munitions bunkers. If it has not done so, the Army should supply Cohasset with information about what has been, or will be, accomplished with the closing of the bunkers, and whether any water supply concerns will remain.

Brass Kettle Brook within the Bound Brook subbasin is tributary to Lily Pond, Cohasset's primary drinking water source. Industrial uses within the Brass Kettle Brook subwatershed include Norfolk Conveyor and the Cohasset Heights Landfill on Crocker Lane. The landfill is located within both the Bound Brook project subbasin (South Coastal Major Basin) and the Weir River project subbasin (Weymouth & Weir Major Basin).

Pollution from the Cohasset Heights Landfill is of concern to the towns of Cohasset and Hingham. The site historically accepted municipal solid waste, but now is permitted for construction and demolition waste only. Contamination from the landfill has been detected in groundwater and surface water, including some groundwater within Cohasset's Lily Pond watershed. Pollutants and excessive amounts of sediment, have adversely affected at least ten acres of adjacent wetlands, according to the town. The Cohasset Water Resources Protection Committee notes that recent sampling of wetlands sediments found levels of contamination high enough to be considered reportable releases under the State 21E Superfund Program.

The old Clapp landfill in Scituate is also within the Bound Brook subbasin and the watershed for Cohasset's Aaron River Reservoir. A Cohasset official noted that there is not much information available about this former landfill.

Duxbury Bay Subbasin

There are many areas with septic system problems due to poor soils in this subbasin. Within Duxbury, failing septic systems in the Snug Harbor commercial area (site 134) and the Blue Fish River (site 144) have been connected to innovative shared septic systems (see Section 6.1). The Alden Heights area (site 135) has density-related septic problems. Island Creek Pond area has 10 to 12 homes which are contributing to high coliform counts at the boating and swimming area. Several areas along Bay Road in Duxbury (sites 136, 137 and 138) have septic system problems. The town would like to pursue a remediation project for this area, similar to the Snug Harbor and Bluefish River projects. The Howland's Landing area (site 142) was also noted for septic system problems. In Marshfield, Gotham Hill (site 231) was noted as a septic system problem area. This area is also partially located in the Green Harbor basin.

DMF's 1996 Triennial Report for the Bluefish River strongly recommends that the town continue to investigate possible septic system failures and develop a water quality program jointly with the harbormaster and the conservation administrator to routinely monitor stormdrains and the major stormwater sources identified in the DMF report. The report also recommends that the town work with the Duxbury Yacht Club Golf Course owners and the Soil Conservation Service regarding stormwater runoff management from the course and the dump. The yacht club has been cooperative regarding environmental improvements. As described in section 6.1, the club is hosting the leaching field for an innovative shared septic system to remediate wastewater problems in Snug Harbor.

Green Harbor River Subbasin

In Marshfield, Gotham Hill (site 231) was noted as a septic system problem area. This area is also partially located in the Duxbury Bay basin.

Indian Head River Subbasin (tributary to the North River Subbasin)

The Indian River is the freshwater portion of the North River, upstream of Third Herring Brook. There is no hydrologic separation between the Indian Head River and the North River, so the water quality issues mentioned in this section are all of concern to the larger North River watershed.

There are many pollution sources in the Indian Head River subbasin, including the Weymouth Naval Air Station, the Fireworks Site at Factory Pond where mercury contamination has led to the issuance of a public health advisory against the consumption of fish, several other confirmed and suspected hazardous waste sites, and former landfills that are discharging leachate into nearby waterways. The investigation and remediation of pollution sources in this subbasin should be given more attention, considering its location at the headwaters of the North River watershed system, and the fact that the 1,442-acre Naval Air Station is proposed for major redevelopment that will increase pollutant loading to the watershed. A UMass student will soon begin sampling of macroinvertebrates in North River tributaries, including the Indian Head River for his Masters in Biology. This research should prove useful in understanding the state of aquatic life in the Indian Head and North Rivers.

Wastewater

The Rockland Wastewater Treatment Plant (site 199) discharges to French Stream, a tributary of the Indian Head River. French Stream discharges to Forge Pond, which in turn discharges to Factory Pond. The outlet of Factory Pond forms the start of the Indian Head River. The 1994 and 1995 Fish Toxics Monitoring Surveys published by DEP's

Office of Watershed Management note that Factory Pond and Forge Pond "apparently received heavy nutrient loadings from the wastewater treatment plant at some time in the past as evidenced by the presence of extremely heavy algal mats and blooms" (DEP, 1994 and DEP, 1995).

In Hanover, there are several septic system problem areas in the Indian Head River Basin due to age, (i.e., old, substandard cesspools) and/or poor soils and high groundwater tables. Older areas with substandard systems include the Main Street and Hanover Street areas. Homes in the Reed Drive/Spring Street area (site 164) are built on silty loam clay with a water table 12 inches below the surface. The Presidential Acres development on Pleasant Street (site 162) has failing septic systems due to high groundwater (12 to 15 inches below the surface) and poor soils (silt and clay). Systems in this area are being repaired on an as-needed basis. The town would like to construct a shared system here, but the only available land is too wet for a leaching field. The Brookwood/Cedarwood area (site 160) also has septic system failure problems due to poor soils.

The Industrial Way development off King Street (site 163) is an old commercial and industrial area. The Board of Health does not have any septic system information on file for these properties. This is a concern, because the developments are old and systems are probably very substandard (cesspools or worse), groundwater is three feet below the surface, lots are small (e.g., in some cases extending only three to five feet beyond the building) and there is no room for construction or upgrading of individual systems. Some businesses have purchased vacant lots to install new systems, but many others have no apparent solutions. A shared septic system is a possible solution for this area.

The Walnut Hill development in Hanover (site 161) is located in both the Indian Head River Basin and the North River Basin. The development is built on ledge and many septic systems are failing. A shared system may be a possible solution for this area.

Two septic system problem areas in Rockland were noted. The Pond Street area (site 116) has problems due to poor soils (till and clay). The Beech Street/Millbrook Drive area (site 118) also has septic system problems. Both areas are now sewered but not all the homes are tied into the sewer system.

Industrial and Hazardous Waste Concerns

One of the most serious hazardous waste sites in the Indian Head River subbasin is the Fireworks site (site 169), located adjacent to Factory Pond in Hanover. This site comprises over 100 acres and hosted industrial and military operations from 1890 to 1969. Factory Pond was used as a disposal and target practice area. According to the Hanover Board of Health Agent, standard disposal practices for wastes laden with arsenic and mercury included sinking 55-gallon drums of waste into Factory Pond (shooting holes in the barrels so they would sink first), shallow burial of wastes (at a depth of about two feet), and bulldozing wastes directly into the pond. Floor drains at the site emptied directly into Drinkwater Stream and Drinkwater Canal.

DEP's Office of Watershed Management conducted fish-flesh monitoring from fish caught in Factory Pond, Forge Pond and the surrounding area in 1993 and 1994. Monitoring included sampling for metals, PCB's and organochlorine pesticides. The 1993 and 1994 sampling identified "extremely elevated" levels of mercury in Factory Pond fishes as wells as elevated levels in fish from the Indian Head River. PCBs and organochlorine pesticides were below detection limits. In June of 1994, the DPH issued a health advisory recommending against consumption fish from Factory Pond. This advisory was expanded in October 1995 and now applies to the Drinkwater and Indian Head Rivers between the Forge Pond Dam and the Luddom's Ford Dam in Hanover/Pembroke.

The Hanover Board of Health Agent also mentioned that the Factory Pond Dam was in a poor state of repair. Failure of this dam could cause severe pollution problems if sediments are washed downstream. In addition, the Health Agent questioned whether dam failure could pose an explosion hazard if long-buried sediments are exposed (the Pond was used for target practice for many years).

The South Weymouth Naval Air Station is the other very significant hazardous waste site in the Indian Head River subbasin. It is the only site in the project area listed on the federal National Priorities List of Superfund Sites. The Naval Air Station encompasses

1,442 acres in the towns of Weymouth, Rockland, Abington and Hingham and straddles the major basin divide separating the South Coastal and Weymouth & Weir basins. The headwaters of French Stream are located on Naval Air Station property. Off-site pollution impacts from the Naval Air Station site have not yet been fully investigated. The Air Station is being decommissioned and is the subject of a major redevelopment proposal.

The January, 1997 Remedial Investigation for the Naval Air Station investigated the following disposal areas in the Indian Head River subbasin (NSRWA, nd):

- The West Gate Landfill, which is an unlined, 5.3-acre landfill located just west of French Stream. Contaminants identified include: polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and pesticides in subsurface soils; volatile organic chemicals (VOCs) and pesticides in surface water and sediment; and asbestos.
- The Fire Fighting Training Area, which is a 3.8 acre site used for fire-fighting training, including the burning of waste oil and other petroleum products. This site is located just west of a drainage swale leading to French Stream. Contaminants identified include organic compounds, pesticides and PAHs in surface and subsurface soils. Additional groundwater sampling is needed to determine the nature and extent of groundwater contamination at this site.
- The Tile Leach Field, which is an abandoned leaching field located just east of French Stream. Contaminants identified include pesticides and PAHs in surface soil, and inorganics (metals) in subsurface soil. Additional surface water and sediment sampling should be conducted downstream in French Stream.
- A former sewage treatment plant that discharged to French Stream. Trace levels of VOCs, pesticides, PAHs, semi- volatile organic chemicals (SVOCs) and PCBs have been found in soils, surface water and sediments.

A second area of concern in Hanover is the Rubber Mill site, adjacent to Mill Pond. From about 1900 to 1940 this site was used as an industrial complex. There is concern about what type of contamination may remain in the sediment from the dumping conducted at this site during the 40-year period.

In Rockland, the Transworld Adhesives facility (site 198) is a DEP-listed priority hazardous waste site. The Beech Street Industrial Park in Rockland (site 233) was noted as a potential pollution source due to soil contamination from industrial operations. DynaFab (site 234) was also mentioned as a potential concern.

Landfills

The old Rockland dump on Pleasant Street and VFW Drive (site 150) received resin from the Boston Whaler facility and leather products from a shoe factory. Leachate from this landfill is reportedly entering Cushing Brook. This site is not capped. Capping this site could reduce leachate generation and should be considered.

The Rockland Landfill on Beech Street is located adjacent to French Stream near the Hanover border. It is in the process of being capped. Severe erosion problems in adjacent streams have been reported, and could be affecting aquatic life. Residents in Hanover are concerned that leachate may be entering groundwater, and their basements, during flooding episodes. There is disagreement between the two towns regarding whether the landfill is causing water quality problems. Rockland officials noted that elevated levels of iron, manganese and silver in groundwater samples collected near the landfill could be due to the former munitions dump in Hanover, whereas Hanover officials cited the landfill as a contributing factor to the contamination of Factory Pond. Silver is extremely toxic to aquatic life, and follow-up monitoring is recommended to understand the extent of this contamination and its potential impact on aquatic life.

Agriculture/Animal Containment Areas

A cattle farm on Concord Street in Rockland (site 237) is a potential source of bacterial contamination. A tree farm located on Circuit and Myrtle Streets in Hanover (site 172) was noted as a concern because it appears to be contributing sediment to an adjacent 35-acre wetland.

Future Development Concerns

The South Weymouth Naval Air Station is proposed for major redevelopment, including housing, a golf course and a "mega-mall." Because of its location at the headwaters of the Indian Head/North River system, this project could have water quality and quantity impacts on the larger North River basin. The communities, state and federal agencies, and the MAPC should work hard to ensure that development of the Naval Air Station does not further degrade water quality.

Jones River Subbasin (Duxbury only)

Duxbury has a municipal well located near Chandler Pond. Thirty-one homes are located on Lower Chandler Pond in Duxbury and Pembroke. Steep slopes and poor soils contribute to septic system problems in this area (site 145). There are also many cranberry bogs ringing the pond.

Figure 3-1 does not show all of the active cranberry bogs within the Duxbury portion of the Jones River subbasin. Table 1-7 lists cranberry bogs in Duxbury that have Water Management Act permits (over 4.6 acres in production, or for new bogs up to 9.2 acres in production if Soil Conservation Service Best Management Practices are used).

North River Subbasin

Wastewater

The Walnut Hill development in Hanover (site 161) is located in both the Indian Head River Basin and the North River Basin. The development is built on ledge and many septic systems are failing. A shared system may be a possible solution for this area. There are older homes in the Four Corners area of Hanover with substandard cesspools.

The Washington Street (Route 53) corridor was cited as a septic system problem area in both Norwell and Hanover. In Hanover, the commercial area along Washington Street (Route 53) is a major concern to the town because it is a densely developed area without adequate wastewater infrastructure. This area (site 174) is located near town wells and is located in the town's Aquifer Protection District. Lots are small and when systems are failing there is often no room for a new system. In some cases, buildings have had to be vacated because of the inability to find an acceptable solution to the wastewater problem.

The Route 53 corridor is of concern not only because of inadequate wastewater treatment, but because of urban runoff, and storage and use of hazardous materials. There are many active commercial and industrial uses within the Aquifer Protection District which could be a threat to drinking water quality. These uses, including a dry cleaning facility and autobody shop, were in existence when Hanover passed its aquifer protection zoning overlay district, and so are now "grandfathered."

In Norwell, there is a high-density trailer park (site 154) and dense commercial development on Washington Street from Queen Anne's Corner all the way to the Hanover border. A remediation plan is being developed for the trailer park. There are many large, commercial septic systems along Washington Street that need to be upgraded.

The Kings Landing area (site 153) is located adjacent to the North River in Norwell. It is built in the marsh and floods in early spring. The development includes a commercial boatyard and old cottages that have their septic systems in groundwater. The North & South River Watershed Association believes that this area may be contributing to pollution of the North River. A 1991 study of the North River by Baystate Environmental Consultants, Inc. (BEC, 1991) recommended construction of a communal septic system in the Kings Landing area and a septage pumping station for the marina.

The Jacobs Trail development (site 155) abuts Washington Street and Jacobs Pond, the source of Third Herring Brook. This development has small lots built on poor soils. Nutrient problems, including signs of eutrophication, have been reported in Jacobs Pond adjacent to the Jacobs Trail development. The Brantwood subdivision (site 149), located off Washington Street and abutting a tributary to Jacobs Pond, was also noted for septic system problems.

The Till Rock Lane development on Barque Hill (site 152) was also noted for septic system failures. The Till Rock Lane development was built in the late 1960's and early

1970's and is located close to the North River on the Norwell side, just south of Route 3. A 1991 study of the North River by Baystate Environmental Consultants noted that the "shallow depth to bedrock and seasonally high groundwater levels suggest that septic system effluents may be a significant source of bacteria to the North River" in the Barque Hill area (BEC, 1991). The report also concludes that urban runoff may be a contributing source, given an extensive drainage system which discharges directly to the river, and that some natural sources are likely to exist in the wooded fringe and marshland near the river.

Water quality testing conducted by the North and South Rivers Watershed Association identified elevated fecal coliform levels at the Corn Hill monitoring station (station #10 in the MAPC database). The source of these elevated counts is not confirmed. See section 2.3.2 and Appendix A for more discussion of this area and a summary of monitoring results. One possible source of these elevated levels is failing septic systems in the Barque Hill area (see above).

The major septic system problem area for Scituate in the North River subbasin is the Greenbush area (site 106), which is located adjacent to the town's municipal reservoir. This area is the town's top priority for sewering once the wastewater treatment plant is upgraded and the sewer moratorium is lifted. The Creelman Drive/Arborway septic system problem area (site 105) is located in both the Bound Brook and North River subbasins.

Septic system problem areas in the Marshfield portion of the North River subbasin include three apartment complexes located on Route 139 (sites 222, 223 and 224). A package treatment plant is under discussion for the Fox Run apartment complex. The other area noted as having septic system problems is Damon's Point (site 221), which has old homes with small lots and is located near a marsh.

Agriculture/Animal Containment Areas

The cranberry bogs on Old Oaken Bucket Road in Scituate were mentioned as a potential source of contamination to the municipal reservoir. The bog's diversion structure is suspected of leaking and there is concern about pesticides and fertilizers entering the water supply.

Nutrient runoff from the cranberry bogs on Cross and Winter Streets in Norwell was mentioned as a potential contributor to the increasing nutrient contamination of Torey Pond (on Second Herring Brook).

An animal containment area on Iron Mine Brook in Hanover (site 171) is of concern to the town with respect to potential water supply impacts. Goats and cattle are kept at this site. The animals traverse freely in and out of the brook, which is used as their water source. This is a concern to the town, because Iron Mine Brook falls within the Zone II of the town's Tindale (or Broadway) wells.

Another animal containment area in the North River subbasin is Briggs Stable on Hanover Street in Hanover (site 170) which has between 60 and 90 horses on 40 acres.

Future Growth Concerns

The South Weymouth Naval Air Station is proposed for major redevelopment, including housing, a golf course and a "mega-mall." Because of its location at the headwaters of the Indian Head/North River system, this project could have water quality and quantity impacts on the larger North River basin.

Two areas of proposed development were cited as a concern for water quality. One is the Walnut Tree Hill development on Cross Street, which involves land in Norwell and Scituate. It is the proposed site of a 61-home subdivision. Norwell cited concerns about sedimentation and the fact that Scituate is requiring a phased plan of construction but is allowing clear cutting of all trees. The second site is a proposed 60-unit assisted living facility adjacent to Jacob's Pond. The concerns surround potential impacts on Jacob's Pond and the Third Herring Brook.

South River Subbasin

In Duxbury, septic systems built in muck soils on Chandler Street (site 127) are showing signs of failure. Former septic lagoons on Keene Street (site 181) are also a source of concern to the town of Duxbury. The site is located close to the Evergreen Street well #1 and in within a Zone II. It is presently used as a dump for tires, stumps and miscellaneous junk.

Six septic system problem areas were noted in the Marshfield portion of the South River basin. The downtown Marshfield area (site 230) has proved a particularly difficult problem. This is a dense commercial area with small lots and poor soils. Water quality sampling conducted by the North and South Rivers Watershed Association (NSRWA) has identified persistently elevated levels of fecal coliform at the Willow Street Bridge station on the South River, near Marshfield center (see Section 2.3.1, Figure 2-3 and Appendix A). The Willow Street Bridge Station is identified as station #8 in the MAPC database.

The town has proposed expansion of the sewer system to serve the downtown area, but Town Meeting twice has failed to provide the two-thirds majority needed to undertake the expansion, due to concerns that new sewers will bring unwanted development. Businesses with small lots and no options for septic system repair are constructing tight tanks. The Health Agent noted that, as of April 1998, there were seven or eight businesses that have a tight tank or are in the process of obtaining one. The town is working to get all of the property owners to convert to tight tanks.

Tight tanks require frequent and expensive pumping and are probably not a good, long-term solution if the business district is to remain viable. The town of Marshfield should consider some innovative wastewater alternatives for this area. A shared septic system is a possibility if land for the leaching field can be obtained, but this is apparently a problem at this location. A very different type of alternative is the SolarAquatics system developed by Ecological Engineering Associations, which is being used by the town of Weston for its downtown area. Information about this system, which utilizes biological removal in a greenhouse environment, is contained in Appendix E.

Other septic system problem areas in the Marshfield portion of the South River basin include Humarock (site 226), Kent Park (site 227), Marsh View Drive (site 228), Silver Pines (site 225), and South Port (site 229). The Silver Pines development is located within a Zone II area. The South Port area is subject to flooding, with sea water flowing into catch basins during high tides.

The North and South River Watershed Association's 1993 stormwater investigation study (NSRWA, 1993), included a detailed investigation of 15 drainage systems of apparent significance. The report concluded that the tributary above Willow Street, the Sea Street drainage pipe, and the Bridgeway Inn pipe were among the greatest probable contributors of all the drainage systems investigated. The Marshview/Bayview pipe was also noted for having some of the highest fecal coliform values recorded. The Marshview area is a known septic system problem area (site 228).

3.2.2 Weymouth & Weir Subbasins

Back River Subbasin

Stormwater Runoff

The Back River subbasin is one of the more heavily developed subbasins in the project study area, with a great deal of impervious surface, and thus greater stormwater runoff volumes and pollutant loads. The Weymouth DPW has mentioned the need for more equipment, more staff and more staff training so that adequate attention can be given to upgrading and maintaining stormwater infrastructure.

In the Back River subbasin, stormwater is a concern for its impact on drinking water supplies, shellfish, and finfish. Town officials in Weymouth raised concerns regarding stormwater runoff on Washington Street where the catch basins drain into the South Cove of Whitman's Pond, a town water supply.

The storm drain at Puritan Road (station #38 in the MAPC database) has been confirmed by the Division of Marine Fisheries as a pollution source, due to cesspools and stormwater runoff. This pollution is affecting potentially productive shellfish beds. A summary of water quality data from this location is included in Appendix A.

The town of Weymouth obtained a grant to install a StormTreat stormwater treatment system at Puritan to remove bacteria, however it now appears that the high groundwater table and tidal influence at this location will make the system unworkable. The project is on hold for the time being.

Stormwater runoff from Jackson Square was cited by the Weymouth Conservation Agent as a concern for its impact on Herring Run Brook, an anadromous fish run between Whitman's Pond (spawning grounds) and the Back River Area of Critical Environmental Concern (ACEC.) Herring Run Brook passes through Jackson Square (High Street), a heavily developed commercial area located on a hill. The Conservation noted that stormwater runoff from Jackson Square discharges into the brook from a 30" discharge pipe and is polluted with gas, oil and sediments. The brook has had to be dredged in the past due to sediment loading. Fecal coliform counts are also elevated. See Appendix A and Chapter 2 for water quality data from the Herring Brook monitoring station (station #42).

The Wharf Street storm drain in Weymouth (station 43 in the MAPC database) has shown consistently elevated fecal coliform counts (see Chapter 2 and Appendix A). These high counts may be due to illicit sewer connections, according to a 1996 draft report prepared for the Back River Committee (Myers, 1996). The Back River Committee report notes that the stormdrain outfall had been used historically by factories and businesses for sewage disposal.

Wastewater Issues

The South Shore Industrial Park located between Derby Street and Route 3 in Hingham, is primarily located in the Back River Basin, in the subwatershed of the Old Swamp River. The Old Swamp River is tributary to the South Cove of Whitman's Pond, a Weymouth drinking water supply. The South Shore Industrial Park is served by on-site septic systems and may not have adequate wastewater treatment. Stormwater from this site is also not well treated.

There are some unsewered homes abutting South Cove (a Weymouth water supply). The town has a grant and betterment program to assist homeowners in connecting to the sewer line. The top priority is placed on homes around the town's drinking water watersheds and the second priority is placed on failed systems. Connections in the South Cove area can be problematic, however, because of the rock ledge around South Cove. The town also faces serious sewer capacity problems.

The Hingham sewer system is old and the town has many problems with inflow and infiltration and several locations where sewer surcharging occurs during wet weather. Several areas in the Weymouth portion of the Back River subbasin are affected by chronic sewer surcharging during wet weather. Problem areas include Middle Street (site 94), Pleasant Street (site 97), Ruggiano Circle (site 95), and the area bounded by the Route 3 and Route 18 highway interchange (site 98) where three sewer lines join. The town of Weymouth and the MWRA are working to resolve these problems.

The sewer surcharging is a concern for Weymouth's water supply because surcharging areas drain into the Old Swamp River which discharges into South Cove. Weymouth prevents water supply contamination by not pumping any water from South Cove up to Great Pond during and after periods of sewer surcharging.

Hazardous Waste and Industrial Uses

The South Weymouth Naval Air Station is the only site in the project area listed on the federal National Priorities List of Superfund Sites. The Naval Air Station encompasses 1,442 acres in the towns of Weymouth, Rockland, Abington and Hingham and straddles the major basin divide separating the South Coastal and Weymouth & Weir basins. The headwaters of the Old Swamp River are located on Naval Air Station property. The Old Swamp River feeds Weymouth's drinking water supply at South Cove (Back River subbasin). Off-site pollution impacts from the Naval Air Station site have not yet been fully investigated. The Air Station is being decommissioned and is the subject of a major redevelopment proposal.

The January, 1997 Remedial Investigation for the Naval Air Station investigated the following disposal areas in the Indian Head River subbasin (NSRWA, nd):

- The Rubble Disposal Area, which is an unlined, 3.8 acre landfill located just west of the Old Swamp River. Contaminants identified include PCBs (in sediments an a wetland adjacent to the river and in surface soil), and pesticides and semi-volatile organic compounds (SVOCs) in surface soil.
- The Small Landfill, which is an unlined 34,700 square foot landfill located just east of the Old Swamp River. Contaminants identified include VOCs (in subsurface soil), and polycyclic aromatic hydrocarbons (PAHs) and pesticides in surface soil.

The Weymouth DPW expressed concerns about the Microsonics confirmed hazardous waste site (site 61), which is a Tier 1A site (the highest ranking possible) located on Winter Street in Weymouth. A small part of this site drains to Swamp Brook, which drains to South Cove (a water supply). There is now a treatment facility in place at the Microsonics site. Monitoring takes place regularly and the town reviews the results, which have been satisfactory to date.

Most of Hingham's South Shore Industrial Park drains to the Old Swamp River, which is tributary to the town of Weymouth's water supply. Several of the industries in this industrial park handle toxic materials, and there have been incidents of toxic material spills. There are a number of contaminated groundwater plumes originating from this site.

Landfills

Leachate from the Hingham landfill (site 86) is a potential source of pollution to the Fresh River, a Back River tributary. According to a 1982 study, leachate is flowing from the landfill into the headwaters of the Fresh River, where there is significant discoloration.* The landfill is slated for closure and capping in 1998.

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* Beal, R.F., et al., The Weymouth Back River: An Ecological View. September 1982. As cited in Myers, Jennifer, Inventory of Natural Resources and Land Use in the Weymouth Back River ACEC. Submitted to the Weymouth Back River Committee. Final Draft. October 1996.

The former Weymouth landfill (site 82), located on Wharf Street adjacent to the Weymouth Back River ACEC, may be contributing pollution to an adjacent salt marsh. The landfill was closed in 1984 and is in the process of being capped. In May, 1998 Weymouth Town Meeting appropriated $1 million to cap the landfill. The town has obtained clay for landfill capping from the Central Artery/Third Harbor Tunnel project.

Future Growth Concerns

The South Weymouth Naval Air Station is proposed for major redevelopment, including housing, a golf course and a “mega-mall.” The Naval Air Station is located at the headwaters of the Old Swamp River and the Indian Head River. The Old Swamp River is designated as a Class A (drinking water) source under the Clean Water Act, because of Weymouth’s surface water withdrawal at Old Swamp River/South Cove (PWS ID-336000-02S). Additional major development in the headwaters of Old Swamp River is likely to bring additional stormwater pollutants into the river (heavy metals, petroleum products, salt, sand) and further stress this river, which does not currently meet its designated use. The communities, state and federal agencies, and the MAPC should work hard to ensure that development of the Naval Air Station protects and restores water resources, particularly this vulnerable drinking water supply.

Fore River Subbasin

Stormwater Runoff

The project study area includes only the portion of the Fore River subbasin located in Weymouth (Quincy, Braintree and other Fore River communities are not part of this study). The Fore River subbasin is the most heavily developed subbasin in the project study area. Based on 1990/1991 MacConnell land use statistics, about 77 percent of the subbasin (Weymouth only) is in developed land uses. Figure 3-1A shows areas greater than five acres where impervious surface is the predominant land cover. Given the high percentage of impervious surface in this subbasin, stormwater runoff is likely to have a significant adverse impact on water quality, both in terms of pollutant loads and changes in stream hydrology (higher peak flows, less base flow, shorter time of concentration, etc.).

In the Fore River subbasin, stormwater is a concern for its impact on shellfish, finfish, bathing beaches and recreational boating. The Weymouth DPW has mentioned the need for more equipment, more staff and more staff training so that adequate attention can be given to upgrading and maintaining stormwater infrastructure.

Wastewater

Several areas in the Fore River are affected by chronic sewer surcharging during wet weather. In the Idlewell area of Weymouth (site 100), there is a bottleneck in the system where two Weymouth interceptors and the Braintree interceptor join the MWRA line. There is also very little slope in the system (about 1 foot of slope in one-quarter mile). The Health agent noted, in a 1996 interview, that it often takes days after a heavy rain before the problem at this location subsides. Other sewer surcharging problem areas in the Fore River identified by the town of Weymouth are a sewer manhole cover on Montcalm Street (site 96) and an MWRA manhole in the Weymouth Landing area (site 99).

A 1998 MWRA fact sheet reports that the MWRA has developed a short-term solution to address the frequent sewage overflows in the North Weymouth area. This project entailed construction of a pipeline beneath Mill Cove, between the Newell Playground in Idlewell and Aspinwall Ave. in North Weymouth. The new pipe should provide relief and redundant service to the area.

Smelt Brook, which empties into the Fore River in Upper Mill Cove near the Braintree/Weymouth town line is also subject to sewer surcharging events. Sewage discharges are caused by a sewage siphon that drops below Smelt Brook shortly before it feeds the Fore River. The siphon is upstream of recreational boating and swimming areas. According to the FRWA and an article by Tellus Institute published in the Massachusetts Watershed Coalition newsletter (Reynolds, 1997), this siphon overflowed for 11 days during an unusually wet weather period in April 1997. FRWA conducts monthly monitoring of Smelt Brook. The Smelt Brook monitoring station is included as station 37 in the MAPC database (see Section 2.3.2 and Appendix A).

In 1997, the FRWA created the Smelt Brook Task Force to bring together watershed association volunteers, the MBTA, the MWRA, Braintree and Weymouth sewer departments, and Tellus Institute, which has conducted extensive study of the Fore River through a MassBays grant. The area of the Smelt Brook siphon was slated for major construction by the MBTA, and the FRWA wanted to ensure that MWRA and MBTA officials were coordinating with regard to infrastructure improvements in this area.

Sampling conducted in the Fore River also identified Phillips Creek as a hot spot of bacterial pollution, possibly due to old cesspools. See the Fore River discussion in Section 2.3.2 for a discussion of this area.

Hingham Harbor Subbasin

Hingham Harbor supports a popular swimming beach and boating area. The Hingham Harbor subbasin includes areas of dense development, particularly in the downtown area and Hingham Center. Based on 1990/1991 MacConnell land use statistics, about 66 percent of the Hingham Harbor subbasin is in developed land uses, making it the second-most developed of the project subbasins. Figure 3-1A shows areas greater than five acres where impervious surface is the predominant land cover. Given the high percentage of impervious surface in this subbasin, stormwater runoff is likely to have a significant adverse impact on water quality, both in terms of pollutant loads and changes in stream hydrology (higher peak flows, less base flow, shorter time of concentration, etc.). The town of Hingham is constructing a stormwater remediation project for runoff that enters the harbor.

Potential sources of pollution in the Hingham Harbor subbasin include six confirmed hazardous waste sites and the South Shore Country Club. The sewage pumping station on South Street has experienced periodic overflows during wet weather. The Division of Marine Fisheries (DMF) reports severe fecal coliform loading problems, including dry weather flows in Town Brook. Town Brook drainage infrastructure is very old and in very bad disrepair in many places.

Town Brook, one of the major drainage areas in the Hingham Harbor subbasin, is one of three subwatersheds for which a detailed assessment and stormwater modeling has been conducted. See Chapter 4 for more information.

Weir River Subbasin

Wastewater

Septic system problem areas in the Weir River subbasin include Rockland and Hull Streets in Hingham (site 113), and Jerusalem Road in Cohasset (site 4). These areas are scheduled to be sewered to the Hull wastewater treatment plant in 1998 as part of an inter-community agreement to protect the Weir River ACEC.

In Hingham, industrial and commercial areas that are served by septic systems and which may not have adequate wastewater treatment include the Derby Street area (including the South Shore Industrial Park), and the Gardner/Whiting Street area. The South Shore Industrial Park is located partially in the Weir River Basin and partially in the Back River basin. There have been spills of toxic material at this location.

Industrial Development and Hazardous Waste

Gasoline-contaminated groundwater plumes from gas stations in the Queen Anne's Corner area (sites 43 and 45 in the MAPC database) threaten Norwell's and Hingham's municipal wells.

Gasoline-contaminated groundwater plumes from old gas spills on Derby Street, Whiting and Gardner Streets (sites 13, 21, 209, 18, and 24 on the MAPC database) are affecting private wells in the Gardner Street area. Town officials and local residents complain of gasoline fumes in the wetlands and from storm drains. The town is frustrated by the exceedingly slow pace of site cleanups. A technical assistance grant (TAG) grant from DEP to the town has spurred some action from the responsible parties.

Other

The Cohasset municipal landfill is located off Cedar Street in the Weir River subbasin (site 89). Groundwater and surface water monitoring has been conducted at the site since 1988 by Camp Dresser & McKee. Low levels of contamination have been detected. Hazardous waste barrels were discovered at the landfill several years ago and were subsequently removed.

The Cohasset Heights Landfill (site 90) is located in both the Weir River and Bound Brook project subbasins. The landfill currently accepts demolition material but accepted municipal solid waste for many years. The site is located on a hill and is surrounded by wetlands. Contamination from the landfill has been detected in groundwater and surface water. Pollutants and excessive amounts of sediment have adversely affected at least ten acres of adjacent wetlands, according to a Cohasset official. The Cohasset Water Resources Protection Committee notes that recent sampling of wetlands sediments found levels of contamination high enough to be considered reportable releases under the State 21E Superfund Program.

The Hingham Conservation Agent noted that stormwater management at the Cohasset Country Club golf course was having impacts on Hingham Skating Pond and Turkey Hill Run Brook.

Chapter 4: Subbasin Assessments and Stormwater Modeling

4.1 Description of Subbasins

Three subbasins were selected for application of the P8 stormwater model under baseline and projected year 2020 conditions: 1) the Town Brook subbasin in Hingham; 2) the Aaron River Reservoir subbasin located in the towns of Hingham, Cohasset, Norwell and Scituate; and 3) the Bluefish River subbasin in Duxbury. The subbasin areas are shown in Figures 4-1, 4-2 and 4-3.

These three subbasins were selected to provide a wide range of land uses, thus providing an opportunity to apply the P8 model to different types of conditions. The subbasins were also selected for the importance of their environmental resources. The Town Brook subbasin is the most densely developed (with an impervious fraction of approximately 0.22). Town Brook drains to Hingham Harbor, which supports swimming, boating and shellfishing. The Aaron River Reservoir subbasin is very undeveloped, with an impervious fraction of less than 0.02. This basin includes a municipal drinking water supply (the Aaron River Reservoir). The Bluefish River subbasin is a mix of residential development, recreation and open space, with an impervious fraction of 0.11. The Bluefish River subbasin supports three drinking water wells and the river supports productive shellfish beds.

The sections below describe baseline (1990/1991) and projected year 2020 land conditions in each of the three subbasins.

4.1.1 Town Brook Subbasin

The Town Brook subbasin comprises 489 acres in and around downtown Hingham. Town Brook hosts an active smelt run and empties into Hingham Harbor, which is utilized for swimming, boating and shellfishing. Figure 4-1 is a map of land use in the Town Brook subbasin.

MAPC digitized the Town Brook subbasin boundary based on a map provided by Coler & Colantonio, a Norwell consulting firm. MacConnell land use data were obtained from

MassGIS for data year 1991. Table 4-1 provides the land use statistics and assumptions about the amount of impervious area and the hydrologic condition of pervious areas. The amount of impervious area and the hydrologic condition of pervious areas are two of the major inputs to the P8 model, as described in sections 4.3 and 4.3.

Commercial uses account for about 5 percent of land use in the subbasin and are concentrated in the downtown area. The downtown area also includes institutional uses such as churches, schools, an armory, and a cemetery (classified in the MacConnell land use data as “urban open”). Outside of the commercial downtown area, development primarily consists of residential uses. Altogether, residential uses account for 60 percent of land use in the subbasin. Recreation, including a golf course (South Shore Country Club) and a ball field account for almost 10 percent of the land use within the subbasin. There is very little industrial land use in the subbasin. The only use categorized as industrial is an autobody shop.

Undeveloped land accounts for approximately 21 percent of the subbasin. Some of this land is wetland, park land or recreation land and is unlikely to be developed, The only significant piece of potentially developable land is Baker Hill. Potential future development scenarios are discussed below under “Future Conditions.”

The Conservation Officer and Town Planner noted that several of the areas classified in the MacConnell data as forest were actually marsh or forested wetlands. Marsh areas were reassigned in Table 4-1 to the “nonforested wetland” category. Forested wetlands were kept as “forest.”

Town Brook is culverted for a large part of its course, with intermittent open channel areas. There are wetlands and floodplain associated with the open channel areas. According to the Conservation Agent and Town Planner, the Town Brook drainage infrastructure is very old, with some stone culverts and pipes dating back approximately 150 years. The older sections of the drainage system are in very bad disrepair, with leaking joints and collapsing culverts. There are sink holes in the downtown area due to

Figure 4-1: Town Brook Land Use

back of Figure 4-1

Table 4-1
Town Brook Subbasin: Land Use & P8 Model Assumptions
Baseline Conditions (1990/1991)

Land Use Code	Land Use Classification	Acres	% of Total	Fraction Imperv.	Acres Imperv.	Hydrologic Classification	Acres Pervious
2	Pasture	12.7	2.6%			meadow/good	12.74
3	Forest	60.1	12.3%			woods/fair	60.14
4	Nonforested Wetland	16.3	3.3%				16.26
6	Open areas, no vegetation	12.0	2.5%			meadow/good	12.03
7	Participation Recreation	42.8	8.8%			grassed/good	42.80
8	Spectator Recreation	3.9	0.8%			grassed/poor	3.94
10	Multifamily Residential	7.8	1.6%	0.44	3.4	grassed/good	4.35
11	Residential (< ¼ acre)	9.0	1.8%	0.38	3.4	grassed/good	5.57
12	Residential (1/4 - 1/2 acre)	226.3	46.3%	0.25	56.6	grassed/good	169.74
13	Residential (> ½ acre)	48.4	9.9%	0.20	9.7	grassed/good	38.70
15	Commercial	24.7	5.0%	0.90	22.2	grassed/fair	2.47
16	Industrial	1.9	0.4%	0.90	1.7	grassed/poor	0.19
17	Urban Open	18.2	3.7%		6.6	grassed/good	11.59
18	Transportation	4.7	1.0%	0.90	4.2	grassed/poor	0.47
TOTAL:		**488.8**	**100.0%**		**107.8**		**380.98**

Town Brook Subbasin Percent Impervious = 22%

Source: 1990/1991 Land Use courtesy of MassGIS and UMass Department of Forestry Resource Mapping Project.

the crumbling drainage infrastructure and the erosive power of the tidally-influenced brook (as tides go in and out, they wash out the surrounding soil material). The downtown area suffers from severe flooding problems.

Water sampling conducted by the Division of Marine Fisheries for the Shellfish Sanitation Program have identified some bacteria problems in the brook. These data are discussed in section 2.3.2. A sewer line runs parallel to the brook throughout much of its length.

Primary pollution impacts to the brook are fertilizer runoff from residential lawns and the golf course, and pollutants in stormwater runoff from impervious areas (primarily parking lots and roads). The downtown area is characterized by dense commercial development with very little pervious area. It experiences heavy traffic flow and parking demand. These uses contribute oil, gas, heavy metals and hydrocarbons to the brook via stormwater runoff.

Specific pollution sources include an autobody shop, a limousine service company that washes cars, and two sewage pumping stations (at South Street and Water Street). The pump station on South Street has had overflow problems in wet weather. The South Shore Country Club may be a source of fecal coliform loading to Town Brook, due to the abundance of waterfowl at the golf course. The golf course is located in the Town Brook flood plain, and may be contributing to pollution of the brook during flood events. The golf course also has irrigation wells drawing from Town Brook.

Future Land Use Change: Town Brook Subbasin

The subbasin is mostly developed with the exception of Baker Hill. There are roughly 50 acres of undeveloped land in the Baker Hill area which could be subject to future development. The town turned down a subdivision proposal for Baker Hill in January 1998, primarily due to stormwater and wastewater concerns. A May 10, 1998 article in the South Weekly section of the Boston Globe reported that a proposal for an apartment complex on Baker Hill is forthcoming.

Future changes in the subbasin may also include a reactivated Old Colony Rail line and its associated parking facility. The railroad line crosses through the subbasin. The tracks run adjacent to Town Brook and cross the brook in several locations. The trains will run on diesel fuel. Leaking fuel from the trains has the potential to increase pollutant loadings to the brook. The town is discussing potential mitigation measures with the MBTA. Improvements to the Town Brook drainage system will probably have to be made in order to accommodate the train.

MAPC made the rough assumption that the rail line, rail station and associated parking facilities would require about 6-1/2 acres of land in the subbasin. For the purposes of the P8 model, these uses were assumed to have an impervious fraction of 0.9.

Future commercial development in the Town Brook subbasin is likely to be limited to redevelopment projects, which will not create additional impervious surfaces.

Based on the information described above, the P8 model run for year 2020 conditions includes two changes relative to baseline conditions. The first is an assumption that 50 additional acres will be devoted to residential uses (in Baker Hill), with an assumed impervious fraction of 0.20. This results in an additional 12 acres of impervious surface. The second change is the addition of about six and one-half acres for the Old Colony Rail line and associated parking facility, resulting in an estimated additional 5.8 acres of impervious surface.

Table 4-2 provides a summary of estimated land use and impervious fraction changes in the Town Brook subbasin under projected year 2020 conditions.

Table 4-2
Town Brook Subbasin: Land Use & Impervious Fraction Change
Baseline (1990/1991) & Future (2020) Conditions

Land Use Code	Land Use Classification	1990/ 1991 Acres	2020 Acres	Land Use Acre Change	1990/1991 Imperv. Surfaces	2020 Imperv. Surfaces	Imperv. Acreage Change
2	Pasture	12.74	0	-12.74			
3	Forest	60.14	29.14	-31			
4	Nonforested Wetland	16.26	16.26				
6	Open areas, no vegetation	12.03	0	-12.03			
7	Participation Recreation	42.8	42.8				
8	Spectator Recreation	3.94	3.94				
10	Multifamily Residential	7.77	7.77		3.4	3.4	
11	Residential (< 1/4 acre)	8.99	8.99		3.4	3.4	
12	Residential (1/4 - 1/2 acre)	226.32	275.68	49.36	56.6	68.9	+12.3
13	Residential (> 1/2 acre)	48.37	48.37		9.7	9.7	
15	Commercial	24.65	24.65		22.2	22.2	
16	Industrial	1.88	1.88		1.7	1.7	
17	Urban Open	18.19	18.19		6.6	6.6	
18	Transportation	4.68	11.09	6.41	4.2	10.0	+5.8
TOTAL:		**488.76**	**488.76**		**107.8**	**125.9**	**18.1**

Town Brook Subbasin Percent Impervious Estimates

Baseline Conditions (1990/1991) = 107.8/488.76 acres = 22% impervious

Future Conditions (2020) = 125.9/488.76 = 26% impervious

4.1.2 Aaron River Reservoir Subbasin

The Aaron River Reservoir Subbasin comprises 3,045 acres in the towns of Norwell (1,943 acres), Scituate (346 acres), Cohasset (228 acres) and Hingham (528 acres). This subbasin is the largest and most undeveloped of the three minor subbasins studied for this project. A large part of the subbasin falls within protected open space, including Wompatuck State Park, town of Norwell Conservation Land, and town of Cohasset water supply land.

One of the reasons this subbasin was selected for assessment is that it contains a municipal drinking water supply, the Aaron River Reservoir. The subbasin includes all of the land area upgradient of the reservoir. The subbasin boundaries were obtained directly from the MassGIS coverage of minor subbasins. The reservoir, a municipal supply for the town of Cohasset, is located almost entirely within the confines of Wompatuck State Park. When water is needed in Lily Pond (the town's other reservoir and the location of the treatment plant), the Bound Brook control structure is partially closed to direct flow from the Aaron River Reservoir into Lily Pond, via the Aaron River. A 1986 study of Cohasset's water supply prepared for the town by Camp, Dresser & McKee (CDM, 1986) noted that the Aaron River Reservoir is high in color and turbidity.

Figure 4-2 is a map showing 1990/1991 MacConnell land use for the Aaron River Reservoir subbasin. Table 4-3 provides a breakdown of the land use statistics, assumptions about the amount of impervious area associated with each land use category, and assumptions about the hydrologic condition of pervious areas associated with each land use category. This latter information is needed for the P8 model run, as discussed in sections 4.3 and 4.4.

According to the MacConnell land use data, 88 percent of the subbasin is undeveloped. The forested land use category, which comprises 78 percent of land use in the subbasin, may include a substantial amount of non-forested wetland areas (e.g., wooded swamps). Only non-forested wetlands (e.g., emergent marshes) are categorized separately as wetlands.

Table 4-3
Aaron River Reservoir Subbasin: Land Use & P8 Model Assumptions
Baseline Conditions (1990/1991)

Land Use Code	Land Use Classification	Acres	% of Total	Fraction Imperv.	Acres Imperv.	Hydrologic Classification	Acres Pervious
1	Cropland	55.7	1.8%	0	0	meadow/good	55.68
2	Pasture	6.8	0.2%	0	0	meadow/good	6.8
3	Forest	2366.8	77.7%	0	0	woods/good	2366.8
4	Wetland	38.2	1.3%	0	0		38.2
6	Open Land	52.6	1.7%	0	0	grassed/fair	52.6
7	Particip. Recreation	34.0	1.1%	0	0	grassed/poor	34.0
12	Residential (1/4 -1/2 acre)	0.6	0.0%	0.25	0.1	grassed/good	0.4
13	Residential (> 1/2 acre)	330.7	10.9%	0.15	49.6	grassed/good	281.1
15	Commercial	0.3	0.0%	0.85	0.2		0.0
17	Urban open	4.3	0.1%	0	0.0	grassed/good	4.3
20	Water	152.1	5.0%	0	0.0		152.1
21	Woody Perennial	3.2	0.1%	0	0.0	grassed/good	3.2
TOTAL:		**3045.3**	**100.0%**		**50.0**		**2995.3**

Aaron River Reservoir Subbasin Percent Impervious = 1.64%

Source: 1990/1991 Land Use courtesy of MassGIS and UMass Department of Forestry Resource Mapping Project.

Eleven percent of the subbasin is used for residential purposes. Residential uses are concentrated along the roads that traverse the subbasin, including: Grove Street, Prospect Street, School Street, and Mount Blue Street in Norwell; Thomas Clapp Road and Summer Street in Scituate; and the Doane Street area in Cohasset. There are no

Figure 4-2: Aaron River Reservoir Land Use
(Map)

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commercial or industrial uses in the subbasin. All of the subbasin area within the town of Hingham falls within Wompatuck State Park.

Potential pollution sources in the subbasin include a former landfill, known as the West End dump or the Clapp landfill, located on Clapp Road in Scituate. Munitions and hazardous waste were historically stored in bunkers throughout Wompatuck State Park, including adjacent to, and even within, the Aaron River Reservoir. The U.S. Army is in the process of closing these bunkers.

Future Land Use Change: Aaron River Reservoir Subbasin

A large percent of the undeveloped land in the Aaron River Reservoir subbasin is either protected open space or non-developable wetlands. The 1986 study by Camp, Dresser and McKee (CDM, 1986) identified 1,455 acres of reserved land and 528 acres of non-developable land in the subbasin.

MAPC interviewed town officials in Cohasset, Norwell, Scituate and Hingham to assess the potential for future growth in the subbasin. Land use within the Hingham portion of the subbasin is not expected to change, since all of this land falls within Wompatuck State Park.. The Cohasset portion of the subbasin includes only a very small amount of residentially-zoned land that is not protected open space. According to a member of the Conservation Commission, there is not enough land here to support additional house lots.

There is a substantial amount of undeveloped land in the Norwell section of the subbasin, the majority of which is protected open space. Wompatuck State Park occupies the bulk of the land area north of Grove Street and town-owned conservation land occupies approximately one-half of the land area south of Grove Street. The remainder of the subbasin in Norwell is zoned for residential development, with a one-acre minimum lot size.

MAPC staff met with the Norwell Conservation and Planning staff to discuss potential future growth in the area. MAPC's most recent population projections predict that

Norwell's population will grow 16% between 1990 and 2020. The town officials did not think that the subbasin would grow at this rate, due to the large amount of open space. They thought a maximum of 5 percent growth by 2020 was a more realistic projection. With 256 acres of baseline (1990/1991) residential land use in Norwell, 5 percent growth of residential acreage would represent an additional 13 acres and a total residential land use in the Norwell subbasin of 269 acres.

Scituate officials commented on the intense growth pressures in Scituate in general, and in the West End of Scituate in particular. Undeveloped land that is not within the Wompatuck State Park (which comprises more than a third of the Scituate land use) or is not wetlands, will likely be developed by 2020. A new 17-lot subdivision has recently been approved for the area abutting Wompatuck State Park and north of Clapp Road. The Town Planner cited an estimate that between 47 and 50 lots could potentially be built in the area west of Summer Street. She thought that the estimate was on the high end, but that it could be used for this assessment. For the projected 2020 conditions, MAPC assumed that an additional 45 acres would be devoted to residential use.

The Scituate Town Planner also thought that an impervious coverage estimate of 15 percent for homes in this area was reasonable. Because land use in Norwell and Scituate are similar, MAPC assumed that 15 percent of the lots were impervious (versus the 20 percent impervious coverage assumed for the Town Brook subbasin).

In sum, the change between baseline and projected 2020 conditions in the Aaron River Reservoir subbasin consists of an additional 58 acres of residential development. Assuming an impervious fraction of 0.15 for these 58 acres, this new development would increase the impervious fraction of the subbasin from an estimated 1.64 percent to 1.93 percent. Table 4-4 provides a summary of estimated land use and impervious fraction changes in the Aaron River Reservoir subbasin under projected year 2020 conditions.

Although the total amount of impervious surface in the watershed is still slight under projected conditions, the projected growth translates into an increase in stormwater runoff pollutants of about 18 percent (see Table 4-8). The projected future growth scenario includes development of land in Scituate that is quite close to the Aaron River

Reservoir. The closer the development, the greater the potential impact since there is less opportunity for pollutants to be attenuated by adsorption to soils, plant uptake or other means. Town officials in Scituate and Norwell should inform Cohasset of development proposals in the watershed, so that Cohasset can comment on projects and take appropriate measures to insure that the water supply is protected.

Table 4-4
Aaron River Reservoir Subbasin: Land Use & Impervious Fraction Change
Baseline (1990/1991) & Future (2020) Conditions

Land Use Code	Land Use Classification	1990/ 1991 Acres	2020 Acres	Land Use Acre Change	1990/1991 Imperv. Surfaces	2020 Imperv. Surfaces	Imperv. Acreage Change
1	Cropland	55.7	55.7	0	0		
2	Pasture	6.8	6.8	0	0		
3	Forest	2366.8	2308.8	58.0	0		
4	Wetland	38.2	38.2	0	0		
6	Open Land	52.6	52.6	0	0		
7	Particip. Recreation	34.0	34.0	0	0		
12	Residential (1/4 -1/2 acre)	0.6	0.6	0	0.1	0.14	0.04
13	Residential (> 1/2 acre)	330.7	388.7	58.0	49.6	58.31	8.71
15	Commercial	0.3	0.3	0	0.2	0.22	0.02
17	Urban open	4.3	4.3	0	0.0		
20	Water	152.1	152.1	0	0.0		
21	Woody perennial	3.2	3.2	0	0.0		
TOTAL:		**3045.3**	**3045.3**		**49.9**	**58.67**	**8.77**

Aaron River Reservoir Percent Impervious Estimates

Baseline Conditions (1990/1991) = 49.9/3,045 = 1.64%

Future Conditions (2020) = 58.67/3,045 = 1.93%

4.1.3 Bluefish River Subbasin

The Bluefish River subbasin encompasses 1,612 acres of land in the town of Duxbury which are drained by the Bluefish River. MAPC delineated the subbasin using USGS topographic maps. The delineation was confirmed by the Duxbury Town Planner.

The Bluefish River is a small tidal river located in the northwest corner of Duxbury Bay. The river is formed by the convergence of three streams. The two northern streams originate in the Millbrook and Hounds Ditch areas and converge behind the Duxbury School complex. The third stream drains upland areas south of Harrison Street, most notably the Duxbury Yacht Club Golf Course and eight small manmade ponds.

Duxbury operates three wells within the Bluefish River subbasin: the Millbrook Pond well, the Depot Street well and the Partridge Road well. The three headwaters of the river are located in Duxbury's Aquifer Protection Zoning District.

Figure 4-3 is a map showing 1990/1991 MacConnell land use for the Bluefish River subbasin. Table 4-5 provides a breakdown of the land use statistics, assumptions about the amount of impervious area associated with each land use category, and assumptions about the hydrologic condition of pervious areas associated with each land use category. The latter information is needed for the P8 model run.

Predominant land uses within the subbasin are: residential (43 percent), forested land (29 percent), and recreation (11 percent). There is no industrial use in the subbasin, and only about 2 percent of the subbasin is devoted to commercial uses.

Most of the residential development consists of homes on one-acre lots, although there are some areas with smaller lots, as well as an elderly housing complex. Forested land includes town-owned conservation and water supply land, the South Shore Marshes Wildlife Management Conservation Area, and other areas of undeveloped land. The forested land use category may include a substantial amount of non-forested wetland areas (e.g., wooded swamps). Recreational uses include playing fields at the Duxbury

Figure 4-3: Bluefish River Land Use

back of figure 4-3

Table 4-5
Bluefish River Subbasin: Land Use & P8 Model Assumptions
Baseline Conditions (1990/1991)

Land Use Code	Land Use Classification	Acres	% of Total	Fraction Imperv.	Acres Imperv.	Hydrologic Classification	Acres Pervious
1	Cropland	17.2	1.1%			meadow/ good	17.2
2	Pasture	13.1	0.8%			meadow/ good	13.1
3	Forest	472.1	29.3%			woods/ good	472.1
4	Wetland	17.2	1.1%				17.2
6	Open Land	8.6	0.5%			meadow/ good	8.6
7	Participation Recreation	146.2	9.1%			grassed/ good	146.2
8	Spectator Recreation	33.3	2.1%			grassed/ poor	33.3
9	Water-based Recreation	3.1	0.2%				3.1
10	Multi-family Residential	13.8	0.9%	0.44	6.1	grassed/ good	7.7
12	Residential (1/4 - ½ acre)	54.5	3.4%	0.25	13.6	grassed/ good	40.9
13	Residential (> ½ acre)	627.7	39.0%	0.15	94.2	grassed/ good	533.6
14	Saltwater Wetland	65.5	4.1%				65.5
15	Commercial	35.3	2.2%	0.7	24.7	grassed/fair	10.6
17	Urban Open	71.8	4.5%	0.46	33.0	grassed/fair	38.8
19	Waste Disposal	3.6	0.2%			construction sites	3.6
20	Water	17.3	1.1%				17.3
21	Woody Perennial	11.2	0.7%				11.2
TOTAL		**1,611.6**	**100%**		**171.6**		**1440.0**

Bluefish River Subbasin Percent Impervious = 10.6%

Source: 1990/1991 Land Use courtesy of MassGIS and UMass Department of Forestry Resource Mapping Project. Some revisions to 1991 MacConnell data made by Duxbury Town Planner.

school complex, the Duxbury Yacht Club Golf Course, and a portion of the North Hill golf course.

There are three areas of land categorized as “urban open” in Figure 4-3 and Table 4-5. The area on Tremont Street includes the Town Hall, town DPW and cemetery. For the purposes of the P8 model, this area was assumed to have an impervious fraction of about 0.20. The area on Washington Street consists of three churches and associated parking areas and was assumed to have an impervious fraction of about 0.40. The third area, which straddles Saint George Street, consists of the Duxbury school complex. Most of the area classified as “urban open” consists of the school buildings and parking lots, and was assumed to have an impervious fraction of about 0.70.

The Bluefish River contains 94 acres of shellfish beds. A substantial fraction of these beds (about two-thirds) are open year-round or on a seasonal basis. About a third of the shellfish beds are closed due to elevated fecal coliform counts. The Bluefish River also supports an anadromous fish run with a privately-owned fish ladder south of Harrison Street.

DMF’s most recent studies of the Bluefish River shellfish growing area are a 1993 Sanitary Survey (MDMF, 1993a) and a 1996 Triennial Report (MDMF, 1996b). Both reports conclude that the potential pollution sources with the greatest potential to adversely affect water quality are: individual sewage disposal systems, storm drains and stormwater runoff, and waterfowl.

Some of the failing septic systems identified in the 1993 survey had been corrected by the time of the 1996 study, and some additional suspected failures were identified. The worst systems, located on Washington Street in filled tideland, have been replaced with an innovative shared system, designed and constructed by the town (see section 6.1).

Water testing conducted by DMF for the 1993 survey demonstrated a significant deterioration in river water quality following significant rain events. The 1996 report concludes that “[S]tormwater runoff should be considered as the primary source of poor water quality in the Bluefish River…During the winter and spring months, fecal coliform levels in the river were generally elevated only during and immediately following rain events."

The DMF studies conclude that the Duxbury Yacht Club Golf Course has a potentially significant effect on water quality. The survey report notes that portions of the golf course drain to a small stream that enters the Bluefish River south of Harrison Street and that the stream could contribute nutrients, fertilizers, pesticides and feces from waterfowl to the river during rain events.

The DMF studies conclude that waterfowl contribute a significant fecal loading in the western portion of the Bluefish River. The golf course, the South Shore Marshes Wildlife Management Conservation Area, Wright's Pond, Christmas Tree Lane Pond, as well as the extensive marsh and manmade ponds, attract large numbers of waterfowl, most notably Canada geese and ducks. Feces from these birds (as much as 3.5 lbs./day per goose, according to the DMF) is carried into the river via stormwater runoff every time it rains.

DMF's 1996 Triennial Report for the Bluefish River strongly recommends that the town continue to investigate possible septic system failures and develop a water quality program jointly with the harbormaster and the conservation administrator to routinely monitor stormdrains and the major stormwater sources identified in the DMF report. The report also recommends that the town work with the Duxbury Yacht Club Golf Course owners and the Soil Conservation Service regarding stormwater runoff management from the course and the dump. The yacht club has been cooperative regarding environmental improvements. As described in section 6.1, the club is hosting the leaching field for an innovative shared septic system to remediate wastewater problems in Snug Harbor.

Future Land Use Change: Bluefish River Subbasin

Future growth in the subbasin is likely to be limited to residential uses, according to Duxbury's Town Planner. There is no industrial use in the subbasin. There may be some redevelopment of commercial uses, but there is not likely to be much, if any, additional land area devoted to commercial uses.

Residential land uses comprise 696 acres, or 43 percent, of baseline 1990/1991 land use. Current MAPC projections estimate that Duxbury's population will experience 8.81 percent growth between 1990 and 2020. The Town Planner notes that this growth rate is a reasonable estimate of growth town-wide (the town uses an estimate of 4 percent growth per decade). Growth in this subbasin, however, will probably happen at a slower rate than the town-wide rate because there is not as much land left for development. MAPC used the 4 percent growth rate per decade, for an overall (prorated) growth rate of 7.6 percent between 1991 and 2020. This assumption results in an additional 53 acres of residential development and an additional 8 acres of impervious surface (assuming an impervious fraction of 0.15).

Table 4-6 provides a summary of estimated land use and impervious fraction changes in the Bluefish River subbasin under projected year 2020 conditions.

4.2 Summary of the P8 Model: Uses and Limitations

MAPC used the "P8 Urban Catchment Model" to estimate and compare runoff volume and pollutant loads under current and projected 2020 conditions for the three project subbasins described in section 4.1. The P8 model, more completely titled "Program for Predicting Polluting Particle Passage Thru Pits, Puddles and Ponds," was developed for the Narragansett Bay Project by William W. Walker, Jr., Ph.D., under a contract with the Environmental Protection Agency.

The P8 model is designed to predict the generation and transport of stormwater runoff pollutants in urban watersheds and to estimate the effectiveness of various Best Management Practices in reducing stormwater pollutant loads. It uses algorithms derived from other tested urban runoff models, including SWMM, HSPF, D3RM and TR-20. P8 was designed to provide a tool for evaluating the impacts of development on water quality, with a minimum of site-specific data.

Table 4-6
Blue River Subbasin: Land Use & Impervious Fraction Change
Baseline (1990/1991) & Future (2020) Conditions

Land Use Code	Land Use Classification	1990/ 1991 Acres	2020 Acres	Land Use Acre Change	1990/1991 Imperv. Surfaces	2020 Imperv. Surfaces	Imperv. Acreage Change
1	Cropland	17.2	17.2				
2	Pasture	13.1	13.1				
3	Forest	472.1	419.2	-52.9			
4	Wetland	17.2	17.2				
6	Open Land	8.6	8.6				
7	Participation Recreation	146.2	146.2				
8	Spectator Recreation	33.3	33.3				
9	Water-based Recreation	3.1	3.1				
10	Multi-family Residential	13.8	13.8		6.1	6.1	
12	Residential (1/4 - ½ acre)	54.5	54.5		13.6	13.6	
13	Residential (> ½ acre)	627.7	680.6	+52.9	94.2	102.1	+7.9
14	Saltwater Wetland	65.5	65.5				
15	Commercial	35.3	35.3		24.7	24.7	
17	Urban Open	71.8	71.8		33.0	33.0	
19	Waste Disposal	3.6	3.6				
20	Water	17.3	17.3				
21	Woody Perennial	11.2	11.2				
TOTAL		**1,611.6**	**1,611.6**	**-**	**171.6**	**179.5**	**+7.9**

Bluefish River Subbasin Impervious Fraction Estimates

Baseline Conditions (1990/1991) = 171.6/1,611 acres = 10.6% impervious

Future Conditions (2020) = 179.5/1,611.6 = 11.1% impervious

The primary intended uses of the model include:

- Evaluating site plans for compliance with a treatment objective, expressed in terms of removal efficiency for total suspended solids (TSS) or a single particle class;
- Selecting and sizing Best Management Practices (BMPs) to achieve a given treatment objective; and
- Comparing the relative (percent) change in pollutant loads under various buildout scenarios.

For this project, the P8 model was used to estimate flow and total pollutant loads in each of the three project subbasins from a specified storm event under current and projected future conditions. As described in the User's Manual, absolute predictions (e.g., concentrations, flows, loads) are less reliable than relative predictions (e.g., percent removal, percent change in load pre- and post-development). The User's Manual notes that "absolute predictions are typically of greater interest in watershed-scale applications, but the reliability of predictions will often be limited by a lack of calibration data. Therefore, the use of the model for 'absolute' predictions applications are considered secondary uses of the model at this time."

<u>Because data were not calibrated, the primary use of the P8 model for this project is for estimating the relative changes in stormwater flows and pollutant loads across time and across subbasins. Absolute predictions of flow and pollutant loads should be used with caution.</u>

The P8 model requires input data on watershed attributes, including:

- watershed area (acres)
- land use data
- percent of the watershed that is impervious (estimated from land use data)
- runoff curve number for pervious portion of the watershed (based on land use and hydrologic soil group)
- precipitation data
- water quality components (model provides data derived from National Urban Runoff Program)
- devices for collection, storage, and/or treatment of runoff

Land use data are used to arrive at a percent imperviousness for a watershed, and to estimate the hydrologic condition of pervious areas. Pollutant concentrations in runoff are assumed to be directly dependent on the amount of impervious cover in the watershed and to be independent of the type of land uses in the watershed. Thus, the model assumes that an acre of impervious surface in a residential area will generate the same pollutant load as an acre of impervious surface in an industrial area. The estimation of loads as a function of impervious surface, regardless of land use, is based on the results of research conducted under the EPA National Urban Runoff Program, or "NURP".

P8 model outputs include the following:

- Estimated flows (acre feet)
- Estimate of pollutant loads (total pounds and concentration), for the following pollutants:
  - total suspended solids
  - total phosphorus
  - total Kjeldahl nitrogen
  - copper
  - lead
  - zinc
  - hydrocarbons

The P8 program is concerned with the total volume of stormwater flow during the specified storm event or time period, not with peak flow rates. Watershed-specific data that are critical to estimating peak flow (such as slope and shape of the drainage area) are not included in the model.

This project used the P8 model for a regional-scale evaluation, not a site-specific evaluation. The size of the watersheds modeled ranged from 489 to 1,612 acres. Because the watersheds were so large, MAPC did not attempt to incorporate detailed watershed data. For example, the P8 model has the capability to incorporate "depression storage" which is related to the ability of the watershed to capture and store the beginning runoff, delaying its flow downstream. Depression storage affects both the volume and rate of runoff. Attenuation of pollutants in wetlands or buffer zones can also be incorporated into the model, but would require more information on the hydrology of the watersheds and the characteristics of wetland and buffer zone areas.

The P8 model can also simulate aquifer recharge and baseflow to streams if air temperature data is included in the model inputs. (Air temperature affects the amount of evapotranspiration, and thus the amount of percolated runoff available for aquifer recharge and baseflow.)

The P8 model can be run using a single storm event or a continuous simulation of rainfall events. For this project, the model was run with an SCS "Type 2" storm. The "Type 2" storm is one of four 24-hour storm distributions that the USDA Soil Conservation Service has developed for various parts of the United States. This hypothetical storm distribution consists of one inch of precipitation over a 24-hour period. The level of moisture in the soil prior to a storm event, referred to as the "antecedent moisture condition," affects the amount of precipitation that will be converted to runoff and is an important component of the model. The SCS "Type 2" storm used for the P8 model run assumes a 75-hour dry period prior to the rainfall event.

The model can be run with other storm events or weather files. The program includes several precipitation files for the Providence, Rhode Island NOAA weather station. The program also allows the user to input hourly precipitation data for any NOAA station or period of record. Many users may find the results more useful if the model is run for an annual period, and pollutant loading results are provided in pounds-per-year rather than pounds-per-storm event, as done here.

For each watershed, P8 default data were used to estimate particle composition and pollutant loads. These data were derived from the National Urban Runoff Program, or NURP (EPA, 1983), and were calibrated to the 50^{th} percentile of sites as reported by NURP. The calibration is also based on simulation of 1983-1987 Providence Airport rainfall data. As noted above, the P8 model assumes the same pollutant loadings from all types of impervious surfaces, regardless of the land use with which they are associated.

The P8 documentation notes that there is a high degree of site-to-site variability and that specification of particle composition and prediction of runoff concentrations at a given site are subject to considerable uncertainty. The model does allow calibration of pollutant concentrations to reflect site-specific conditions.

4.3 P8 Model Application

This section describes how the P8 model was used for this application, using the Town Brook subbasin as an example.

As used for this project, the P8 model required three basic inputs for each watershed:

1) number of acres;
2) percent impervious cover; and
3) runoff curve number for pervious areas.

The percent of impervious cover in each watershed was estimated using land use data and assumptions about the percent of impervious cover for each land use category. Section 4.1 provides tables with the baseline and projected land use for each subbasin and the impervious fraction assumptions for each land use category. The acres of land for each category were multiplied by the impervious fraction for each category to arrive at impervious acres for each category. For land uses that are totally pervious (e.g., pasture, forest, etc.), the fraction and acres impervious columns are left blank. The example on the next page demonstrates this calculation for the Town Brook subbasin.

The percent of impervious cover associated with a given land use type can vary considerably. In some cases, MAPC adjusted the impervious assumptions provided in the P8 program documentation to account for differences among the subbasins. For example, residential development with lot sizes greater than ½ acre was assumed to have an impervious fraction of 0.20 in the Town Brook subbasin, but 0.15 in the other two subbasins to reflect their lower density. Likewise, the “urban open” classification in the MacConnell data can have a range of uses, including schools, cemeteries, or churches. Impervious fractions for these uses were estimated based on discussions with local officials.

Town Brook Example 1: Calculating Impervious Fraction (Baseline Land Use)

The impervious fraction estimate for each land use is used to calculate the impervious acres for each land use type. (Acres x Impervious Fraction Estimate = Acres Impervious). The Acres Impervious for each category are added together to calculate the total impervious acreage in the subbasin (e.g., 107.8 acres). (Note: example below shows only land uses with impervious fractions.)

Land Use Classification	**Acres**	**Impervious Fraction Estimate**	**Acres Impervious**
Multifamily Residential	7.8	0.44	3.4
Residential (< ¼ acre)	9.0	0.38	3.4
Residential (1/4 - 1/2 acre)	226.3	0.25	56.6
Residential (> ½ acre)	48.4	0.20	9.7
Commercial	24.7	0.90	22.2
Industrial	1.9	0.90	1.7
Urban Open	18.2		6.6
Transportation	4.7	0.90	4.2
TOTAL			**107.8**

To calculate the percent of impervious surface in the subbasin, the total acres impervious figure is divided by the total acreage in the subbasin.

107.8 (Acres Impervious) / 488.8 (total acres in subbasin) = <u>22% impervious</u>

The runoff curve number is the next major input into the P8 model. MAPC utilized a very "broad brush" method to estimate the runoff curve number for each subbasin, given that two of the subbasins are larger than 1,000 acres. If the model is used on a site-specific scale, a more accurate method could be used to calculate the runoff curve number.

Estimation of the runoff curve number includes several steps, the first of which is calculation of the hydrologic soil groups in the subbasin. The hydrologic soil group (A, B, C, or D) indicates the degree to which precipitation will leave the site as runoff or infiltrate into the ground. The Soil Conservation Service's <u>Soil Survey of Norfolk and Suffolk Counties, Massachusetts</u> (USDA, 1989) and the SCS <u>Soil Survey for Plymouth</u>

County (USDA, 1969) provide soil classifications and hydrologic soil group information.*

MAPC reviewed the SCS Soil Surveys and made an approximate determination of the percent of each hydrologic soil group (A, B, C, or D) in the subbasin. Technically, the hydrologic soil group distribution should be estimated for pervious areas only, but this more "broad brush" method was used given the large-scale nature of this assessment. The distribution of hydrologic soil groups by subbasin is shown in Table 4-7, along with the other P8 model inputs.

Once the hydrologic soil groups are known, a runoff curve number can be calculated for each type of pervious cover. The P8 model includes a "lookup table" that provides runoff curve numbers for various soil groups depending on cover type (e.g., grass, forest, bare soil) and hydrologic condition (e.g., whether grassed areas are in good, fair or poor condition). This table is included in Appendix C. The hydrologic condition assumptions for each land use category are shown in the land use tables in Section 4.1.

As with the impervious fraction assumptions, MAPC made general and watershed-specific assumptions about the hydrologic condition of pervious areas associated with various land uses, using the P8 lookup table as a guideline. For example, pervious uses associated with residential land uses were assumed to be in good condition, but pervious areas associated with commercial or industrial uses were generally assumed to be in fair or poor condition.

* The 1969 SCS survey for Plymouth County (USDA, 1969) contains a map of soil types, but does not contain the hydrologic soil classification for each soil type. The Plymouth County Natural Resource Conservation Service (formerly SCS) in West Wareham, has posted this information on their Worldwide Website (http://members.aol.com/plysoil).

Table 4-7
P8 Model Inputs

Subbasin	Area (acres)	Percent Impervious (Baseline)	Estimated % Impervious (Year 2020)	Hydrologic Soil Groups	Runoff Curve Number
Town Brook	489	22%	26%	A – 20% B – 1% C – 71% D – 8%	68
Aaron River Reservoir	3,045	1.64%	1.93%	A – 30% B – 2% C – 29% D – 39%	61
Bluefish River	1,612	10.6%	11.1%	A – 84% B – 7% D – 9%	41

After determining the acreage and hydrologic condition of pervious areas, MAPC applied a weighted average for each pervious cover type and hydrologic soil group to arrive at an average runoff curve number for each subbasin. Appendix C contains the runoff curve calculations for each subbasin.

An example of the runoff curve calculation for the Town Brook subbasin is provided below.

Town Brook Example 2: Calculating the Runoff Curve Number

Table 4-1 in Section 4.1 shows a hydrologic classification for each land use category (except for water and wetland categories) in the Town Brook subbasin. This classification reflects the condition of pervious areas associated with the land use category. Similar hydrologic classifications are lumped together and totaled, as shown in the chart below (e.g., there are 24.77 acres classified as "meadow/good"). The chart below also shows the fraction that each category represents of the total amount of pervious area.

Hydrologic Classification	Acres	Fraction of Total Pervious Area
Meadow/good	24.77	0.068
Woods/fair	60.14	0.16
Grassed/good	272.75	0.75
Grassed/fair	2.47	0.01
Grassed/poor	4.60	0.01
TOTAL:	**364.72**	**1.00**

Next, we calculate a runoff curve number for each of the above hydrological classifications. To do this, we need to know the distribution of Hydrologic Soil Groups in the Town Brook subbasin, as shown below. (See description in paragraphs prior to this example.)

<u>Distribution of Hydrologic Soil Groups for Town Brook Subbasin:</u>
A = 20%   B = 1%   C = 71%   D = 8%

Then, using the Runoff Curve Number "Lookup Table" from the P8 User Documentation (included in Appendix C), and a weighted average for the hydrologic soil group distribution, we calculate the runoff curve number for each hydrologic classification.

The chart below shows the runoff curve number for each hydrologic classification and hydrologic soil group, based on the P8 "Lookup Table". Since we conducted a basin-wide hydrologic soil group distribution, we assumed that each hydrologic classification has the same distribution of soil groups. Taking the first row as an example, we multiply the runoff curve number for each hydrologic soil group by its percent distribution in the subbasin. This calculation is shown in the last column, and produces a runoff curve number of 65 for all "meadow/good" areas. This process is repeated for each hydrologic classification, with the results shown in the last column.

Hydrologic Classification	Runoff Curve Number by Hydrologic Soil Group				Runoff Curve Number
	A (.20)	B (.01)	C (.71)	D (.08)	
Meadow/good	38	58	71	78	38(.2)+58(.01)+71(.71)+78(.08) = 65
woods/fair	36	60	73	79	66
Grassed/good	39	61	74	88	68
Grassed/fair	49	69	79	84	73
Grassed/poor	68	79	86	89	83

Town Brook Example 2: Calculating the Runoff Curve Number (continued)

Finally, we take the runoff curve number for each hydrologic classification and multiply it by the fraction of the total pervious area it represents. This provides us with a weighted average of the runoff curve numbers (last column in the chart below). When these weighted averages are summed, we have the final runoff curve number for the subbasin.

Hydrologic Classification	Runoff Curve Number	Fraction of Total	Weighted Average
meadow/good	65	0.068	4
woods/fair	66	0.16	11
grassed/good	68	0.75	51
grassed/fair	73	0.01	0
grassed/poor	83	0.01	1
TOTAL:		**1.00**	**68**

Final runoff curve number for Town Brook Subbasin = 68

4.4 Subbasin Assessment Results

Using the watershed characteristics and land use scenarios described above, the P8 model was run for a "Type 2" storm event for the three subbasins under baseline (1991) and projected year 2020 conditions. The Type 2 storm is a 24-hour, one-inch storm with a 75-hour interval between storms (see section 4.3). The model can also be run for a specified timeframe. Running the model on an annualized basis would provide pollutant loadings in pounds/year, which may be more easily communicated and understood than the results for one storm event.

In the P8 model, stormwater loads and flows are assumed to be directly proportional to the amount of impervious surface in the basin. Table 4-7 shows the percent of impervious surface under baseline and projected year 2020 conditions. In an article titled “The Importance of Imperviousness,” the Center for Watershed Protection of Silver Spring, Maryland, reviewed numerous research articles that examine the relationship of urbanization on stream quality. This research has shown that stream degradation occurs at relatively low levels of imperviousness (about 10 to 20 percent). (Center for Watershed Protection, 1994). In general, these findings show that streams in watersheds with impervious coverage of 11 to 25 percent are moderately impacted and streams in watersheds with impervious coverage above 25 percent are degraded.

Using this as a guideline, the Town Brook subbasin is just below the degraded threshold at 22 percent impervious, and will exceed 25 percent impervious coverage under year 2020 conditions. The Bluefish River subbasin, at 10.6 percent impervious coverage, is hovering right at the threshold for moderately impacted watersheds, and is projected to inch over the 11 percent impervious coverage mark by year 2020. The percent of impervious coverage in the Aaron River Reservoir subbasin remains below 2 percent in both scenarios, although the change under projected future conditions represents about an 18 percent increase in impervious surface and associated pollutant loads. Furthermore, new developments are being built in Scituate in close proximity to the reservoir, so although the total percent impervious is low, the stormwater runoff impact of these projects could be significant in themselves.

The model provides estimated flows in acre-feet, and the concentration (ppm) and total load (pounds) for pollutants typical of urban runoff, including total suspended solids, total phosphorus, total Kjeldahl nitrogen, copper, lead, zinc, and hydrocarbons. Pollutant loadings for each subbasin are shown in Table 4-8. Stormwater flow volumes are shown in Table 4-9.

Table 4-8 P8 Predicted Pollutant Loads for an SCS Type 2 Storm

Town Brook Subbasin (489 acres)				
Pollutant	1990/1991 Load (lbs.)	2020 Load (lbs.)	Percent Change	Concentration (ppm)
Total Suspended Solids	1,282.43	1,498.20	16.8%	52.40
Total Phosphorus	5.39	6.29	16.7%	0.22
TKN	26.23	30.64	16.8%	1.07
Copper	0.59	0.69	16.9%	0.02
Lead	0.28	0.33	17.9%	0.01
Zinc	2.80	3.27	16.8%	0.11
Hydrocarbons	34.98	40.86	16.8%	1.43

Aaron River Reservoir Subbasin (3,045 acres)				
Pollutant	1990/1991 Load (lbs.)	2020 Load (lbs.)	Percent Change	Concentration (ppm)
Total Suspended Solids	593.99	699.03	17.7%	52.51
Total Phosphorus	2.49	2.93	17.7%	0.22
TKN	12.13	14.28	17.7%	1.07
Copper	0.28	0.32	14.3%	0.02
Lead	0.13	0.15	15.4%	0.01
Zinc	1.29	1.52	17.8%	0.11
Hydrocarbons	16.19	19.06	17.7%	1.43

Bluefish River Subbasin (1,612 acres)				
Pollutant	1990/1991 Load (lbs.)	2020 Load (lbs.)	Percent Change	Concentration (ppm)
Total Suspended Solids	2,032	2,128	4.7%	52.51
Total Phosphorus	8.52	8.93	4.8%	0.22
TKN	41.50	43.46	4.7%	1.07
Copper	0.94	0.99	5.3%	0.02
Lead	0.44	0.46	4.5%	0.01
Zinc	4.43	4.64	4.7%	0.11
Hydrocarbons	55.39	58.00	4.7%	1.43

Note that Table 4-8 shows that pollutant concentrations remain constant across basins and across time. This is because the model was run using the same pollutant particle file (median values as reported in EPA's 1983 NURP study) and was not calibrated to reflect actual stormwater runoff concentrations. As stated in section 4.2, relative comparisons of loads and flows (across time and across basins) is useful, but absolute loadings are not reliable unless calibrated.

Table 4-9
P8 Predicted Stormwater Flows under Baseline and Projected 2020 Conditions

Subbasin	1990/1991 (flows in acre-ft)	2020 (flows in acre-ft)	Percent Change
Town Brook	9.01	10.52	16.8%
Aaron River Reservoir	4.16	4.9	17.8%
Bluefish River	14.24	14.91	4.7%

Massachusetts surface water quality standards (314 CMR 4.00) do not contain quantitative standards for these pollutants. To provide an understanding of what these loadings and concentrations mean in terms of water quality, Appendix C provides water quality criteria for these pollutants, primarily from USEPA and the State of Rhode Island.

The 1994 Resource Assessment for the Neponset River Watershed (DEP, 1994) included some guidance for suspended solids. Suspended solids concentrations of less than 25 mg/l were assumed to support water quality designation for Class B waters. Concentrations of 25 to 80 mg/l were assumed to partially support water quality, and concentrations greater than 80 mg/l were assumed to be non-supportive of water quality.

The primary strategy for addressing stormwater, under the DEP Stormwater Management Standards, is to require that all new development include stormwater management systems designed to remove 80 percent of the average annual load of total suspended solids. (These standards are discussed in more detail in Chapter 5). DEP selected TSS as the target pollutant constituent because of "its widespread contribution to water quality and aquatic habitat degradation, because many other pollutant constituents including heavy metals, bacteria, and organic chemicals sorb to sediment particles, and because the available data sets for BMP removal efficiency reveal that TSS has been the most frequently and consistently sampled constituent."

The DEP stormwater standards are currently being applied to projects that fall under local Conservation Commission jurisdiction (e.g., within 100 feet of a wetland, within 200 feet of a river or stream). A few communities (such as Duxbury), are applying these standards to all new subdivisions, regardless of whether the project falls under Conservation Commission jurisdiction.

Table 4-10 and Figure 4-4 illustrate the difference in TSS loading for the three subbasins under three conditions: 1) baseline conditions with no TSS removal; 2) projected year 2020 conditions with no TSS removal; and 3) projected year 2020 conditions with 80 removal of TSS loads associated with new development. TSS loading is shown in pounds/acre, so that the loadings are comparable across the subbasins.

Table 4-10
Predicted TSS Loads (lbs./acre) for an SCS "Type 2" Storm with 80% TSS Removal

Subbasin	1990/1991 Baseline	2020 No Controls	2020 80% Removal
	TSS (lbs/acre)	TSS (lbs/acre)	TSS (lbs/acre)
Town Brook	2.62	3.06	2.71
Aaron River Res.	0.20	0.23	0.20
Bluefish River	1.26	1.32	1.27

Figure 4-4 shows that removal of 80 percent of TSS loads from new development will certainly reduce future loadings, but the magnitude of existing loadings, which will continue into the future, overshadow this reduction. This underscores the importance of addressing existing as well as future pollutant loads, particularly for subbasins that are already mostly developed. The DEP Stormwater Management Standards state that redevelopment of previously developed sites should meet the standards to the maximum extent practicable, but that redevelopment should at least be designed to improve existing conditions. It is important for Conservation Commissions to hold redevelopment projects to these standards.

Municipalities that are heavily developed and are already experiencing pollution problems from stormwater runoff will have to address existing development in order to improve existing conditions. This can be done by requiring improvements during redevelopment, and through selective remediation, possibly using sources of available grant funding. Grant programs that fund stormwater improvement projects include DEP's Section 319 program, Coastal Zone Management Office's Coastal Pollution Remediation Program, the State Revolving Fund, and the federal Transportation Enhancements Program.

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Figure 4-4: Predicted TSS Loads (lbs. / acre) for an SCS "Type 2" Storm

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Chapter 5: Assessment of Local Regulations and Practices

5.1 Assessment of Local Regulations

This chapter and Appendix D provide an evaluation of local regulations and management practices relative to water quality for each of the nine project communities. Appendix D provides a summary of each town's regulations, including zoning, subdivision regulations, site plan review, wetlands regulations and bylaws, and general bylaws. Table 5-1 is a checklist of local bylaws and regulations. Table 5-2 is a more detailed checklist of local stormwater and erosion control regulations.

The findings and recommendations from the town regulatory reviews are provided below.

Cohasset

Findings

- Good wetlands regulations, including requirement for undeveloped 50-foot buffer adjacent to wetlands.
- Water Resource Protection District and general bylaws for hazardous materials control.

Recommendations

- Subdivision regulations should be strengthened with respect to stormwater and erosion control.
- Site plan regulations should be strengthened with respect to stormwater management.

Duxbury

Findings

- Subdivision regulations include stormwater management requirements, including compliance with DEP stormwater management standards.
- Subdivision regulations require erosion control plan.

- Subdivision regulations include nutrient loading limits, and mitigation measures, to protect Zone II's, freshwater ponds, and coastal ponds or embayments. Loading analyses must predict nutrient concentrations under build-out conditions.

Duxbury (continued)

Findings

- Comprehensive nitrogen loading analysis and limits are applied to new developments in the Aquifer Protection District.
- Strong wetlands protection, including wetlands protection zoning district and local wetlands bylaw and regulations including setbacks.
- Off-street parking regulations include stormwater management requirements.

Recommendations

- Could consider adding impervious surface limits to Aquifer Protection District requirements.

Hanover

Findings

- Conservation Commission has adopted comprehensive regulations for design of detention basins.
- Conservation Commission has adopted wetlands protection bylaw, including 35-foot setback adjacent to wetlands.
- Stormwater management provisions included in Water Resource Protection District zoning and general bylaw.

Recommendations

- Subdivision regulations do not mention stormwater quality and could be strengthened.

Hingham

Findings

- Wetland protection regulations require setbacks of structures and paved areas from wetland resources.

- The Accord Pond Watershed and Hingham Aquifer Protection District control hazardous materials and underground storage tanks in drinking water protection areas.

Table 5-1: Checklist of Local Bylaws & Regulations

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Table 5-2: Stormwater & Erosion Control Regulations in the Project Communities

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Hingham (continued)

Findings

- Stormwater requirements in subdivision regulations focus mostly on off-site flooding impacts.
- Conservation Commission regulations do not contain stormwater and erosion control requirements, but these are required during the permit process.
- The Conservation Commission and Planning Board have some conflicting regulations with regard to basin design, and are working to resolve these.

Recommendations

- The Accord Pond Watershed and Hingham Aquifer Protection District should be strengthened to control additional land uses, to maximize recharge (while protecting groundwater quality) and to limit impervious surfaces.
- The zoning bylaw should be amended to include impervious coverage limits for residential districts.
- Stormwater provisions in site plan regulations should be strengthened.
- Subdivision and site plan regulations should be strengthened to include erosion controls.
- Zoning bylaw has maximum building coverage limits for most non-residential districts; Planning Board could consider total impervious coverage limits for each district.

Marshfield

Findings

- Marshfield's subdivision regulations contain excellent stormwater and erosion control measures.
- Stormwater regulations aim to minimize impacts to water resources through good site planning, protection of natural features, and minimizing changes to existing hydrology.
- Stormwater regulations aim to minimize long-term maintenance burden of stormwater facilities.

- Strong zoning overlay district for aquifer protection.
- Strong wetlands protection measures (overlay zoning, general bylaw and regulations).
- Conservation Commission reserves right to regulate projects outside of 100-foot buffer zone, if stormwater discharges are likely to have adverse wetlands impacts.

<u>Norwell</u>

Findings

- Strong wetlands protection regulations; Conservation Commission regulations prohibit disturbances within 50 feet of vegetated wetlands or vernal pools.
- The Conservation Commission has adopted stormwater and erosion control measures as part of its Special Conditions.
- Strong aquifer protection regulations; approximately one-third or more of Norwell's land area is zoned for aquifer protection in a bylaw that protects the DEP-approved Zone I, Zone II and Zone III.
- Subdivision regulations allow Planning Board to require a Conservation Plan with detailed requirements for erosion control.

Recommendations

- Subdivision and site plan review regulations should be strengthened to include stormwater management controls (e.g., on-site recharge, water quality protections).
- Off-street parking regulations require no increase in peak discharges but could be strengthened to include water quality protection measures.

<u>Rockland</u>

Findings

- The town has adopted a Watershed Protection District that focuses on hazardous materials storage and discharge.

<u>Rockland (cont'd)</u>

Recommendations

- The Watershed Protection District bylaw could be strengthened with regard to stormwater runoff and land use controls.
- Site plan review and Subdivision regulations should be strengthened with regard to controlling the quality of stormwater runoff.
- Site Plan Review and Subdivision regulations should be strengthened to include requirements for erosion control plans, with performance standards, for large projects.
- The Wetlands Bylaw (in zoning) could be strengthened to provide the Commission with more authorization for hiring of technical experts.

<u>Scituate</u>

Findings

- Scituate is the only project community that has a Stormwater Management Plan. The plan recommends regulatory and non-regulatory measures to improve stormwater runoff quality.
- The DPW has adopted regulations for the design of detention basins, which aim to reduce impacts to adjacent wetlands and waterbodies, as well as to reduce flooding.
- The town has adopted a Water Resource Protection District that protects the watershed for the town's reservoir and the recharge area of several wells.
- Conservation Commission regulations require a continuous, undisturbed, vegetated buffer strip (generally a minimum of 25 feet) between development activities and wetland resource areas. More stringent standards for replication are also required.
- Zoning protects wetlands through underlying Conservation District and Saltmarsh and Tideland overlay districts.

Recommendations

- The town should work to implement its Stormwater Management Plan recommendations.

- Subdivision and site plan regulations do not include measures for control of stormwater quality or erosion/sedimentation, and should be strengthened.
- The Floodplain and Watershed Protection District was enacted prior to the Federal Flood Insurance Program and therefore does not match the FEMA maps; it should be revised accordingly.

<u>Weymouth</u>

Findings

- Approximately one-half of town is included in Watershed Protection Overlay District.
- Conservation Commission has included strong erosion control and stormwater management provisions in its Standard Order of Conditions.
- Strong local hazardous materials bylaw and inspection program.

Recommendations

- Groundwater Protection Overlay District should be strengthened to include additional prohibited and special permit uses and control of hazardous materials.
- Watershed Protection Overlay District should be strengthened to include additional prohibited and special permit uses and control and management of stormwater runoff.
- Planning Board could consider strengthening subdivision and site plan review regulations to include specific performance standards for stormwater systems; these regulations require analysis of stormwater impacts, but no specific standards.

5.2 Wastewater Infrastructure

<u>Cohasset</u>

Approximately seven to eight percent of Cohasset is served by the town's sewage treatment plant, which discharges to Cohasset Harbor. The plant is undergoing a major upgrade to advanced tertiary treatment. Cohasset completed an Infiltration and Inflow study in Spring, 1995.

The Town has a plan to expand sewer coverage to serve approximately 38 percent of the town by mid-2000. Areas in North Cohasset were scheduled to be completed by mid-1998, but may be somewhat delayed. Central Cohasset should be completed by mid-2000. The plan begins by sewering the most densely populated areas and areas with poor soils.

Much of the town is plagued with failing septic systems due to poor soils and a high water table. Specific problem areas include the developments along Jerusalem Road, the Veterans and Hillside housing developments.

Duxbury

Approximately five percent of Duxbury is sewered. This area is developed with 203 homes along the barrier beach, Gurnet Street, and is tied into the Town of Marshfield's system. The treatment plant in Duxbury is at the high school and provides service to the high school as well as some of the municipal departments (library, pool, senior center).

Duxbury has constructed the state's first two innovative shared septic systems to remedy failing septic systems in the Snug Harbor and Bluefish River areas. These projects are described in section 6.1.

Hanover

Hanover has no municipal sewer service. The Hanover Mall on Route 53 is served by its own package treatment plant. Hanover has many areas with on-site wastewater problems, as described in Chapter 3 (Indian Head and North River subbasin descriptions).

Hingham

Approximately 17 percent of Hingham is sewered to the MWRA wastewater treatment plant in Boston Harbor. The town has a bylaw for connecting to the MWRA system. A new sewer district is being created in the Weir River District through an inter-community agreement between Hingham, Hull and Cohasset. This new district will sewer areas in

Hingham (Rockland and Hull Streets) and Cohasset that are polluting the Weir River ACEC. Sewage will be treated at the Hull treatment plant. There is one existing and one potential connection to the Weymouth sewer system (Remington Arms factory and Volusia Rd., respectively).

Marshfield

About 35 percent of Marshfield's population is served by sewers. The town's sewage treatment plant discharges to Massachusetts Bay (site 200). Expansion of the sewer service area to serve failing systems in the town center has been hotly debated in town, but has not been able to win the two-thirds majority vote needed from Town Meeting, due to concerns about the adverse growth impacts of sewers.

Norwell

Norwell is entirely served by on-site wastewater systems. There are several septic system problem areas, as discussed in Chapter 3, but no plans for creating sewers in the town. The town does anticipate using a betterment system for upgrading septic systems in the future.

Rockland

With the exception of three small areas, totaling about 30 homes, the entirety of Rockland now has access to sewer service. The primary issue at this time is getting residents to tie into the new sewer lines. Greg Thomson of the Sewer Commission estimates that about 1,250 out of 6,500 residences are not tied into the system. The Board of Health has adopted a rule requiring hook-up within five years.

Scituate

Approximately 25 percent of Scituate has sewer service. The wastewater treatment plant, which discharges to a tidal ditch tributary to the Herring River, is being upgraded under a DEP consent order. There is currently a moratorium on connections until the treatment plant is upgraded. The town has a Final Facilities Plan for Wastewater Management (Metcalf & Eddy, November 1995) which recommends sewering nine priority areas.

These prioritized areas are shown as "septic system problem areas" on Figure 3-1. The top priority for sewering is the Greenbush area, which abuts Scituate's municipal reservoir.

Scituate's wastewater treatment plant will be expanded from 0.8 million gallons per day to 1.6 million gallons per day. Sewering of the nine priority areas will utilize most or all of this capacity. Other problem areas exist, and more are likely to be discovered in the future. Capacity will not exist for new development, although there is some concern that towns have limited authorization to refuse sewer service to new developments when sewer access is available.

Weymouth

Ninety-two percent of Weymouth is sewered to the MWRA sewage treatment plant in Boston Harbor. Sewer service is available to 95 percent of the existing buildings. There are several areas in Weymouth that suffer chronic sewer surcharging during wet weather. These problems stem from several compounding factors, including: infiltration of groundwater into old and leaking sewer pipes; direct inflow of stormwater from sump pumps; and inadequate capacity and design problems (e.g., inadequate slope) in the municipal and MWRA sewer lines.

The town and the MWRA are working to solve these problems. The town has an ongoing I & I investigation and remediation program. A video camera is used to detect visible leaks in the sewer line and leaking joints are sealed. The MWRA is implementing its Braintree/Weymouth Relief Facilities Project with is scheduled to begin in June 1999 and last five years. The project includes a deep rock tunnel and new and rehabilitated pump stations, as well as a short-term solution in the Idlewell section of North Weymouth.

5.3 Stormwater Infrastructure and Roadway Maintenance

Roadway runoff routinely carries contaminants such as oil, gasoline, heavy metals, road salt, and sand into the wetlands and waterways where stormwater is discharged. Local governments and the Massachusetts Highway Department maintain and upgrade roadways within the project subbasins. A regular program of catch basin cleaning and street sweeping can remove pollutants before they enter waterways.

Table 5-3 provides local schedules for street sweeping and catch basin cleaning, and provides information on catch basin design, and whether the town has a map of its storm drain system. Table 5-4 is a summary of local road salting practices.

Table 5-3: Stormwater Infrastructure and Maintenance

Town	Storm Drains Mapped?	Catch Basin Cleaning Schedule	Approx % Basins w/ Oil/Grease Removal	Street Sweeping Schedule
Cohasset	No but plan to include storm drains in ongoing town GIS project	Once/year. Low areas 2 or 3 times/year. Staffing problems make schedule difficult to adhere to.	5%. New developments have separators	Fall and Spring (except town common and harbor area every 4-5 weeks)
Duxbury	Yes	Once/year. Bay Road area is a priority.	<1%. New developments have hoods.	Spring and Summer. Problem areas swept again in the Fall.
Hanover	Yes	Once/year.	Required in last few years in Aquifer Protection District only, which covers about 20% of town..	Annually, in Spring
Hingham	No	Once/year. Schedule is difficult to maintain due to staff limitations.	2%. Separators required in new developments for past 7 or 8 years.	Annually, except downtown more frequently
Marshfield	Yes, but map is becoming outdated.	Once/year, but more often on bottoms of hills, areas with lots of runoff, or complaints of clogged basins.	Approximately 20-30 hooded catch basins. Use Sewer Department's vacuum truck for cleaning	Try for every road annually, except business areas more frequently
Norwell	Along North River corridor and most other areas	Every other year (half the town cleaned each year). Main streets and low areas prioritized. Staffing an issue.	10%. New basins require hoods.	Annually, in Spring
Rockland	No	At least once/year (summer). Low lying areas prioritized	New basins require hoods	Twice/year - Fall and Spring
Scituate	Yes	Annually cleaned with claw and vacuum	Oil/grease traps installed in all new developments since 1980. Use MHD design	Once/year. Would like to prioritize sensitive areas, but budget isn't available.
Weymouth	Yes, but many inaccuracies	No regular cleaning program due to lack of funding and staff. Use vacuum and claw. Basins at Whitman's Pond are prioritized.	Small percentage now have hoods. Standard design for new basins include hoods.	Once/year in Spring

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Table 5-4: Town De-icing Programs

Town	Roads Maintained by State	Local Sand: Salt Ratio and Policy	Salt Storage Facility
Cohasset	Rt 3A	3:1 with less salt applied near water supplies	Covered salt shed; uncovered loading area w/ impervious floor. Site graded for runoff collection.
Duxbury	Rt 3A, 3, 53	3:1 with low salt areas near wells where CaCl is used	Graded runoff collection. Uncovered loading area with impervious floor.
Hanover	Rt 53, 139	4:1 with no salt used in well protection zone	Covered shed with covered loading area on impervious floor.
Hingham	Rt 3A, 53	4:1. Use salt substitute in low salt areas (near wells)	Salt in covered shed on Hersey St. Piles are covered, have outdoor uncovered loading area. Cons. Agent reports runoff appears to reach lower wetland/stream area. Plowed snow stockpiles adjacent to Harbor and at Conservatory Park, in ACEC.
Marshfield	Rt 3, 139, 3A	3:1. 3 low salt areas around well pump stations	Salt in covered shed. Loading area uncovered but on an impervious surface.
Norwell	Rt 53	Standard 14% salt, varies depending on the street. No salt around streams, waterbodies. Use magnesium acetate as substitute.	Covered salt shed. Loading areas are uncovered on an impervious surface. Site graded for runoff collection.
Rockland	Plain Street, Rt 123, 139	2:1 standard ratio. No salt areas near wells	1 active shed, 2 under construction. All are covered sheds. Loading areas are uncovered on an impervious surface. Brine is collected. Plowed snow stockpiled at landfill
Scituate	Rt 3A	No low salt areas	Covered shed; uncovered loading area.
Weymouth	Rt 3, 3A, 18, 53	10:1 standard ratio, but pure salt on main roads. No salt on Thatchet and Randolph Streets.	Covered shed; uncovered, paved loading area.

5.4 Other Local Practices

5.4.1 Household Hazardous Waste and Waste Oil Collection

Improper disposal of household hazardous wastes and used motor oil can be a significant source of water pollution and dumping of these materials into storm drains can adversely affect water quality. All of the project towns have adopted programs to address household hazardous waste and automotive wastes, including used motor oil and automotive batteries, as shown in Table 5-5. Those programs include local "collection events" that are held annually in the spring and/or fall. During these collection events, town residents are encouraged to dispose of a wide range of hazardous household wastes. Items such as ammunition, explosives and medical waste are usually not accepted.

All of the project communities are members of the South Shore Regional Refuse Disposal Planning Board (soon to become the South Shore Recycling Cooperative), which since 1995 has solicited and awarded a contract for conducting the annual household hazardous waste collection days for member communities and has helped staff and supervise the events.

To encourage the proper disposal of hazardous household waste on a regional level, the Board has helped draft reciprocity agreements that allow residents from any of the member communities to dispose of waste at any collection event held in another member community. The Board currently organizes waste disposal for approximately 15 towns along the South Shore ranging from Braintree to Plymouth, including all of the project communities. Several grants have recently been applied for that would allow the Board to purchase the equipment and staff to collect household hazardous waste on a regional scale.

Table 5-5: Household Hazardous Waste Collection Programs in the Study Communities

Town	Household Hazardous Waste	Waste Oil and Other Automotive Wastes
Cohasset	Annual HHW day at town landfill. Paint exchange once/month (exchange oil for water-based)	Waste oil collection at the former landfill. Also auto batteries and oil filters.
Duxbury	Annual HHW collection	Waste oil collection at transfer station
Hanover	Annual HHW collection	Waste oil collection at transfer station, also antifreeze. Used oil filters part of recycling program
Hingham	At least once/year	Waste oil collection at landfill. Batteries collected at landfill. Tires collected several times a year.
Marshfield	Annual HHW collection	Automobile batteries and tires accepted at landfill.
Norwell	Annual HHW collection	Waste oil collection at DPW yard, collection overseen by DPW staff
Rockland	Once or twice a year, focused on oil-based paints and thinners.	Waste oil collection at landfill, collection overseen by town staff
Scituate	At least once/year	Waste oil and automotive wastes (car batteries, gas, antifreeze) collected at landfill
Weymouth	HHW collection in spring and fall. Paint swap locker at DPW garage.	Waste oil collection at DPW garage

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5.4.2 Boat Pumpout Programs

Discharge of untreated or minimally treated sanitary wastes from marine craft can be a locally significant source of pathogens in harbors. The chemicals used to deodorize and disinfect this sewage (alcohol, formaldehyde, zinc and ammonium salts and chlorine) also degrade marine water quality.

Boat heads (toilets) can either be installed or uninstalled. Uninstalled heads simply stores waste until the boat returns to its slip, where the head can be carried off the boat and emptied. Installed marine heads, which are not removable, are regulated by the US coast Guard under the terms of the Federal Water Pollution Control Act Amendments of 1972. Unfortunately, illegal discharges from all types of marine heads commonly occur in nearshore waters and harbors.

While a boat's sewage may seem insignificant, the cumulative wastes from many boats may be a significant source of contamination in parts of the South Shore. However, because of the intermittent, transient, and sometimes covert, nature of these discharges, the overall impact of boat wastes to the South Shore coastal waters is difficult to assess. Generally, the impact tends to be site-specific, although pathogens and chemical disinfectants from boat discharges almost certainly impair water quality to some degree. The greatest impacts occur in embayments and other poorly flushed areas with low dilution.

All the coastal towns in the project area have boat pumpout programs. Those include:

- *Cohasset* – Mobil boat pumpout operational during the summer months. Waste is disposed directly into the town's sewer system.
- *Duxbury* - Operational from June 15 to September 15 and is located at Snug Harbor. Waste is disposed at the Marshfield wastewater treatment plant.
- *Hingham* – Mobil boat pumpout operational from June 15 to October 15. Located at the Hewitt's Cove Marina. Waste is disposed at the Marshfield wastewater treatment plant.

- *Marshfield* – Operational from May through November. This modern facility is enclosed, offers fresh water and operated as a cooperative between two marinas, a yacht club and the Town of Marshfield. Waste is disposed into the Marshfield wastewater treatment plant.
- *Scituate Harbor* – A stationary pumpout facility is located on the harbor dock and a mobile pumpout boat is also available. Waste is pumped into the town sewer system.
- *Weymouth* has a boat pumpout station at the Wessagusset Yacht Club. Waste is pumped into the town sewer system.

Chapter 6: Recommended Nonpoint Source Management Strategies

6.1 On-site Wastewater Disposal

On-site wastewater disposal problems were identified as one of the most major, if not the major, nonpoint source management issue in the project communities. Failing septic systems can contribute to the closure of shellfish beds and swimming beaches, as well as cause a general degradation of water quality. In many areas, soils are not adequate to sustain properly functioning septic systems, yet alternatives to on-site wastewater disposal do not exist. There are many areas with old, substandard cesspools, and in extreme cases there are cesspools located in groundwater. In many cases, systems cannot be upgraded to meet Title 5 standards because there is not the required depth to groundwater, the required setback distance from wetlands or water bodies, or the room to install a new leaching field.

The following recommendations are intended to help communities address on-site wastewater problems:

- Wastewater management planning can help towns develop a comprehensive understanding of wastewater problems and tailor solutions to each problem area, for example by identifying where shared systems or decentralized treatment plants might be feasible. Towns that have few sewer alternatives and many septic system problem areas (e.g., Duxbury, Hanover, Norwell) or towns that are opposed to expansion of their sewer system (e.g., Marshfield) would likely benefit from wastewater management planning. Multi-town wastewater planning would be useful for the Route 53 commercial corridor, which spans Hanover and Norwell.
- Towns should strive to develop equitable solutions for homeowners burdened by septic system repair costs. Towns should take advantage of "betterment" programs that allow homeowners to repay septic system repair costs over a 20-year period. Betterment funds should prioritize loans based on their environmental sensitivity and degree of failure.
- As appropriate, towns should become involved in the planning, design, funding and construction of wastewater alternatives for problem areas. Joint solutions, such as

shared systems or decentralized treatment plants, may in some cases provide more equitable and workable solutions than the individual upgrading of many on-site systems, each of which has to be maintained in good working order. In some cases, individual remedies are not feasible because of the lack of space for septic system leaching fields. Duxbury's two innovative, shared septic systems in the Bluefish River and Snug Harbor areas provide a good model for town involvement (see below). Appendix E provides information on the Duxbury systems and other alternative systems.

- Towns should consider adopting a local septic system management program to help the town track information about on-site systems, including inspection and maintenance records, and proximity to wells and other sensitive resources.
- Towns should take maximum advantage of available state funding resources to plan, design, and construct wastewater solutions. Available funding sources include the Clean Water State Revolving Loan Fund (SRF), Section 319 Nonpoint Source Grants, grant funds from the MassBays Program, which can be used to remediate wastewater problems that are contributing to the closure of shellfish beds. Grant and loan programs are discussed further in Section 6.4.

Innovative Solutions

With the tightening of Title 5 regulations, many communities are hard-pressed to find solutions. Even so, some communities have worked extremely hard to find solutions that work. Duxbury provides an excellent example of a success story, as outlined below and in Appendix E.

Bluefish River & Snug Harbor Innovative Shared Systems

The Bluefish River and Snug Harbor projects in the town of Duxbury provide two excellent examples of how innovative solutions can be used to solve seemingly intractable on-site wastewater disposal problems. Both solutions entailed construction of a wastewater collection and transmission system and a shared leaching field on off-site property. The Bluefish Project was the first use of a shared leaching system in the state of Massachusetts.

In the Bluefish River area, the Division of Marine Fisheries' 1993 Sanitary Survey identified three failing on-site wastewater systems as major contributors to the bacterial pollution that required closure of the Bluefish River shellfish beds. The systems were located in filled tidelands and were subject to frequent flooding. There was not the required depth to groundwater or setback to wetlands to upgrade the systems. The Mass. Bays Program awarded a $32,000 grant for system design. The final chosen design was a shared system that consists of a traditional gravity collection system, a submerged pump station, a pressure main, and a dosing leaching field located at the South Shore Conservatory of Music. The Conservatory is located a few hundred yards from the failed systems and was about to pursue its own septic system upgrade. The Conservatory agreed to allow the installation of the shared system under its new parking area.

The Snug Harbor project was constructed to solve on-site septic system problems in a commercial business district that was contributing pollution to Duxbury Bay. The Snug Harbor area was built on filled tideland. Lots are small and there was not the room, nor the required depth to groundwater, to construct new on-site systems that would comply with Title 5. Business properties could not be sold and could not obtain building permits or bank loans to operate. Some buildings had been abandoned. The business area was in a slow decline with property values dropping, resulting in loss of property tax dollars and jobs. Using the knowledge gained from the Bluefish Project, the town designed a similar shared system consisting of a conventional gravity system, a grinder pump station, and a pressure dosed leaching field located at an off-site host location. The Duxbury Yacht Club agreed to be the host facility. The system is designed for 9,900 gpd (just below the 10,000 gpd level at which a state groundwater discharge permit is required).

The town of Duxbury owns and operates both systems. Duxbury Town Meeting authorized bonding to design the Snug Harbor project and to construct both systems. 100 percent of the design and construction costs for the Snug Harbor Project and 75 percent of the construction costs for the Bluefish Project will be repaid through betterments assessed on the properties. The remaining 25 percent of construction costs for the Bluefish Project will be paid for by a modest increase in shellfish harvest license fees. The Massachusetts DEP has awarded the town a low-interest loan totaling nearly $680,000 to reduce costs to participating landowners.

See Appendix E for more information on the Duxbury shared systems.

Other Innovative Community Solutions

Several other Massachusetts communities, including Acton, Gloucester and Weston, have developed innovative solutions to difficult wastewater disposal problems. The Acton and Gloucester cases, in addition to Duxbury's Bluefish Project, are discussed in an MAPC "Planners Exchange" contained in Appendix E. The Acton project proposal entails a "package" treatment plant for South Acton Village. The overall project proposal has been revised since the article was written (to address additional areas in the town), but the issues and ideas are still relevant. The Gloucester project entails a STEP (Septic Tank Effluent Pump) project to serve 500 households in the Gloucester area. STEP technology uses septic tanks to treat solids and effluent pumps to send liquids to an off-site treatment facility. The North Gloucester project also includes a demonstration component in which several innovative systems were designed and installed in properties chosen for their difficult and unusual site conditions.

The town of Weston has installed a Solar Aquatics system, designed by Ecological Engineering Associates, to serve the downtown area. This system treats wastewater through the biological uptake of wastes in a greenhouse environment. It is an expensive system, due to the need to maintain greenhouse temperatures, but some applications may be well suited to this technology. See Appendix E for more information on the Solar Aquatics system.

6.2 Stormwater Infrastructure and Maintenance

Infrastructure Maintenance & Design

Roadways and catch basins have typically been designed to move the water off the roadway and into a collection system as efficiently as possible. The removal of pollutants has not been a consideration until fairly recently. The DEP Stormwater Management Policy and Standards (see section 6.3.2) apply to redevelopment of roadways as well as building sites and require such projects to meet the standards to the maximum extent practicable and to at least improve existing conditions. "Redevelopment" includes "maintenance and improvements of existing roadways, including widening less than a single lane, adding shoulders, and correcting substandard intersections and drainage, and repaving..."

MAPC recommends that state as well as local highway departments integrate stormwater improvements into the design of roadway maintenance projects. New roadways should be designed with environmental protection, as well as safety, in mind.

Street sweeping and catch basin cleaning can remove contaminants before they enter waterways. It is important to remove the accumulated sediment from the winter months as soon as possible before heavy and frequent spring precipitation. Budgets for maintaining catch basins are always going to be constrained. It is important for roadway managers to prioritize basins and clean priority basins more frequently. Priority criteria should include the relative importance of nearby water resources (e.g., drinking water resources, cold water fisheries, swimming beaches, shellfish beds), and the relative amount of debris (e.g., sand, leaves) an area typically receives.

Adequate funding and maintenance of stormwater management structures is a difficult issue for many communities. It is very important for there to be communication between the Planning Board and the Department of Public Works (or Highway Department or Sewer Commission) regarding funding and maintenance of BMPs. The DPW needs to provide input on whether structures are practical to maintain. The Finance Committee and Town Meeting need to provide adequate funds.

Issues that need to be resolved include:

- Who will own and maintain the BMP?
- What are the maintenance requirements and does the town have the necessary equipment and expertise?
- Will permits be needed for maintenance (e.g., Order of Conditions to remove sediments)?
- Is maintenance adequately funded for the life of the project?

Larry Boutiette of the Natural Resource Conservation Service provides the following advice to communities:

- Involve the Public Works Department early in the process as roads and drainage facilities are being planned. If facilities are to be maintained by the DPW, ensure that the DPW has the necessary expertise and equipment.
- Require developers to prepare a plan that includes details on operation and maintenance of stormwater BMPs. Public Works Departments can use these plans to support their request for maintenance funding.
- Town maintenance of BMPs is probably preferable to homeowner maintenance since the town is best equipped to own, inspect, and maintain these facilities.
- The town budget should include a line item for BMP maintenance (specify number of basins or devices).
- Drainage areas to critical resources (e.g., wells, reservoirs, shellfish beds, swimming beaches) should be delineated. Catch basin cleaning and street sweeping schedules should prioritize these critical areas and should also reflect the intensity and nature of land use.
- Ideally, local boards would work together with consistent regulations and in harmony toward the same goals.

Funding constraints for maintenance of stormwater BMPs such as detention basins can be reduced by requiring developers and property owners to pay for future maintenance. The Buzzards Bay model stormwater regulation (see Appendix F) requires the developer to provide an escrow account to fund maintenance costs for 20 years. Towns can also utilize a betterment system for developments with detention basins and other BMPs. The town would conduct the maintenance, but property owners would be assessed a charge for this maintenance (through property taxes). It is easy, however, for these betterment funds to get used for other purposes, so there has to be a mechanism to ensure that the maintenance will get conducted.

Remediation of Existing Stormwater Problems

Remediation of stormwater runoff pollution should be given serious consideration once the town identifies stormwater outfalls that are causing significant pollution problems. Retrofits to existing drainage systems can markedly decrease the amount of pollutants entering a waterway. Grant funds are available on a competitive basis for remediating stormwater pollution problems.

There are numerous technologies now available to reduce stormwater pollution from new and existing developments. These include small-scale treatment units that can be installed in a wide variety of conditions to provide long-term water quality treatment for stormwater runoff. Three Stormwater Technology Tradeshows have been held in Massachusetts in the past few years, and additional tradeshows are planned for other parts of New England. For more information, contact EPA's Center for Environmental Industry and Technology at (800) 575-CEIT or visit their website at http//www.epa.gov/region01/steward/ceit.

Communities that wish to remediate known stormwater pollution problems can seek grant funding from a number of programs. Three of the most relevant programs are:

- the Section 319 Nonpoint Source Competitive Grants program, managed by the Department of Environmental Protection, which targets implementation of measures to prevent, control and abate nonpoint source pollution (contact DEP at (508) 792-7470);
- the Coastal Pollutant Remediation (CPR) Program managed by the Massachusetts Coastal Zone Management Program which targets treatment of stormwater pollution from roadways and construction of boat pumpouts. Projects in the Greater Massachusetts Coastal Watershed (220 municipalities, including all of the Neponset Basin communities) are eligible. Contact MCZM at (617) 727-9530; and
- the Transportation Enhancements Program managed by the MAPC which includes in its categories of funding eligibility projects that address stormwater pollution from roadway runoff (contact MAPC at (617) 451-2770).

Other resources for information and technical assistance include:

- The Natural Resource Conservation Service's (NRCS) Community Assistance Program (CAP). CAP program staff includes a soil scientist, engineer and planners who can assist communities with long-term watershed planning, efforts to reduce stormwater and nonpoint source pollution, and applications for funding under the Section 319 Nonpoint Source grant program. Contact the CAP program at (508) 295-1481.
- The Nonpoint Education for Municipal Officials (NEMO) project run by the University of Connecticut Cooperative Extension System. Call Chester Arnold at (860) 345-4511 or visit their World Wide Web site at http://www.lib.uconn.edu/CANR/ces/nemo1.html.
- The Center for Watershed Protection, a non-profit organization focusing on urban watershed restoration and protection. The Center publishes the quarterly bulletin Watershed Protection Techniques, edited by Tom Schueler. Contact the Center at (301) 589-1890.

Road De-icing Programs

Applications of road salt for highway de-icing by state and local highway departments is an essential public safety measure, but the amount of salt used should be minimized by careful control of application rates.

There are several major highways in the project communities that receive significant amounts of road salt. The Massachusetts Highway Department (MHD) utilizes straight road salt applications (not pre-mixed with sand) at a rate of 300 pounds per lane mile. Roads maintained by MHD are shown in Table 5-4.

Several local wells are located in close proximity to highways. Marshfield wells are close to Routes 2, 139, 3A. The town has not yet identified sodium problems, but has expressed concerns. Norwell and Hanover water supply wells have high sodium levels (up to 60 mg/l, according to the EOEA South Coastal Basin Team Leader), and proposed expansion of Route 53 may add to the high sodium levels. Stormwater from the Route 53 expansion project will be discharged to Silver Brook, which is a tributary of Third

Herring Brook (parts of which may be classified as Outstanding Resource Waters, or ORWs).

In general, groundwater must have sodium levels above 20 mg/l and be used as a drinking water supply before MHD will consider a request for a reduced-salt application area. Towns should work with Mass. Highway Department to designate low-salt areas if sodium levels begin to approach the 20 mg/l level.

Within the study area, only Rockland has a small portion of highway that is designated as a low salt area. The Massachusetts Highway Department defines this area as, "Route 123 from Carey St. in Brockton to the junction of Route 18. Route 18 from the Whitman Maintenance Depot to the Abington/Weymouth Town Line." The de-icing materials used in this low-salt area are a pre-mix (blend of 4 parts sodium chloride / one part calcium chloride) mixed 1:1 with sand. The Highway Department applies 240 lbs. of the mix per lane mile. This portion of highway, covering 4.1 linear miles, travels through the towns of Abington, Brockton, Rockland and Whitman near several municipal water supplies.

Towns should carefully manage their de-icing programs to minimize the amount of salt applied, by mixing salt with sand at ratios ranging from 1:5 to 1:10 (salt:sand). Salt spreading equipment should be calibrated and maintained to apply de-icing materials at the correct rate. Salt:sand ratios should be reduced, or sodium chloride substitutes used, in wellhead protection areas. Increased use of sand does not come without a cost, however, as sand from de-icing programs is a major contributor of sediment to waterways.

Salt storage practices and removal and stockpiling of plowed snow can also affect water resources. Salt should be stored in covered, sheltered areas on an impervious surface and should be located at least 100 feet from streams and floodplains. Plowed snow stockpiles should be located on flat areas outside of the Zone II of drinking water supplies and at least 100 feet from streams, wetlands or floodplains.

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6.3 Local Stormwater Regulation

Section 6.3 is organized as follows:

- Section 6.3.1 discusses some of the major goals and issues relative to local stormwater regulation.

- Section 6.3.2 reviews the DEP Stormwater Management Standards published in November 1996. These standards are intended to be used by Conservation Commissions for projects in wetland resource areas and the 100-foot buffer zone.

- Section 6.3.3 reviews model stormwater management bylaws for implementation by Planning Boards, Conservation Commissions, and Boards of Health.

6.3.1 Local Stormwater Management: Goals, Issues, and Resources

It is important for local boards to keep in mind some major goals and guidelines for regulating stormwater. The following list, adapted from William Domey, P.E. of the Massachusetts Association of Health Boards, Inc., and the Buzzards Bay Project of Massachusetts Coastal Zone Management Office, may be helpful:

- Reproduce, as nearly as possible, the hydrological conditions in the ground and surface waters prior to development;
- Reduce stormwater pollution to the maximum extent possible, using Best Management Practices (BMPs);
- Utilize systems that have an acceptable future maintenance burden and ensure through routine scheduling, maintenance plans, and site inspections and enforcement, that systems are working properly;
- Have a neutral effect on the natural and human environment;
- Be appropriate for the site, given physical constraints;
- Provide erosion control measures for the construction phase;
- Address rate, volume, and quality of stormwater runoff;

- Ensure consistency of stormwater regulations among Planning Boards, Conservation Commission, and Boards of Health;
- Reduce uncertainty for the developer while allowing creativity and flexibility in meeting performance standards; and
- Address existing stormwater problems by requiring improvement of stormwater management systems when sites are redeveloped.

Communities should also aim for consistency in their regulations. Planning Boards, Boards of Health and Conservation Commissions should be adopting similar standards for stormwater management (although sensitive areas, such as wetlands, may require additional measures). Section 6.3.1 discusses model regulations that provide consistent regulations for local boards.

The Center for Watershed Protection Techniques recommends that communities tailor their stormwater management strategies to fit the land use patterns of individual watersheds. Zoning and other land use controls in watersheds that have good water quality and a minimum of impervious surface (i.e., below 10 percent) should protect these resources through more stringent limits on impervious cover, wide riparian buffers and transfer of development rights. Zoning and land use controls in degraded watersheds should focus on minimizing downstream pollutant loads and encouraging infill and redevelopment.

6.3.2 DEP Stormwater Management Standards

In November 1996 the Department of Environmental Protection issued a Stormwater Management Policy that established nine Stormwater Management Standards for discharges into wetland resource areas and the wetland buffer zone (see Appendix G). DEP is requiring local Conservation Commissions to apply the standards during routine project review under the Wetlands Protection Act. In March 1997, DEP and the Massachusetts Office of Coastal Zone Management published the Stormwater Handbook for use in implementing the stormwater policy and standards.

The DEP Stormwater Handbook states that the standards should be applied to projects in all wetland resource areas (including the newly created riverfront area) and the 100-foot buffer zone. Projects that do not require the filing of a Notice of Intent are not expected to meet the Standards.

The DEP Stormwater Management Standards are as follows:[2]

1) No new stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

2) Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.

3) Loss of annual recharge to ground water should be minimized through the use of infiltration measures to the maximum extent practicable. The annual recharge from the post-development site should approximate the annual recharge from the pre-development or existing site conditions, based on soil types.

4) For new development, stormwater management systems must be designed to remove 80% of the average annual load (post-development conditions) of Total Suspended Solids (TSS). It is presumed that this standard is met when:

a) Suitable nonstructural practices for source control and pollution prevention are implemented;

b) Stormwater management best management practices (BMPs) are sized to capture the prescribed runoff volume; and

c) Stormwater management BMPs are maintained as designed.

5) Stormwater discharges from areas with higher potential pollutant loads require the use of specific stormwater management BMPs. The use of infiltration practices without pretreatment is prohibited.

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[2] Certain projects are exempt from the new standards (e.g., single-family house projects residential subdivisions with four or fewer lots if discharges will not affect a critical area; emergency road or drainage system repairs).

6) Stormwater discharges to critical areas must utilize certain stormwater management BMPs approved for critical areas. Critical areas are Outstanding Resource Waters (ORWs), shellfish beds, swimming beaches, cold water fisheries and recharge areas for public water supplies.

7) Redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable. However, if it is not practicable to meet all the Standards, new (retrofitted or expanded) stormwater management systems must be designed to improve existing conditions.

8) Erosion and sediment controls must be implemented to prevent impacts during construction or land disturbance activities.

9) All stormwater management systems must have an operation and maintenance plan to ensure that systems function as designed.

6.3.3 Model Stormwater Regulations

While the DEP standards are a good start, they do not address projects outside of the wetland buffer zone and they do not involve the primary body in town that deals with issues of site planning, subdivisions and zoning – the Planning Board. MAPC recommends that Planning Boards consider incorporating stormwater standards — either the DEP standards or other, similar and compatible, standards — into their site plan and subdivision regulations to address areas outside of the Conservation Commission's jurisdiction.

Planning Boards can adopt the DEP standards as written, or they can adopt new regulations that better fit their needs and goals. Likewise, the Conservation Commission can adopt regulations in addition to the DEP standards, although they should treat the DEP standards as minimum standards. Stormwater regulations should be consistent across town boards to the extent possible.

The DEP standards require removal of 80 percent of the Total Suspended Solids (TSS) load in stormwater. Some communities may want a higher removal rate, and can require this through a local regulation. The DEP standards require some on-site recharge of stormwater, with the percent of recharge required dependent on the recharge capability (hydrologic soil group) of the soils. Some local and model bylaws require new development projects to result in no increase in volume, which requires on-site recharge of all increased volume. This requirement may not be practicable unless soils can infiltrate this amount. Infiltration systems are very hard to maintain and have a high failure rate, so requiring them to be installed in all cases may result in future problems. Towns should be careful to ensure that local stormwater bylaws can be implemented given local conditions.

This section summarizes three model or example stormwater regulations available for review and consideration by local boards. The Buzzards Bay model regulations provide a set of consistent regulations for Planning Boards, Conservation Commissions, and Boards of Health. The town of Rowley's regulations provide consistent regulations for Planning Boards and Conservation Commissions. The town of Sudbury's Planning Board regulations, which are similar to Rowley's, provide a set of clear and strong stormwater regulations for subdivisions.

These regulations generally address the volume as well as the rate and quality of stormwater runoff. They require stormwater management plans with site-specific data and hydrologic calculations. The Buzzards Bay and Rowley regulations require mechanisms to ensure adequate funding for future maintenance.

The full texts of these three sets of regulations are included in Appendix F. Table 6-1 is a matrix which compares these regulations as well as the town of Duxbury's subdivision regulations.

Buzzards Bay Project: Unified Rules and Regulations for Planning Boards, Conservation Commissions and Boards of Health

The Buzzards Bay project of the Massachusetts Coastal Zone Management (MCZM) Office has developed a set of consistent stormwater management regulations to be used by the Planning Board (through subdivision regulations), Conservation Commission

Table 6-1: Comparison of Existing & Model Stormwater Standards

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(through Order of Conditions), and Board of Health (through a stormwater management permit[3]). The full text of these regulations is included as Appendix F.

The primary focus of the model regulation is the Stormwater Management Plan. The plan requires detailed information on pre- and post-development conditions (including soil logs and maximum groundwater elevations for proposed BMP locations, and information on rate and volume of flow). The model regulations include a check-off sheet for the submittal of information required to be included in the Stormwater Management Plan. A maintenance plan is required as part of the Stormwater Management Plan, including a maintenance schedule, an outline of responsible parties and owners, and all pertinent agreements.

General standards in the Buzzards Bay regulation include:

- No discharge of runoff directly into rivers, streams, watercourses or wetlands.
- Post-development runoff must not exacerbate or create flooding conditions or alter surface water flow paths that impact adjacent properties during 2, 10, 25 and 100-year 24-hour storm events.
- No increase in peak rate of runoff for 2, 10, 25 and 100-year 24-hour storm event.
- No increase in volume of runoff for 10-year 24-hour design storm.
- First flush of stormwater runoff treated prior to discharge.
- Treatment must be provided to achieve 80 percent removal of TSS from first flush. (In nitrogen-sensitive areas, treatment must include nitrogen removal at 30 percent efficiency rate, and development in freshwater ponds watersheds must incorporate phosphorus removal at a design rate of 50 percent or greater.)
- No alteration of natural watercourses.

The regulation includes very detailed standards and specifications for design, construction and maintenance of stormwater BMPs.

Maintenance requirements include annual inspections, submittal of inspection reports to the town, and posting of a security adequate to cover inspection and maintenance costs for a design life of twenty years (including full or partial replacement, if necessary). “As-built” plans are required to confirm compliance with the Stormwater Management

[3] The Board of Health must decide on thresholds for compliance with the regulations (e.g., commercial and industrial projects above a specified size or with more than a specified amount of impervious surface and subdivisions or “approval not required” projects greater than a specified number of lots.)

Plan. The town is authorized to evaluate the system's effectiveness in an actual storm, and require necessary modifications, prior to the release of the performance guarantee.

Town of Sudbury Subdivision Regulation

The Town of Sudbury, Massachusetts has incorporated strong stormwater management regulations into its subdivision regulations. These regulations are attached in Appendix F. The following statement provides a good overview of the nature and purpose of Sudbury's stormwater regulations for subdivisions:

> "The stormwater management plan shall resemble the natural (predevelopment) hydrology, hydrodynamics, and drainage patterns inherent to the property. This drainage system shall maintain the natural (predevelopment) ratio of infiltration to surface runoff of site precipitation and shall minimize alterations to the natural drainage patterns. Any necessary alterations to these natural drainage patterns may not change the natural patterns of drainage outside of the subdivision."

Applicants must demonstrate that the stormwater management system has been designed and can be maintained to meet specific performance standards, including:

- Post-development runoff must approximate pre-development rate of flow, time of concentration and water quality;
- The natural hydrodynamic characteristics of the sub-basin of the watershed must be maintained;
- The quality of all watercourses, waterbodies, aquifers and wetlands must be maintained or improved;
- No impact on the natural levels and seasonal fluctuations of the groundwater table outside the site;
- No impact on the values and functions of wetlands;
- Preserve the cumulative water storage and infiltration capacities of the land;

Design standards in the Sudbury regulations include the following:

Treatment

- Direct discharge of runoff into any watercourse, waterbody or wetland is prohibited (including discharge to existing systems that have a point source to a wetland).
- Pretreatment of runoff is required prior to discharge into leaching structures or storm drains.
- Parking lot and road runoff must be treated via sand filters or oil-water separation devices.
- At a minimum, the "first flush" of runoff (defined as the first inch of runoff) from all changed surfaces must be treated and re-infiltrated on-site.
- Changes in the volume, rate, or quality of surface runoff must be minimized to the greatest extent feasible.
- Surface runoff must be routed through structural and nonstructural systems designed to allow suspended solids to settle, to remove pollutants and to maintain the predevelopment time of concentration, velocity and infiltration ratio of the surface runoff.

Miscellaneous

- Erosion and sediment controls must be shown on the definitive plan.
- An operation and maintenance plan for the stormwater system must be developed;
- If the system is composed of numerous, complex or new technologies, the Planning Board can require homeowner maintenance and ownership through an enforceable covenant.

Detention and Retention Basins

- water quality monitoring must be conducted prior to release of the performance bond and the Planning Board may require design modifications if water quality degradation is indicated;

Additional standards for detention basins include:

- no significant increase or decrease in peak flow discharges from the one, two, five, ten, twenty-five, fifty, and one hundred year storm;
- basins must not be placed where infiltration generates a potential for groundwater contamination;
- outflow must be directed to swales and must be discharged to wetlands or watercourses in a manner similar to predevelopment conditions;
- prior to town acceptance, sedimentation must be excavated at least semi-annually and uprooted vegetation must be replaced.

Town of Rowley Stormwater Management Regulations

The Town of Rowley, Massachusetts has adopted a set of Stormwater Management Regulations for implementation by the Planning Board and Conservation Commission. These regulations, which are included as Appendix F, were first drafted by the Massachusetts Audubon Society.

Projects above specified size thresholds are required to comply with the regulations. The regulations require a Stormwater Management Plan. The plan must include detailed site characteristic information, including flow rate and volume, depth to groundwater, 100-year flood zones, topography, and soils. Proposed alterations of the site, the proposed development layout, and drainage systems must be described in detail.

Standards and requirements include the following:

- The flow of runoff into rivers, streams or watercourses.
- The natural hydrodynamic characteristics of the watershed must be maintained.
- The quality of surface and groundwater must be protected or improved.
- The quality of existing discharges or runoff must not be further degraded.
- Groundwater levels must be protected or maintained.
- No alteration of natural watercourses.
- Treatment and re-infiltration of the first one inch of runoff from impervious surfaces is required.
- Parking lot and road runoff must be treated to remove oil and sediment.
- Monitoring wells must be installed at the outlet of retention basins.
- Sedimentation must be excavated at least semi-annually and after every major storm event; vegetation uprooted by sediment removal must be replaced.
- A maintenance plan including a maintenance schedule, an outline of responsible parties and owners, and all pertinent agreements.
- Posting of a security for future maintenance, which can be used by the town if maintenance procedures are not followed. (The unused portion of the security is returned to the developer or homeowner's association if the stormwater system is accepted by the town.)
- Some specific design standards are included in the regulations.

6.4 Funding Sources for Nonpoint Source Management Projects

Towns should take maximum advantage of available funding resources to address the many sources of nonpoint source pollution, including failing septic systems, stormwater discharges, hazardous waste sites, boat wastes, etc. The table below lists some of the relevant grant and loan programs available to communities. Fore more information on these programs, including contact people, visit the MAPC Worldwide Website at www.mapc.org.

Table 6-2
Funding Resources for Communities

Name of Program	Description	Funding Agency
Massachusetts Clean Water State Revolving Fund (SRF)	Loan program. Funds planning for nonpoint source problems (failing septic systems) and construction of nonpoint source pollution abatement projects. Funds planning, design and construction of wastewater treatment facilities, infiltration/inflow correction, combined sewer overflows.	Massachusetts Department of Environmental Protection (DEP)
Community Septic Management Program	Provides grant and loans to develop comprehensive community septic management programs and local betterment (loan) programs.	DEP
Section 319 Nonpoint Source Pollution Grants	Grant fund, with 40% local match required. Eligible projects include: alternative wastewater treatment systems, comprehensive subwatershed projects, projects that demonstrate new or innovative technologies, resource restoration projects.	DEP
Coastal Pollutant Remediation (CPR) Program	Reimbursement grant that can be used for projects that implement Best Management Practices for controlling runoff from roads, parking lots, and bridges, and for construction of boat pumpout facilities, when water quality impacts have been demonstrated.	Massachusetts Office of Coastal Zone Management (CZM)
Transportation Enhancement Program	Grant program (10% match required) to fund projects in several categories, including mitigation of nonpoint pollution due to highway runoff.	Metropolitan Area Planning Council (contact agency)
604(b) Water Quality Management Planning Grants	Watershed or subwatershed nonpoint source assessments.	DEP
Clean Vessel Act Grant Program	Grants for construction of boat pump-out stations. Most South Shore towns have used these funds.	DFWELE*
Massachusetts Environmental Trust	Provides grants for public education, advocacy and research projects, and projects that encourage direct citizen and community action to restore, protect and enhance water resources.	Massachusetts Environmental Trust
Technical Assistance Grants (TAG)	Maximum grants of $10,000 for hiring of experts to review hazardous waste site assessment and cleanup reports, and help applicant prepare comments.	DEP
Massachusetts Self-Help Program	Reimbursement grant for funds expended to acquire conservation and recreation lands. Must have updated Open Space Plan.	Division of Conservation Services, EOEA**
Urban Rivers Grant Program	Grant program for projects that revitalize urban river corridors, including projects that enhance aesthetic or ecological values of urban rivers.	Riverways Program, DFWELE
Lakes and Ponds Small Grants Program	Grant program with 50% cash match required. Funds lake management analysis and planning, public education, watershed management techniques, in-lake management techniques.	Mass. Department of Environmental Management

* DFWELE = Mass Department of Fisheries, Wildlife and Environmental Law Enforcement

** EOEA = Executive Office of Environmental Affairs

6.5 Site Planning through Zoning, Site Planning and Subdivision Regulations

Proper site planning can help ensure that developments achieve environmental protection and stormwater management goals. Site planning that integrates comprehensive stormwater management into the site development process from the outset is the most effective approach to reduce and prevent potential pollution and flooding problems. Early stormwater management planning will generally minimize the size and cost of structural solutions.

The Stormwater Handbook (DEP/MCZM, 1997) cites the following goals for site planning in relation to prevention of stormwater pollution. These goals can be incorporated into site plan review and subdivision regulations:

- Avoid construction and development in sensitive areas (e.g., buffer zones, natural drainageways, steep slopes and porous and erodable soils).
- Reduce and minimize impervious surfaces.
- Include specific Best Management Practices (BMP) requirements.
- Reproduce pre-development hydrological conditions.
- Fit the development to the terrain.
- Preserve and utilize natural drainage systems.

Zoning can be used to limit the amount of impervious surface, limit development in sensitive areas such as steep slopes and can include provisions to regulate impacts such as sedimentation and erosion, and water quality impacts from parking lots. Zoning bylaws can encourage site design that is protective of environmental resources through criteria for site plans and major developments and provisions for flexible or cluster developments.

Transfer of development rights is a rarely-used zoning tool that can be used to steer development away from sensitive areas or pristine watersheds and into development centers where infrastructure already exists. None of the nine towns in this study have adopted transfer-of-development-rights regulations.

Subdivision regulations can exacerbate stormwater runoff problems by requiring excessively large street widths and curb and gutter drainage. Subdivision regulations should aim for flexibility while ensuring safety. Subdivision regulations can require projects to minimize cut and fill, the dimension of paved areas and the area over which vegetation is disturbed. All three of the model stormwater regulations reviewed in Section 6.3.3 are intended to be inserted into Planning Board Rules and Regulations for the Subdivision of Land. Duxbury and Marshfield have adopted excellent stormwater controls through subdivision regulations.

The DEP/MCZM Performance Standards and Guidelines for Stormwater Management in Massachusetts (DEP/MCZM, March, 1997) and other documents currently available in the literature provide guidance for drafting site plan and subdivision regulations that minimize stormwater and other environmental impacts.

6.6 Erosion and Sediment Control

Soil erosion from poorly stabilized streambanks, development sites and agricultural areas sends sediment-laden runoff into adjacent waterways. Stream bank erosion tends to increase as an area becomes more urban. As the imperviousness of an area increases, peak runoff rates and stream water velocities increase and the magnitude and frequency of floods increases. These changes contribute to stream bank erosion and higher sediment loads.

Too much suspended material has a deleterious affect on aquatic life. Phytoplankton, fish and invertebrates have difficulty breathing if sediment loads are too high. Suspended sediments reduce the amount of light that penetrates the water. This can kill underwater vegetation and can make it difficult for sight-feeding predators to capture prey. Excessive sediment loads clog catch basins and cause flooding of roads, and fill river channels, lakes, wetlands and reservoirs. Many other pollutants, including heavy metals, bacteria and organic chemicals, sorb to sediment particles and can harm aquatic life and human health. When suspended solids settle out, they can lead to lower dissolved oxygen levels and can contaminate the sediments with toxic chemicals. When settled sediments are disturbed and re-suspended, these pollutants re-enter the water column.

Stormwater permits under the NPDES (National Pollutant Discharge Elimination System) program are required for construction activities that result in the disturbance of five acres and have a point source discharge (through a pipe, ditch or swale) to a river, pond, stream, wetland or storm drain. The DEP Stormwater Management Standards (see Section 6.3.2) require erosion and sediment controls during construction, but these standards apply only to areas under the Conservation Commission's jurisdiction.

MAPC recommends that communities adopt local bylaws or regulations to ensure that the harmful effects of erosion and sedimentation are controlled. Communities can limit the harmful effects of erosion and sedimentation through various mechanisms. Several of the communities, most notably Duxbury, Marshfield and Norwell, have adopted strong erosion control measures.

Appendix F contains two model erosion control regulations: one developed by the Middlesex and Essex Conservation Districts, and the other by the Massachusetts Audubon Society.

The Middlesex and Essex Conservation District model bylaw requires a permit, obtained from the Conservation Commission, for land-disturbing activities that involve 5,000 square feet or more of land. Full land disturbance permits are required for large projects (e.g., disturbs more than 20,000 square feet) and require detailed plans and specifications for proper erosion and sediment control. Smaller projects require limited permits which have fewer submittal requirements. Stabilization measures are required for all projects requiring a permit. The Conservation Commission may require a performance bond. Although the Conservation Commission is the issuing authority, the bylaw is intended to be applied to projects town-wide, not just those within the 100-foot wetlands buffer zone.

The Massachusetts Audubon Society has developed a model bylaw for adoption by Planning Boards and Conservation Commissions. It is intended to be adopted through subdivision regulations, site plan regulations and the local wetlands bylaw or regulation. Applicants must submit an erosion/sedimentation control plan with detailed specifications for erosion control. The bylaw includes design standards for erosion control structures, maintenance standards, and a performance guarantee.

Communities looking for assistance with developing sediment and erosion controls should contact the Community Assistance Program of the U.S. Natural Resource

Conservation Service at (508) 295-1481. The newly revised "Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas," (March 1997) is another valuable resource for municipal officials. The document was prepared by the Franklin, Hampden and Hampshire Conservation Districts for the Massachusetts DEP and other agencies. It contains information on the principles and practices of erosion and sediment control and the selection of best management practices, and is geared toward the layperson. It also includes a sample erosion and sedimentation control plan and a bibliography.

6.7 Wetlands Protection

Wetlands are environmental resources that provide critical functions, including flood control, storm damage prevention, fisheries and wildlife habitat, preservation of water quality, and water supply. MAPC recommends that wetlands losses and impacts be avoided unless no feasible alternative exists, that unavoidable losses be minimized, and that, as a final step, mitigation be used to restore or replicate lost wetland functions and acreage. In April 1990 the Commonwealth of Massachusetts adopted a policy of "no net loss of wetlands" in the short-term and a "net gain" in the long term.

Local Conservation Commissions have a key role to play in ensuring that stormwater runoff from newly developed or redeveloped areas does not adversely impact wetlands and water resources. In addition to their role in enforcing local wetlands bylaws and regulations, Conservation Commissions are now responsible for implementing the state-wide Stormwater Management Standards, issued by DEP in November 1996 (see Section 6.1.2 and Appendix G).

Conservation Commissions are also responsible for implementing the Rivers Protection Act. This act expands the Wetlands Protection Act to include protection for a 200-foot riparian zone, known as the "Riverfront Area," on either side of rivers and perennial streams.[4] Regulations for implementation of the Rivers Protection Act went into effect in October 1997.

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[4] Within the Riverfront Area, permits may not be granted for: 1) work that would result in a significant adverse impact; or 2) projects for which there is a practicable and substantially equivalent economic alternative with less adverse impacts.

Wetland and riparian buffers are a very effective measure for reducing the impacts of stormwater runoff from developed areas. Buffers should be widest where aquatic resources are the most healthy and diverse. Several of the nine towns have also adopted wetland setbacks that establish "no-build" zones within a certain distance of wetland resources. (See chapter 5 and Appendix D).

6.8 Other Regulatory Measures

Other regulatory measures that communities can utilize to protect water quality include local floor drain regulations, hazardous materials bylaws, underground storage tank bylaws, and pet waste control regulations.

Many commercial and industrial facilities have been designed with floor drains that discharge to the ground either directly through a leaching pit or dry well or indirectly by means of a separator or septic system that leads to a leaching field. Until recently, the Massachusetts Plumbing Code required floor drains in vehicle maintenance facilities, however this regulations was revised in December 1991 at the recommendation of DEP's Division of Water Supply. Vehicle maintenance and related facilities, if located within the Zone II of a public water supply, must now seal their floor drains or connect them to a municipal sewer system or a DEP-approved holding tank. Because these regulations are so recent, it will take some time before the majority of facilities are in compliance.

MAPC recommends that communities consider adoption of a Board of Health regulation for floor drains that requires elimination of hazardous discharges to the ground anywhere they occur (not just in the Zone II). Appendix F includes a model Board of Health floor drain regulation developed by the DEP.