INTRODUCTION

The Massachusetts watershed approach is a collaborative effort between state and federal environmental agencies, municipal agencies, citizens, non-profit groups, businesses and industries in the watershed. The mission is to improve water quality conditions and to provide a framework under which the restoration and/or protection of the watershed's natural resources can be achieved. Figure 6 illustrates the management structure to carry out the mission. This report presents the current assessment of water quality conditions in the South Shore Coastal Watersheds. The assessment is based on information that has been researched and developed by the Massachusetts Department of Environmental Protection (MassDEP) through the first three years (information gathering, monitoring, and assessment) of the five-year cycle in partial fulfillment of the mandate to report on the status of the Commonwealth's waters under the Federal Water Pollution Control Act (commonly known as the Clean Water Act).

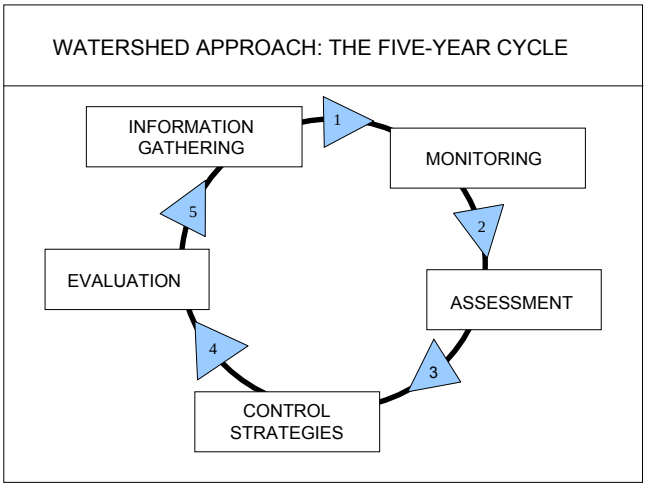


Figure 6. Five-year cycle of the Watershed Approach

The goal of the Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (Environmental Law Reporter 1988). To meet this objective the CWA requires states to develop information on the quality of the Nation's water resources and report this information to the U.S. Environmental Protection Agency (EPA), the United States Congress, and the public. Together, these agencies are responsible for implementation of the CWA mandates. Under Section 305(b) of the Federal Clean Water Act, every two years MassDEP must submit to the EPA a statewide report, which describes the status of water quality in the Commonwealth. Up until 2002 this was accomplished as a statewide summary of water quality (the 305(b) Report). States are also required to submit, under Section 303(d) of the CWA, a List of Impaired Waters requiring a total maximum daily load (TMDL) calculation. In 2002, however, EPA required the states to combine elements of the statewide 305(b) Report and the Section 303(d) List of Impaired Waters into one "Integrated List of Waters" (Integrated List). This statewide list is based on the compilation of information for the Commonwealth's 27 watersheds. Massachusetts has opted to write individual watershed water quality assessment reports and use them as the supporting documentation for the Integrated List. The assessment reports utilize data compiled from a variety of sources and provide an evaluation of water quality, progress made towards maintaining and restoring water quality, and the extent to which problems remain at the watershed level. Instream biological, habitat, physical/chemical, toxicity data and other information are evaluated to assess the status of water quality conditions. This analysis follows a standardized process described below (Assessment Methodology). Once the use assessments have been completed, the segments are categorized for the Integrated List.

ASSESSMENT METHODOLOGY

The CWA Section 305(b) water quality reporting process is an essential aspect of the Nation's water pollution control effort. It is the principal means by which EPA, Congress, and the public evaluate existing water quality, assess progress made in maintaining and restoring water quality, and determine the extent of remaining problems. In so doing the States report on waterbodies within the context of meeting their designated uses (described above in each class). Each class is identified by the most sensitive and, therefore, governing water uses to be achieved and protected. These uses include: *Aquatic Life, Fish Consumption, Drinking Water, Primary Contact Recreation, Secondary Contact Recreation, Shellfish Harvesting* and *Aesthetics*. Two subclasses of Aquatic Life are also designated in the standards: Cold Water Fishery (capable of sustaining a year-round population of cold water aquatic life, such as trout) and Warm Water Fishery (waters that are not capable of sustaining a year-round population of cold water aquatic life).

The Surface Water Quality Standards (SWQS), summarized in Table 1, prescribe minimum water quality criteria to sustain the designated uses. Furthermore, these standards describe the hydrological conditions at which water quality criteria must be applied (MassDEP 1996). In rivers the lowest flow conditions at and above which aquatic life criteria must be applied are the lowest mean flow for seven consecutive days to be expected once in ten years (7Q10). In artificially regulated waters, the lowest flow conditions at which aquatic life criteria must be applied are the flow equal to or exceeded 99% of the time on a yearly basis or another equivalent flow that has been agreed upon. In coastal and marine waters and for lakes, MassDEP will determine by on a case-by-case basis the most severe hydrological condition for which the aquatic life criteria must be applied.

The availability of appropriate and reliable scientific data and technical information is fundamental to the 305(b) reporting process. It is EPA policy (EPA Order 5360.1 CHG 1) that any organization, performing work for or on behalf of EPA, establish a quality system to support the development, review, approval, implementation, and assessment of data collection operations. To this end MassDEP describes its Quality System in an EPA-approved Quality Management Plan to ensure that environmental data collected or compiled by the Agency are of known and documented quality and are suitable for their intended use. For external sources of information, MassDEP requires the following: 1) an appropriate *Quality Assurance Project Plan*, including a laboratory Quality Assurance /Quality Control (QA/QC) plan, 2) use of a state certified lab (or as otherwise approved by MassDEP for a particular analysis), and 3) sample data, QA/QC and other pertinent sample handling information are documented in a citable report. This information will be reviewed by MassDEP to determine its validity and usability to assess water use support. Data use could be modified or rejected due to poor or undocumented QAPP implementation, lack of project documentation, incomplete reporting of data or information, and/or project monitoring objectives unsuitable for MassDEP assessment purposes.

EPA provides guidelines to the States for making their use support determinations (EPA 1997 and 2002, Grubbs and Wayland III 2000 and Wayland III 2001). The determination of whether or not a waterbody supports each of its designated uses is a function of the type(s), quality and quantity of available current information. Although data/information older than five years are usually considered “historical” and used for descriptive purposes, they can be utilized in the use support determination provided they are known to reflect the current conditions. While the water quality standards (Table 1) prescribe minimum water quality criteria to sustain the designated uses, numerical criteria are not available for every indicator of pollution. Best available guidance in the literature may be applied in lieu of actual numerical criteria (e.g., freshwater sediment data may be compared to *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* 1993 by D. Persaud, R. Jaagumagi and A. Hayton). Excursions from criteria due to solely “naturally occurring” conditions (e.g., low pH in some areas) do not constitute violations of the standards.

Each designated use within a given segment is individually assessed as ***support*** or ***impaired***. When too little current data/information exist or no reliable data are available, the use is ***not assessed***. In this report, however, if there is some indication that water quality impairment may exist, which is not “naturally occurring”, the use is identified with an “Alert Status”. Detailed guidance for assessing the status of each use follows in the Designated Uses Section of this report. It is important to note that not all waters are

assessed. Many small and/or unnamed ponds, rivers, and estuaries are currently ***unassessed***; the status of their designated uses has never been reported to EPA in the Commonwealth's 305(b) Report or the Integrated List of Waters nor is information on these waters maintained in the Waterbody System database (WBS) or the new assessment database (ADB).

Table 1. Summary of Massachusetts Surface Water Quality Standards (MassDEP 1996, MDPH 2002, and FDA 2003).

Dissolved Oxygen	Class A, Class B Cold Water Fishery (BCWF), and Class SA: ≥6.0 mg/L and ≥75% saturation unless background conditions are lower Class B Warm Water Fishery (BWWF) and Class SB: ≥5.0 mg/L and ≥60% saturation unless background conditions are lower Class C: Not ≤5.0 mg/L for more than 16 of any 24-hour period and not ≤3.0 mg/L anytime unless background conditions are lower; levels cannot be lowered below 50% saturation due to a discharge Class SC: Not ≤5.0 mg/L for more than 16 of any 24-hour period and not ≤4.0 mg/L anytime unless background conditions are lower; and 50% saturation; levels cannot be lowered below 50% saturation due to a discharge
Temperature	Class A: ≤68°F (20°C) and Δ1.5°F (0.8°C) for Cold Water and ≤83°F (28.3°C) and Δ1.5°F (0.8°C) for Warm Water. Class BCWF: ≤68°F (20°C) and Δ3°F (1.7°C) due to a discharge Class BWWF: ≤83°F (28.3°C) and Δ3°F (1.7°C) in lakes, Δ5°F (2.8°C) in rivers Class C and Class SC: ≤85°F (29.4°C) nor Δ5°F (2.8°C) due to a discharge Class SA: ≤85°F (29.4°C) nor a maximum daily mean of 80°F (26.7°C) and Δ1.5°F (0.8°C) Class SB: ≤85°F (29.4°C) nor a maximum daily mean of 80°F (26.7°C) and Δ1.5°F (0.8°C) between July through September and Δ4.0°F (2.2°C) between October through June
pH	Class A, Class BCWF and Class BWWF: 6.5 - 8.3 SU and Δ0.5 outside the background range. Class C: 6.5 - 9.0 SU and Δ1.0 outside the naturally occurring range. Class SA and Class SB: 6.5 - 8.5 SU and Δ0.2 outside the normally occurring range. Class SC: 6.5 - 9.0 SU and Δ0.5 outside the naturally occurring range.
Solids	All Classes: *These waters shall be free from floating, suspended, and settleable solids in concentrations or combinations that would impair any use assigned to each class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.*
Color and Turbidity	All Classes: *These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use.*
Oil and Grease	Class A and Class SA: *Waters shall be free from oil and grease, petrochemicals and other volatile or synthetic organic pollutants.* Class SA: *Waters shall be free from oil and grease and petrochemicals.* Class B, Class C, Class SB and Class SC: *Waters shall be free from oil* and *grease, petrochemicals that produce a visible film on the surface of the water, impart an oily taste to the water or an oily or other undesirable taste to the edible portions of aquatic life, coat the banks or bottom of the water course or are deleterious or become toxic to aquatic life.*
Taste and Odor	Class A and Class SA: *None other than of natural origin.* Class B, Class C, Class SB and Class SC: *None in such concentrations or combinations that are aesthetically objectionable, that would impair any use assigned to each class, or that would cause tainting or undesirable flavors in the edible portions of aquatic life.*
Aesthetics	All Classes: *All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.*
Toxic Pollutants	All Classes: *All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife… The division shall use the recommended limit published by EPA pursuant to 33 USC 1251, 304(a) as the allowable receiving water concentrations for the affected waters unless a site-specific limit is established*.
Nutrients	*Shall not exceed the site-specific limits necessary to control accelerated or cultural eutrophication.*

Note: *Italics are direct quotations.*

Δ criterion (referring to a change from natural background conditions) is applied to the effects of a permitted discharge.

Table 1 continued. Summary of Massachusetts Surface Water Quality Standards (MassDEP 1996, MDPH 2002, and FDA 2003).

Bacteria (MassDEP 1996, MDPH 2002, and FDA 2003) Class A criteria apply to the *Drinking Water Use*. Class B and SB criteria apply to *Primary Contact Recreation Use* while Class C and SC criteria apply to *Secondary Contact Recreation Use*.	<u>Class A:</u> Fecal coliform bacteria: An arithmetic mean of <20 cfu/100 ml in any representative set of samples and <10% of the samples >100 cfu/100 ml. <u>Class B:</u> At public bathing beaches, as defined by MDPH, where *E. coli* is the chosen indicator: No single *E. coli* sample shall exceed 235 *E. coli* /100 ml and the geometric mean of the most recent five *E. coli* samples within the same bathing season shall not exceed 126 *E. coli* / 100 ml. At public bathing beaches, as defined by MDPH, where Enterococci are the chosen indicator: No single Enterococci sample shall exceed 61 Enterococci /100 ml and the geometric mean of the most recent five Enterococci samples within same bathing season shall not exceed 33 Enterococci /100 ml. Current standards for other waters (not designated as bathing beaches), where fecal coliform bacteria are the chosen indicator: Waters shall not exceed a geometric mean of 200 cfu/100 ml in any representative set of samples, nor shall more than 10% of the samples exceed 400 cfu/100 ml. (This criterion may be applied on a seasonal basis at the discretion of the MassDEP.) <u>Class C:</u> Fecal coliform bacteria: Shall not exceed a geometric mean of 1000 cfu/100ml, nor shall 10% of the samples exceed 2000 cfu/100 ml. <u>Class SA:</u> Fecal coliform bacteria: Waters approved for open shellfishing shall not exceed a geometric mean (most probable number (MPN) method) of 14 MPN/100 ml, nor shall more than 10% of the samples exceed 28 MPN/100 ml in a 12-tube single dilution test (or 43 MPN/100 ml in a 5-tube decimal dilution test). At public bathing beaches, as defined by MDPH, where Enterococci are the chosen indicator: No single Enterococci sample shall exceed 104 Enterococci /100 ml and the geometric mean of the five most recent Enterococci levels within the same bathing season shall not exceed 35 Enterococci /100 ml. Current standards for other waters (not designated as shellfishing areas or public bathing beaches), where fecal coliform bacteria are the chosen indicator: Waters shall not exceed a geometric mean of 200 cfu/100 ml in any representative set of samples, nor shall more than 10% of the samples exceed 400 cfu/100 ml. (This criterion may be applied on a seasonal basis at the discretion of the MassDEP.) <u>Class SB:</u> Fecal coliform bacteria: In waters approved for restricted shellfish, a fecal coliform median or geometric mean (MPN method) of <88 MPN/100 ml and <10% of the samples >260 MPN/100 ml. At public bathing beaches, as defined by MDPH, where Enterococci are the chosen indicator: No single Enterococci sample shall exceed 104 Enterococci /100 ml and the geometric mean of the most recent five Enterococci levels within the same bathing season shall not exceed 35 Enterococci /100 ml. Current standards for other waters (not designated as shellfishing areas or public bathing beaches), where fecal coliform bacteria are the chosen indicator: Waters shall not exceed a geometric mean of 200 cfu/100 ml in any representative set of samples, nor shall more than 10% of the samples exceed 400 cfu/100 ml. (This criterion may be applied on a seasonal basis at the discretion of the MassDEP.) <u>Class SC:</u> Fecal coliform bacteria: Shall not exceed a geometric mean of 1000 cfu/100 ml, nor shall 10% of the samples exceed 2000 cfu/100 ml.

DESIGNATED USES

The Massachusetts Surface Water Quality Standards designate the most sensitive uses for which the surface waters of the Commonwealth shall be enhanced, maintained and protected. Each of these uses is briefly described below (MassDEP 1996).

- *AQUATIC LIFE* - suitable habitat for sustaining a native, naturally diverse, community of aquatic flora and fauna. Two subclasses of aquatic life are also designated in the standards for freshwater bodies: *Cold Water Fishery* - capable of sustaining a year-round population of cold water aquatic life, such as trout, and *Warm Water Fishery* - waters that are not capable of sustaining a year-round population of cold water aquatic life.
- *FISH CONSUMPTION* - pollutants shall not result in unacceptable concentrations in edible portions of marketable fish or for the recreational use of fish, other aquatic life or wildlife for human consumption.
- *DRINKING WATER* - used to denote those waters used as a source of public drinking water. They may be subject to more stringent regulation in accordance with the Massachusetts Drinking Water Regulations (310 CMR 22.00). These waters are designated for protection as Outstanding Resource Waters under 314 CMR 4.04(3).
- *SHELLFISH HARVESTING* (in SA and SB segments) – Class SA waters in approved areas (Open Shellfish Areas) shellfish harvested without depuration shall be suitable for consumption, and Class SB waters in approved areas (Restricted Shellfish Areas) shellfish harvested with depuration shall be suitable for consumption.
- *PRIMARY CONTACT RECREATION* - suitable for any recreation or other water use in which there is prolonged and intimate contact with the water with a significant risk of ingestion of water. These include, but are not limited to, wading, swimming, diving, surfing and water skiing.
- *SECONDARY CONTACT RECREATION* - suitable for any recreation or other water use in which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact incident to shoreline activities.
- *AESTHETICS* - all surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.
- *AGRICULTURAL AND INDUSTRIAL* - suitable for irrigation or other agricultural process water and for compatible industrial cooling and process water.

The guidance used to assess the *Aquatic Life, Fish Consumption, Drinking Water, Shellfish Harvesting, Primary* and *Secondary Contact Recreation* and *Aesthetics* uses follows.

AQUATIC LIFE USE

This use is suitable for sustaining a native, naturally diverse, community of aquatic flora and fauna. The results of biological (and habitat), toxicological, and chemical data are integrated to assess this use. The nature, frequency, and precision of the MassDEP's data collection techniques dictate that a weight of evidence be used to make the assessment, with biosurvey results used as the final arbiter of borderline cases. The following chart provides an overview of the guidance used to assess the status (support or impaired) of the *Aquatic Life Use*.

Variable	***Support*** - Data available clearly indicates support or minor modification of the biological community. Excursions from chemical criteria (Table 1) not frequent or prolonged and may be tolerated if the biosurvey results demonstrate support.	***Impaired*** There are frequent or severe violations of chemical criteria, presence of acute toxicity, or a moderate or severe modification of the biological community.
BIOLOGY		
Rapid Bioassessment Protocol (RBP) III*	Non/Slightly impacted	Moderately or Severely Impacted
Fish Community	Best Professional Judgment (BPJ)	BPJ
Habitat and Flow	BPJ	Dewatered streambed due to artificial regulation or channel alteration, BPJ
Eelgrass Bed Habitat (Howes *et al.* 2003)	Stable (no/minimal loss), BPJ	Loss/decline, BPJ
Macrophytes	BPJ	Exotic species present, BPJ
Plankton/Periphyton	No/infrequent algal blooms	Frequent and/or prolonged algal blooms
TOXICITY TESTS**		
Water Column/Ambient	≥75% survival either 48 hr or 7-day exposure	<75% survival either 48 hr or 7-day exposure
Sediment	≥75% survival	<75% survival
CHEMISTRY-WATER**		
Dissolved oxygen (DO)/percent saturation (MassDEP 1996, EPA 1997)	Infrequent excursion from criteria (Table 1), BPJ (minimum of three samples representing critical period)	Frequent and/or prolonged excursion from criteria [river and shallow lakes: exceedances >10% of measurements; deep lakes (with hypolimnion): exceedances in the hypolimnetic area >10% of the surface area].
pH (MassDEP 1996, EPA 1999a)	Infrequent excursion from criteria (Table 1)	Criteria exceeded >10% of measurements.
Temperature **(**MassDEP 1996, EPA 1997)	Infrequent excursion from criteria (Table 1) [1]	Criteria exceeded >10% of measurements.
Toxic Pollutants (MassDEP 1996, EPA 1999a) Ammonia-N (MassDEP 1996, EPA 1999b) Chlorine (MassDEP 1996, EPA 1999a)	Infrequent excursion from criteria (Table 1) Ammonia is pH and temperature dependent[2] 0.011 mg/L (freshwater) or 0.0075 mg/L (saltwater) total residual chlorine (TRC) [3]	Frequent and/or prolonged excursion from criteria (exceeded >10% of measurements).
CHEMISTRY-SEDIMENT**		
Toxic Pollutants (Persaud *et al.* 1993)	Concentrations ≤ Low Effect Level (L-EL), BPJ	Concentrations ≥ Severe Effect Level (S-EL) [4], BPJ
CHEMISTRY-TISSUE		
PCB – whole fish (Coles 1998)	≤500 μg/kg wet weight	BPJ
DDT (Environment Canada 1999)	≤14.0 μg/kg wet weight	BPJ
PCB in aquatic tissue (Environment Canada 1999)	≤0.79 ng TEQ/kg wet weight	BPJ

*RBP II analysis may be considered for assessment decision on a case-by-case basis, **For identification of impairment, one or more of the following variables may be used to identify possible causes/sources of impairment: NPDES facility compliance with whole effluent toxicity test and other limits, turbidity and suspended solids data, nutrient (nitrogen and phosphorus) data for water column/sediments. [1]Maximum daily mean T in a month (minimum six measurements evenly distributed over 24-hours) less than criterion. [2] Saltwater is temperature dependent only. [3] The minimum quantification level for TRC is 0.05 mg/L. [4]For the purpose of this report, the S-EL for total polychlorinated biphenyl compounds (PCB) in sediment (which varies with Total Organic Carbon (TOC) content) with 1% TOC is 5.3 ppm while a sediment sample with 10% TOC is 53 ppm.

Note: National Academy of Sciences/National Academy of Engineering (NAS/NAE) guideline for maximum organochlorine concentrations (i.e., total PCB) in fish tissue for the protection of fish-eating wildlife is 500μg/kg wet weight (ppb, not lipid-normalized). PCB data (tissue) in this report are presented in μg/kg wet weight (ppb) and are not lipid-normalized to allow for direct comparison to the NAS/NAE guideline.

FISH CONSUMPTION USE

Pollutants shall not result in unacceptable concentrations in edible portions of marketable fish or for the recreational use of fish, other aquatic life or wildlife for human consumption. The assessment of this use is made using the most recent list of Fish Consumption Advisories issued by the Massachusetts Executive Office of Health and Human Services, Department of Public Health (MDPH), Bureau of Environmental Health Assessment (MDPH 2004a). The MDPH list identifies waterbodies where elevated levels of a specified contaminant in edible portions of freshwater species pose a health risk for human consumption. Hence, the Fish Consumption Use is assessed as non-support in these waters.

In July 2001 MDPH issued new consumer advisories on fish consumption and mercury contamination (MDPH 2001).

1. The MDPH "…is advising pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age to refrain from eating the following marine fish; shark, swordfish, king mackerel, tuna steak and tilefish. In addition, MDPH is expanding its previously issued statewide fish consumption advisory which cautioned pregnant women to avoid eating fish from all freshwater bodies due to concerns about mercury contamination, to now include women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age (MDPH 2001)."
2. Additionally, MDPH "…is recommending that pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age limit their consumption of fish not covered by existing advisories to no more than 12 ounces (or about 2 meals) of cooked or uncooked fish per week. This recommendation includes canned tuna, the consumption of which should be limited to 2 cans per week. Very small children, including toddlers, should eat less. Consumers may wish to choose to eat light tuna rather than white or chunk white tuna, the latter of which may have higher levels of mercury (MDPH 2001)."

Other statewide advisories that MDPH has previously issued and are still in effect are as follows (MDPH 2001):

1. Due to concerns about chemical contamination, primarily from polychlorinated biphenyl compounds (PCBs) and other contaminants, no individual should consume lobster tomalley from any source. Lobster tomalley is the soft green substance found in the tail and body section of the lobster.
2. Pregnant and breastfeeding women and those who are considering becoming pregnant should not eat bluefish due to concerns about PCB contamination in this species.

The following is an overview of EPA's guidance used to assess the status (support or impaired) of the *Fish Consumption Use*. Because of the statewide advisory, no waters can be assessed as support for the *Fish Consumption Use*. Therefore, if no site-specific advisory is in place, the *Fish Consumption Use* is not assessed.

Variable	***Support*** No restrictions or bans in effect	***Impaired*** There is a "no consumption" advisory or ban in effect for the general population or a sub-population for one or more fish species or there is a commercial fishing ban in effect
MDPH Fish Consumption Advisory List (MDPH 2001, MDPH 2002)	Not applicable, precluded by statewide advisory (Hg)	Waterbody on MDPH Fish Consumption Advisory List

Note: MDPH's statewide advisory does not include fish stocked by the state Division of Fisheries and Wildlife or farm-raised fish sold commercially.

DRINKING WATER USE

The term *Drinking Water Use* denotes those waters used as a source of public drinking water. These waters may be subject to more stringent regulation in accordance with the Massachusetts Drinking Water Regulations (310 CMR 22.00). They are designated for protection as Outstanding Resource Waters (ORWs) in 314 CMR 4.04(3). MassDEP's Drinking Water Program (DWP) has primacy for implementing the provisions of the federal Safe Drinking Water Act (SDWA). Except for suppliers with surface water sources for which a waiver from filtration has been granted (these systems also monitor surface water quality) all public drinking water supplies are monitored as finished water (tap water). Monitoring includes the major categories of contaminants established in the SDWA: bacteria, volatile and synthetic organic compounds, inorganic compounds and radionuclides. The DWP maintains current drinking supply monitoring data. The suppliers currently report to MassDEP and EPA the status of the supplies on an annual basis in the form of a consumer confidence report (http://yosemite.epa.gov/ogwdw/ccr.nsf/Massachusetts). Below is EPA's guidance to assess the status (support or impaired) of the drinking water use.

Variable	***Support***	***Impaired***
	No closures or advisories (no contaminants with confirmed exceedances of maximum contaminant levels, conventional treatment is adequate to maintain the supply).	Has one or more advisories or more than conventional treatment is required or has a contamination-based closure of the water supply.
Drinking Water Program Evaluation	See note below	See note below

Note: While this use is not assessed in this report, information on drinking water source protection and finish water quality is available at http://www.mass.gov/dep/brp/dws/dwshome.htm and from the South Shore Coastal Shore Watershed's public water suppliers.

SHELLFISH HARVESTING USE

This use is assessed using information from the Department of Fish and Game's Division of Marine Fisheries (DMF). A designated shellfish growing area is an area of potential shellfish habitat. Growing areas are managed with respect to shellfish harvest for direct human consumption, and comprise at least one or more classification areas. The classification areas are the management units, and range from being approved to prohibited (described below) with respect to shellfish harvest. Shellfish areas under management closures are *not assessed.* Not enough testing has been done in these areas to determine whether or not they are fit for shellfish harvest, therefore, they are closed for the harvest of shellfish.

Variable	***Support***	***Impaired***
	SA Waters: Approved[1] SB Waters: Approved[1], Conditionally Approved[2] or Restricted[3]	SA Waters: Conditionally Approved[2], Restricted[3], Conditionally Restricted[4], or Prohibited[5] SB Waters: Conditionally Restricted[4] or Prohibited[5]
DMF Shellfish Project Classification Area Information (DFWELE 2000)	Reported by DMF	Reported by DMF

NOTE: Designated shellfish growing areas may be viewed using the MassGIS datalayer available from MassGIS at http://www.mass.gov/mgis/dsga.htm. This coverage currently reflects classification areas as of July 1, 2000.

[1] **Approved** - "...open for harvest of shellfish for direct human consumption subject to local rules and regulations..." An approved area is open all the time and closes only due to hurricanes or other major coastwide events.

[2] **Conditionally Approved** - "...subject to intermittent microbiological pollution..." During the time the area is open, it is "...for harvest of shellfish for direct human consumption subject to local rules and regulations…" A conditionally approved area is closed some of the time due to runoff from rainfall or seasonally poor water quality. When open, shellfish harvested are treated as from an approved area.

[3] **Restricted** - area contains a "limited degree of pollution." It is open for "harvest of shellfish with depuration subject to local rules and state regulations" or for the relay of shellfish. A restricted area is used by DMF for the relay of shellfish to a less contaminated area.

[4] **Conditionally Restricted** - "...subject to intermittent microbiological pollution..." During the time area is restricted, it is only open for "the harvest of shellfish with depuration subject to local rules and state regulations." A conditionally restricted area is closed some of the time due to runoff from rainfall or seasonally poor water quality. When open, only soft-shell clams may be harvested by specially licensed diggers (Master/Subordinate Diggers) and transported to the DMF Shellfish Purification Plant for depuration (purification).

[5] **Prohibited -** Closed for harvest of shellfish.

PRIMARY CONTACT RECREATION USE

This use is suitable for any recreational or other water use in which there is prolonged and intimate contact with the water with a significant risk of ingestion of water during the primary contact recreation season (1 April to 15 October). These include, but are not limited to, wading, swimming, diving, surfing and water skiing. The chart below provides an overview of the guidance used to assess the status (support or impaired) of the *Primary Contact Recreation Use*. Excursions from criteria due to natural conditions are not considered impairment of use.

Variable	***Support*** Criteria are met, no aesthetic conditions that preclude the use	***Impaired*** Frequent or prolonged violations of criteria and/or formal bathing area closures, or severe aesthetic conditions that preclude the use
Bacteria (MassDEP 1996 and MDPH 2002)	At "public bathing beach" areas: formal beach postings/advisories neither frequent nor prolonged during the swimming season (the number of days posted or closed cannot exceed 10% during the locally operated swimming season). Other waters: samples* collected during the primary contact season must meet criteria (Table 1). Shellfish Growing Area classified as "Approved" by DMF.	At "public bathing beach" areas: formal beach closures/postings >10% of time during swimming season (the number of days posted or closed exceeds 10% during the locally operated swimming season). Other waters: samples* collected during the primary contact season do not meet the criteria (Table 1).
Aesthetics (MassDEP 1996) - *All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance* [growth or amount] *species of aquatic life*		
Odor, oil and grease, color and turbidity, floating matter	Narrative "free from" criteria met or excursions neither frequent nor prolonged, BPJ.	Narrative "free from" criteria not met - objectionable conditions either frequent and/or prolonged, BPJ.
Transparency (MDPH 1969)	Public bathing beach and lakes – Secchi disk depth ≥1.2 meters (≥ 4') (minimum of three samples representing critical period).	Public bathing beach and lakes - Secchi disk depth <1.2 meters (< 4') (minimum of three samples representing critical period).
Nuisance organisms	No overabundant growths (i.e., blooms) that render the water aesthetically objectionable or unusable, BPJ.	Overabundant growths (i.e., blooms and/or non-native macrophyte growth dominating the biovolume) rendering the water aesthetically objectionable and/or unusable, BPJ.

* Data sets to be evaluated for assessment purposes must be representative of a sampling location (minimum of five samples per station recommended) over the course of the primary contact season. Samples collected on one date from multiple stations on a river are not considered adequate to assess this designated use. An impairment decision will not be based on a single sample (i.e., the geometric mean of five samples is <200 cfu/100 ml but one of the five samples exceeds 400 cfu/100 ml). The method detection limit (MDL) will be used in the calculation of the geometric mean when data are reported as less than the MDL (e.g. use 20 cfu/100 ml if the result is reported as <20 cfu/100 ml). Those data reported as too numerous to count (TNTC) will not be used in the geometric mean calculation; however, frequency of TNTC sample results should be presented.

SECONDARY CONTACT RECREATION USE

This use is suitable for any recreation or other water use in which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact incident to shoreline activities. Following is an overview of the guidance used to assess the status (support or impaired) of the *Secondary Contact Use*. Excursions from criteria due to natural conditions are not considered impairment of use.

Variable	***Support*** Criteria are met, no aesthetic conditions that preclude the use	***Impaired*** Frequent or prolonged violations of criteria, or severe aesthetic conditions that preclude the use
Fecal Coliform Bacteria (MassDEP 1996)	Other waters: Samples* collected must meet the Class C or SC criteria (see Table 1).	Other waters: Samples* collected do not meet the Class C or SC criteria (see Table 1).
Aesthetics (MassDEP 1996) - *All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance* [growth or amount] *species of aquatic life*		
Odor, oil and grease, color and turbidity, floating matter	Narrative "free from" criteria met or excursions neither frequent nor prolonged, BPJ.	Narrative "free from" criteria not met - objectionable conditions either frequent and/or prolonged, BPJ.
Transparency (MDPH 1969)	Public bathing beach and lakes – Secchi disk depth ≥1.2 meters (≥ 4') (minimum of three samples representing critical period).	Public bathing beach and lakes - Secchi disk depth <1.2 meters (< 4') (minimum of three samples representing critical period).
Nuisance organisms	No overabundant growths (i.e., blooms) that render the water aesthetically objectionable or unusable, BPJ.	Overabundant growths (i.e., blooms and/or non-native macrophyte growth dominating the biovolume) rendering the water aesthetically objectionable and/or unusable, BPJ.

*Data sets to be evaluated for assessment purposes must be representative of a sampling location (minimum of five samples per station recommended) over time. Samples collected on one date from multiple stations on a river are not considered adequate to assess this designated use.

AESTHETICS USE

All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life. The aesthetic use is closely tied to the public health aspects of the recreational uses (swimming and boating). Below is an overview of the guidance used to assess the status (support or impaired) of the *Aesthetics Use*.

Variable	***Support*** Narrative "free from" criteria met	***Impaired*** Objectionable conditions frequent and/or prolonged
Odor, oil and grease, color and turbidity, floating matter	Narrative "free from" criteria met or excursions neither frequent nor prolonged, BPJ.	Narrative "free from" criteria not met - objectionable conditions either frequent and/or prolonged, BPJ.
Transparency (MDPH 1969)	Public bathing beach and lakes – Secchi disk depth ≥1.2 meters (≥ 4') (minimum of three samples representing critical period).	Public bathing beach and lakes - Secchi disk depth <1.2 meters (< 4') (minimum of three samples representing critical period).
Nuisance organisms	No overabundant growths (i.e., blooms) that render the water aesthetically objectionable or unusable, BPJ.	Overabundant growths (i.e., blooms and/or non-native macrophyte growth dominating the biovolume) rendering the water aesthetically objectionable and/or unusable, BPJ.

SOUTH SHORE COASTAL WATERSHEDS DESCRIPTION AND CLASSIFICATION

DESCRIPTION

The South Shore Coastal Watersheds have a drainage area of approximately 240 square miles. The area is one of the eleven coastal drainage areas in eastern Massachusetts discharging directly to the ocean. There are 16 communities located entirely or partly within the South Shore Coastal Watersheds area: Bourne, Cohasset, Duxbury, Halifax, Hanover, Hanson, Hingham, Kingston, Marshfield, Norwell, Pembroke, Plymouth, Plympton, Rockland, Scituate and Weymouth. Located along the coast of Massachusetts Bay south of Boston, the South Shore Coastal Watersheds contains several independent coastal river subbasins as well as significant groundwater aquifer resources. Descriptions of these communities can be found in the Regional Open Space Plan (GeoSyntec 2003).

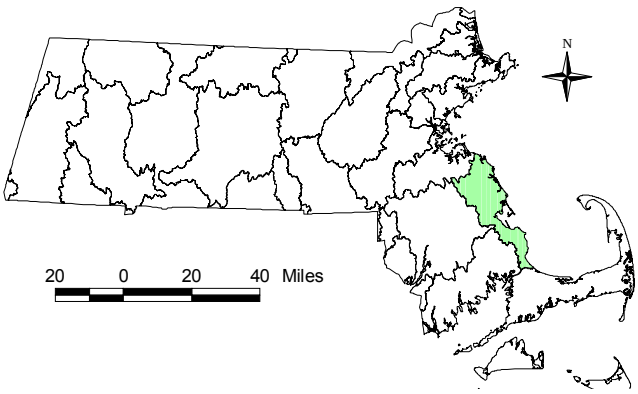


Figure 7. Location of the South Shore Coastal Watersheds.

The three largest subwatersheds in the South Shore Coastal Subwatersheds area are the Cohasset Harbor system, the North and South rivers systems and the Plymouth Bay system including the Jones and Eel rivers. Stream flows are, on average, highest in March and lowest in September. The larger coastal embayments include Little Harbor and The Gulf in Cohasset, Green Harbor in Marshfield, Scituate Harbor in Scituate, Plymouth Harbor in Plymouth, and Plymouth Bay (including Duxbury/Kingston Bay) in Duxbury/Kingston/Plymouth. There are 167 lakes and ponds, 14 of which are designated as Class A Public Water Supplies and Outstanding Resource Waters. Only one lake is larger than 500 acres; Silver Lake in Kingston/Pembroke is 617 acres. Several kettle ponds and streams pocket the coastal outwash plain. They are fed by groundwater discharge and are not being significantly influenced by runoff. As a result the flows in these streams do not fluctuate greatly over the year.

In 1978 MA DCR (formerly MA DEM) designated the North River a state scenic river by to be managed under a protective order administered by the North River Commission (MA DEM 1979). The freshwater portions of the upper North River include the Indian Head River, Drinkwater Rivers, and French Stream. The *Scenic and Recreational River Protective Order for the North River* established a commission made up of representatives from each of the six affected communities to review applications for any activities within the North River, associated wetlands and lands generally within 300 feet of the natural bank. The aim of the Order is to protect public and private property, wildlife, fresh and saltwater fisheries, and irreplaceable wild, scenic and recreational river resources. The Order identifies specific site design standards such as maintaining a minimum 100-foot buffer strip from the natural bank of the North River and a 40-foot buffer strip from any tributary thereto, whether natural or man-made.

The most significant groundwater resource is the Plymouth/Carver sole-source aquifer, encompassing the southern portion of the South Shore Coastal Watersheds area. This aquifer, the second largest in Massachusetts, underlies 140 mi^2 in eight towns in Southeastern Massachusetts. EPA designated it as a sole-source aquifer pursuant to Section 1424(e) of the Safe Drinking Water Act since it provides much of the drinking water for the region and, if groundwater contamination were to occur, it would pose a significant public health hazard and a serious financial burden to the area residents (EPA 1990). The rough bounds of the aquifer are the Jones River on the north, Cape Cod Bay on the east, Cape Cod Canal and Buzzards Bay on the south and the groundwater divide of the Sippican, Taunton and Jones River watersheds on the west. Containing more than 500 billion gallons of freshwater (on average), 168 million gallons flow through the aquifer each day (Hansen and Lapham 1992 and EPA 1990). The competing demands on this resource will be studied by USGS (Appendix F, Project 2005-01/SRF).

CLASSIFICATION

The Massachusetts Surface Water Quality Standards (SWQS) designate the most sensitive uses for which the surface waters of the Commonwealth shall be enhanced, maintained and protected; prescribe minimum water quality criteria required to sustain the designated uses; and include provisions for the prohibition of discharges (MassDEP 1996). These regulations should undergo public review every three years. The surface waters are segmented and each segment is assigned to one of the six classes described below. Each class is identified by the most sensitive and therefore, governing, water uses to be achieved and protected. Surface waters may be suitable for other beneficial uses, but shall be regulated by the Department of Environmental Protection to protect and enhance the designated uses.

Of the five classes of water quality (A, SA, B, SB, and C), Classes A and SA have the highest water quality standards to protect the highest uses of human consumption and excellent habitat quality. The overlay designation of Outstanding Resource Water (ORW) is applied to those waters with exceptional socio-economic, recreational, ecological and/or aesthetic values (MassDEP 1996 and Rojko *et al.* 1995). ORWs have more stringent requirements than other waters because the existing use is so exceptional or the perceived risk of harm is such that no lowering of water quality is permissible. ORWs include certified vernal pools and all designated Class A Public Water Supplies and may include surface waters found in National Parks, State Forests and Parks, Areas of Critical Environmental Concern and those protected by special legislation, such as the North River Protective Order (MA DEM 1979). Wetlands that border ORWs are designated as ORWs to the boundary of the defined area. Two Areas of Critical Environmental Concern (ACECs) have been designated in the southern section of the South Shore Coastal Drainage Area - Ellisville Harbor and the Herring River Watershed (MA DCR 2003a). Ellisville Harbor is an embayment of Cape Cod Bay located in the town of Plymouth that was designated an ACEC in January 1980. The Herring River Watershed was designated an ACEC in November 1991 and is located on the boundary with Buzzards Bay Watershed in the towns of Plymouth and Bourne.

Ellisville Harbor ACEC (MA DCR 2003b)

> "The Ellisville Harbor ACEC comprises approximately 600 acres of widely diverse habitats and vegetation including a sheltered harbor, sandy beaches, salt marsh, steep bluffs, kettle holes [Center Hill and Black Ponds], a small sphagnum bog, and scenic, rural upland sites with woodland and meadow. Its ponds and marshes are feeding and breeding grounds for many aquatic birds, and the salt marsh supports shellfish and finfish. The barrier beach system, dunes, and salt marshes provide storm protection for the low-lying inland areas. The open areas are a vestige of the extensive farmlands that once characterized the Massachusetts coast. The maintenance of high water quality, vulnerable because of the high water table, is important to the public health for water supply, and for shellfishing, fishing, and recreation. Situated along the western shore of Cape Cod Bay, just five miles north of the Cape Cod Canal, the ACEC borders the Cape Cod Bay Ocean Sanctuary. In 1991, DCR acquired nearly 100 acres at the heart of the ACEC, as the Ellisville Harbor State Park. A Master Plan was developed for the state park in 1993. Protection of resources is the first priority for management and only low-impact passive recreation is encouraged. The park offers outstanding scenic qualities through forested uplands, salt marsh, and beach access."

Herring River (MA DCR 2003c)

> "The 4450-acre Herring River Watershed ACEC contains eleven lakes and ponds (the largest [Great Herring Pond] is 376 acres), numerous freshwater wetlands, productive cranberry bogs, and over 250 acres of protected open space. The area contains one of the most important anadromous fish runs along the coast [The Herring River] and Great Herring Pond supports a regionally important freshwater recreational fishery. Other recreational activities revolve around boating and three major summer camps for children. The area lies within the Plymouth Carver Sole Source Aquifer, and thus is critical to public water supply. At least three known state-listed rare and endangered species, including the box turtle and spotted turtle, are present."

Inland Water Classes

1. ***Class A*** *– These waters are designated as a source of public water supply. To the extent compatible with this use they shall be an excellent habitat for fish, other aquatic life* and *wildlife, and suitable for primary and secondary contact recreation. These waters shall have excellent aesthetic value. These waters are designated for protection as Outstanding Resource Waters (ORWs) under 314 Code of Massachusetts Regulations (CMR) 4.04(3)* (MassDEP 1996 and Rojko *et al.* 1995).
2. ***Class B*** *– These waters are designated as a habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation. Where designated they shall be suitable as a source of water supply with appropriate treatment. They shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*
3. ***Class C*** *– These waters are designated as a habitat for fish, other aquatic life and wildlife, and for secondary contact recreation. These waters shall be suitable for the irrigation of crops used for consumption after cooking and for compatible industrial cooling and process uses. These waters shall have good aesthetic value.*

Coastal and Marine Classes

4. ***Class SA*** *– These waters are designated as an excellent habitat for fish, other aquatic life and wildlife and for primary and secondary recreation. In approved areas they shall be suitable for shellfish harvesting without depuration (Open Shellfishing Areas). These waters shall have excellent aesthetic value.*
5. ***Class SB*** *– These waters are designated as a habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation. In approved areas they shall be suitable for shellfish harvesting with depuration (Restricted Shellfishing Areas). These waters shall have consistently good aesthetic value.*
6. ***Class SC*** *– These waters are designated as a habitat for fish, other aquatic life, and wildlife and for secondary contact recreation. They shall also be suitable for certain industrial cooling and process uses. These waters shall have good aesthetic value.*

Consistent with the National Goal Uses of “fishable and swimmable waters”, a list of the waters in the South Shore Coastal Watersheds, grouped according to the classification in the Massachusetts Surface Water Quality Standards (MassDEP 1996), is provided below.

Class A

- Aaron River Reservoir, to its outlet in Hingham and those tributaries thereto (ORW)
- Furnace Pond, to its outlet in Pembroke and those tributaries thereto (ORW)
- Great Sandy Bottom Pond, to its outlet in Pembroke and those tributaries thereto (ORW)
- Great South Pond, to its outlet in Plymouth and those tributaries thereto (ORW)
- Hingham Street Reservoir, to its outlet in Rockland and those tributaries thereto (ORW)
- Lily Pond, to its outlet in Cohasset and those tributaries thereto (ORW)
- Little South Pond, to its outlet in Plymouth and those tributaries thereto (ORW)
- Old Oaken Bucket Pond (Herring Brook Pond), to its outlet in Scituate and those tributaries thereto (ORW)
- Silver Lake, to its outlet in Kingston and those tributaries thereto (ORW)

Class SA

- Cohasset Harbor
- Little Harbor
- Scituate Harbor
- North River, from Curtis Crossing Dam to Massachusetts Bay (ORW due to the North River Protective Order)
- South River, the entire length (ORW)*
- Green Harbor

*NOTE. The upper reach of the South River is actually a freshwater system (to the dam at Main Street [Route 3A] in Marshfield). The next revision of the MA SWQS should reflect this correctly.

Class B

- French Stream, the entire length
- Drinkwater River, the entire length
- Indian Head River, from the source to Curtis Crossing Dam
- Jones River, source to Elm Street

Class SB

- The Gulf

There are no Class C or SC waters in the South Shore Coastal Watersheds. Unlisted waters in South Shore Coastal area that are not otherwise designated in the SWQS are designated *Class B* for inland waters and *Class SA* for coastal and marine waters. According to the SWQS, where fisheries designations are necessary they shall be made on a case-by-case basis.

SOURCES OF INFORMATION

Multiple local, state and federal agencies provided information used in the water quality assessment of the South Shore Coastal Watersheds. Within the Department of Environmental Protection (MassDEP) information was obtained from three programmatic bureaus: Bureau of Resource Protection (BRP, see below), Bureau of Waste Prevention (industrial wastewater discharge information) and the Bureau of Waste Site Cleanup (hazardous waste site cleanup information). Specifically, water quality data collected from rivers (Appendices A and B), lake synoptic survey data (1996) and lake water quality data (2001) (Appendix C), and toxics in fish flesh data (Appendix D) were provided by MassDEP's Division of Watershed Management (DWM), Watershed Planning Program. The MassDEP Southeast Regional Office and the DWM, Watershed Permitting Program, provided water withdrawal and wastewater discharge permit information (Water Management Act, and National Pollutant Discharge Elimination System) (Appendix E). [Note: The BRP Drinking Water Program evaluates the status of the *Drinking Water Use* and this information is, therefore, not provided in this assessment report.] Projects funded through various MassDEP grant and loan programs also provide valuable information that may be used in the water quality assessment report. A summary of these projects and projects funded through grants from the Massachusetts Office of Coastal Zone Management (CZM), the Massachusetts Department of Conservation and Recreation (MA DCR), the Massachusetts Watershed Initiative Roundtable and the Army Corps of Engineers (ACOE) for the South Shore Coastal Watersheds is provided in Appendix F. While some projects relate to very specific areas (these are noted in the appropriate segments), others such as the *South Shore Nonpoint Source Management Plan* and the *Regional Open Space Plan for the South Coastal Watershed* (Appendix F, Project 95-03/604 and MWI grant, respectively) are applicable to the entire watershed area. Several other projects described in Appendix F (e.g., 99-12 and 13/MWI and 04-02 and 03/319) are statewide projects. Still other projects are regional (e.g., Project 03-03/319, Community Septic Management Program, MWI Project Cohasset, Scituate and Norwell). Appendix G provides a complete listing of DMF shellfish area classifications in the South Shore Coastal Watershed. Lastly, a Technical Memorandum for the record prepared by Gerald M. Szal (MassDEP) and related to review of the Pilgrim Nuclear Power Station: intake and discharge effects to finfish is provided in Appendix H.

Other state agencies contributing information to this report include: the Massachusetts Department of Public Health (MDPH); the Department of Fish and Game's (MA DFG) Division of Marine Fisheries (DMF), Division of Fisheries and Wildlife (MDFW) and Riverways Program; MA DCR and CZM. Federal agencies contributing include the United States Environmental Protection Agency (EPA), ACOE, and United States Geological Survey (USGS).

In addition to state and federal agencies, regional and local groups provide information that may be used to indicate areas of both high and degraded water quality, as well as causes and sources of contamination. The Massachusetts Bays Program (MBP), launched in 1988 to address environmental threats to the larger Massachusetts and Cape Cod Bay ecosystem, is a federal, state, regional, and local partnership that is administered by CZM. As part of this program, a Comprehensive Conservation & Management Plan (CCMP) was developed in 1996 and was recently updated (MBP 1996 and MBP 2003). There are two regional planning agencies in the South Shore Coastal Watersheds area -- the Metropolitan Area Planning Council (MAPC), which serves Cohasset, Duxbury, Hanover, Hingham, Marshfield, Norwell, Pembroke, Rockland, Scituate, and the Old Colony Planning Council (OCPC), which

serves Abington, Halifax, Hanson, Kingston, Pembroke, Plymouth, Plympton, and Whitman. Among other activities, the regional planning agencies provide technical assistance and planning services through grants from the MBP. As part of the Massachusetts Ecosystem Assessment Project, CZM is coordinating the collection and analysis of sediment, waters and fish tissue samples from selected stations (identified by EPA, CZM and partners) in order to evaluate the ecological conditions of Massachusetts's estuaries and near coastal waters. This project is conducted within the context of EPA's larger National Coastal Assessment Program. Since 2000 scientists from the University of Massachusetts (UMass) Boston, UMass Dartmouth, and CZM have been conducting some water quality (*in-situ* measurements and discrete sampling) and sediment quality sampling according to standardized procedures in the South Shore Coastal Watersheds as part of this project (Strobel 2000 and EPA 2001).

The MBP is also participating in two other regional monitoring initiatives: Gulfwatch and the Northwest Atlantic Monitoring Network. Gulfwatch is a Gulf of Maine-wide monitoring program that uses the blue mussel, *Mytilus edulis*, as an indicator of habitat exposure to contaminants.

The North River Commission was established to administer the Scenic and Recreational Rivers Act to protect the North River, as well as parts of associated tributaries in the towns of Scituate, Marshfield, Pembroke, Norwell, Hanover, and Hanson.

The South Coastal Watershed Network (SCWNetwork) is an informal group of citizens, local officials, nonprofit organizations, and government agencies that work together to protect our coastal and inland water resources. This group was originally formed as the South Coastal Watersheds Team of the Massachusetts Watershed Initiative. Despite the demise of the Watershed Initiative, the network remains committed to the watershed approach to help solve regional environmental problems in the South Shore Coastal Watershed. The North and South River Watershed Association (NSRWA), the Massachusetts Bays National Estuary Program, and the Massachusetts Office of Coastal Zone Management coordinate the SCWNetwork. Active watershed associations include NSRWA, the Eel River Watershed Association, the Jones River Watershed Association, the Billington Sea Association, the Six Ponds Improvement Association, the Plymouth Pondwatchers, and the newly formed Pembroke Watershed Association.

The Center for Student Coastal Research (CSCR) in Cohasset, a nonprofit organization, is also actively educating students and young adults in environmental stewardship. Several projects including a study to evaluate non-point source pollution in the Gulf River and a physical, chemical, and bacteriological study of Cohasset Harbor have been initiated and additional projects are being proposed (Buckley 2005, Genello 2005, and CES 2005).

In August 2001, the Massachusetts "Beach Bill" was enacted by the legislature and signed by the Governor (MGL. C111. S5S). This act created minimum standards for public bathing waters adjacent to any public or semi-public bathing beach in the Commonwealth. A "public bathing beach" is defined as a beach open to the general public whether or not any entry fee is charged that permits access to bathing waters. A "semi-public bathing beach" is defined as a bathing beach used in connection with a hotel, motel, trailer park, campground, apartment house, condominium, country club, youth club, school, camp, or similar establishment where the primary purpose of the establishment is not the operation of the bathing beach, and where admission to the use of the bathing beach is included in the fee paid for use of the premises. A semi-public bathing beach shall also include a bathing beach operated and maintained solely for the use of members and guests of an organization that maintains such bathing beach. Under the Beach Bill, the Massachusetts Department of Public Health (MDPH) was directed to establish minimum uniform water quality standards for coastal and inland beach waters as well as determining the frequency and location of testing, reporting requirements, and requirements for notifying the public of threats to human health or safety. *105 CMR 445.000: Minimum Standards for Bathing Beaches (State Sanitary Code, Chapter VII)* outlines MDPH's guidelines for the Beach Bill. Additionally, under the Beach Bill and MDPH guidelines, local boards of health and state agencies are responsible for collecting samples from public beaches using testing procedures consistent with the American Public Health Association's *Standard Methods for Examination of Water and Waste Water* or methods approved by EPA. Operators of semi-public beaches are responsible for the costs of testing their beaches. Results of testing, monitoring, and analysis of public and semi-public beaches must be submitted in an annual report to MDPH by 31 October of each year (MDPH 2002).

MA DFG's Division of Fisheries and Wildlife (MDFW), in collaboration with MassDEP DWM, performs fish population monitoring in selected watersheds each summer. In 2001 Beaver Dam Brook, Ben Mann Brook, Drinkwater River, Eel River, First Herring Brook, French Stream, Island Creek, Indian Head Brook, Indian Head River, Longwater Brook, Second Herring Brook, Torrey Brook, Wildcat Brook, Wildcat Creek, an unnamed tributary to Black Pond Brook and Jacobs Pond were monitored for fish population assemblages.

Prompted by concerns over declining smelt catches, MA DFG's Division of Marine Fisheries (DMF) Sportfisheries/Technical Assistance Program conducted a field sampling program to monitor rainbow smelt (*Osmerus mordax*) populations in the Gulf of Maine Coast of Massachusetts from the New Hampshire Border to the Cap Cod Canal (Chase in preparation). Smelt, an anadromous fish, migrate from coastal waters into estuaries in the fall, provide a valuable fall and winter fishery in communities along the coast and spawn past the extent of saltwater encroachment in the increased flow of shallow riffles. The purpose of the program was to 1) provide baseline data useful to resource management goals of protecting sensitive spawning habitat from further degradation and restoring the Commonwealth's rainbow smelt populations and 2) to characterize river systems by the collection of baseline chemistry and document the occurrence of other diadromous species in the river systems. In the South Shore Coastal Watersheds area, a total of 45 specific locations were surveyed, including the following river systems: Bound Brook, Satuit Brook, North River, South River, Island Creek, Jones River, Town Brook, and Eel River. Plymouth Harbor was confirmed as the southernmost location with smelt runs in the Gulf of Maine. The results of the surveys conducted in rivers not assessed in this report are described below (Chase in preparation).

Satuit Brook: This small coastal creek flows for approximately 4 km from wetlands in Scituate to discharge into Scituate Harbor. Smelt eggs were found in Satuit Brook in 1993 and 1994 along a short stretch of habitat that started in the salt marsh upstream from Front Street and ended slightly upstream from the driveway to the Scituate Senior Center off First Parish Road. The length of the spawning habitat was only 55 m. This brook can be characterized as a late-starting spawning run with low numbers of participants. The brook should be recognized as a smelt run by local authorities and receive protection from alterations.

Island Creek: This stream originates at the outlet of Island Creek Pond in Duxbury and empties into Kingston Bay. Smelt eggs were found near the railroad embankment downstream from Tremont Street. Egg densities were low, however. Several factors including low flows, acidic water quality conditions, and blockage of the railroad culvert with wood debris were identified as issues of concern by DMF biologists. Additional monitoring for streamflow and pH as well as clearing of debris and/or replacement with properly sized culvert and protecting the existing riparian buffer are strongly recommended.

Town Brook: This stream originates at the outlet of Billington Sea in Plymouth and flows into Plymouth Harbor. Smelt eggs were found from the upstream side of Pleasant Street bridge to below the Route 3A bridge. The available spawning habitat in Town Brook was found to be limited in size and was degraded by the deposition of road sand and other sediments. Reducing the weir height at Water Street should provide an opportunity to improve the degraded status of the smelt-spawning habitat in Town Brook and may improve passage by allowing fish to pass over a greater range of the tide. Controlling sediment deposition originating in downtown Plymouth should be supported and continued in order to correct the significant sedimentation of smelt spawning riffles between Water Street and Pleasant Street.

Surface Water Discharge Permits

The South Shore Coastal Watersheds receive discharges of treated wastewater (Appendix E, Table E1) from 14 primary sources. The following types of National Pollutant Discharge Elimination System (NPDES) surface water discharges occur in the watershed (MassDEP 2005a).

Municipal wastewater treatment plants

- Cohasset WWTP (MA0100285) discharges to Cohasset Cove (Segment MA94-32).

- Marshfield WWTP (MA0101737) discharges to Massachusetts Bay (not a segment).
- Plymouth WWTP (MA0100587) discharges to Plymouth Harbor (Segment MA94-16) with additional groundwater discharge to Eel River (Segment MA94-23).
- Rockland WWTP (MA0101923) discharges to French Stream (Segment MA94-03).
- Scituate WWTP (MA0102695) discharges to Herring River via a tidal ditch (Segment MA94-07).

Sanitary wastewater treatment plants

- Golden Rooster Restaurant (MA0005797) discharges to The Gulf (Segment MA94-19).
- Stellwagon Bank National Marine Sanctuary (MA0090531) has a small treatment plant that discharges into Scituate Harbor (Segment MA94-02).

Industrial discharges

- Battelle Duxbury Operations WWTP (MA0025852) discharges culture water and non-contact cooling water to Duxbury Bay (Segment MA94-15).
- Entergy Nuclear Generation Company (ENGC) - Pilgrim Nuclear Station (MA0003557) discharges cooling water and stormwater to Cape Cod Bay (not a segment).
- Harborview Place (MAG250020) discharges non-contact cooling water to Plymouth Harbor (Segment MA94-16)

Municipal Public Drinking Water Treatment Plants (WTP)

- Abington/Rockland Joint WTP on Hingham Street (MAG640010) discharges to Ben Mann Brook (a tributary of Drinkwater River Segment MA94-21).
- Broadway WTP (MAG640063) discharges to Iron Mine Brook (MA94-24).
- Brockton WTP (MAG640029) discharges to a lagoon of Silver Lake (MA94143).
- Cohasset Water Department (MA0103098*)* discharges supernatant to Lily Pond (MA94179).
- Pond Street WTP in Hanover (MAG640043) discharges to Third Herring Brook (MA94-27) via the wetland area Old Pond Meadows.

Industrial non-process discharges

- Several industries have general permits issued to the facilities by EPA for the discharge of non-contact cooling water and stormwater. While these discharges are authorized and controlled under general permits, the associated impacts from these facilities are minimal and do not get significant review from MADEP.

Battelle Duxbury Operations WWTP, the Pond Street WTP in Hanover and the municipal wastewater treatment plants in the South Shore Coastal Watersheds submit toxicity testing reports to EPA and MassDEP as required by their NPDES permits. Data from these toxicity reports are maintained by DWM in a database entitled "Toxicity Testing Data - TOXTD". Information from the reports includes: survival of test organisms exposed to ambient river water (used as dilution water), physicochemical analysis (e.g., hardness, alkalinity, pH, total suspended solids) of the dilution water, and the whole effluent toxicity test results. Data from 1996 to 2004 were reviewed and summarized for use in the assessment of current water quality conditions in the South Shore Coastal Watershed.

The NPDES permits and toxicity test results are described in detail in the water body segment receiving the discharge. The only exception is ENGC-Pilgrim Nuclear Power Plant and Marshfield WWTP since these plants discharge directly into Cape Cod Bay and Massachusetts Bay, respectively, which are not waterbodies assessed in this report. Information for these facilities is summarized below.

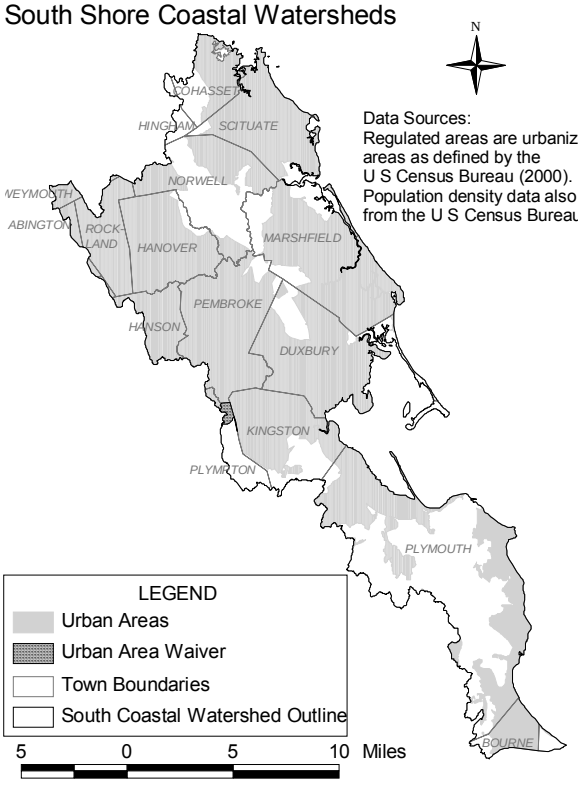
The Town of Marshfield is authorized (MA0101737 issued in September 2001) to discharge from the Marshfield Wastewater Treatment Plant (WWTP) a flow of 2.1 MGD (average monthly) of treated effluent via outfall #001 to Massachusetts Bay. In the last 3 years, this conventional activated sludge facility has upgraded its disinfection process from gaseous chlorination to ultraviolet disinfection (Silva 2004 and Kelly 2004). The facility's whole effluent toxicity testing limit is $LC_{50} \geq 100\%$ effluent using *Mysidopsis bahia.* Toxicity testing for this facility is required four times/year. No acute toxicity has been detected in the effluent ($LC_{50} > 100\%$ effluent) in the 13 tests conducted between October 2001 and September 2004.

The ENGC operates Pilgrim Nuclear Power Plant in accordance with NPDES Permit MA0003557, issued in 29 April 1991 (modified 30 August 1994) and transferred to Entergy Nuclear from Boston Edison on 22 September 1999. This permit is still in effect since the renewal application received in March 1996 is under review. The permit allows 10 outfalls to discharge into Cape Cod Bay and can be summarized in the following manner.

- A barrier net is maintained “as near to the end of the discharge canal as good engineering practices will allow” to minimize entrainment of fish, primarily flounder, menhaden, and migrating rainbow smelt. As an alternative to the physical barrier, the EPA and MassDEP could require the Permittee maintain an average dissolved nitrogen level of 115% in the canal to minimize gas bubble disease in finfish. DMF manages a monitoring program for finfish, shellfish and wildlife within Cape Cod Bay including one beach seine station, S-5, in Plymouth Harbor (MA94-16).
- Condensor cooling water is discharged from Outfall 001 at an average monthly flow of 447 MGD with a maximum daily temperature limit of 102 ºF, a ΔT of 32 ºF, and boron and sodium nitrite limited to < 1.0 mg/L and 2.0 mg/L, respectively, above background levels.
- Thermal backwash for bio-fouling control is discharged from Outfall 002 when the operation is required but limited to 3 hours/day twice weekly at a maximum daily rate of 255 MGD. Temperature of the discharge cannot exceed 120 ºF.
- Intake screen wash (fish sluice water) is discharged from Outfall 003 at a rate of 4.1 MGD. Chlorine can be used as a biocide with an average monthly limit on the Total Residual Oxidant of 0.5 mg/L (1.0 mg/L maximum daily).
- Yard drains are discharged through Outfalls 004, 005, 006, and 007 with an average monthly limit on TSS of 30 mg/L.
- Potable water for sea foam suppression can be discharged from Outfall 008 at a maximum daily rate of 0.73 MGD.
- Plant service cooling effluent is discharged from Outfall 010 at an average monthly flow of 19.2 MGD. Continuous chlorination is allowed with an average monthly limit on Total Residual Oxidant of 0.5 mg/L (1.0 mg/L daily).
- Makeup water and demineralizer effluent is discharged from Outfall 011 at a monthly average rate of 0.015 MGD (0.06 MGD daily max) with a TSS limit of 30 mg/L.

The NPDES Phase II General Permit program requires NPDES permit coverage for stormwater discharges from small municipal separate storm sewer systems (MS4s), and construction activity disturbing one acre or more of land in a mapped "urbanized area" defined and delineated by the US Bureau of Census in 2000 http://www.epa.gov/npdes/pubs/fact2-2.pdf. Large and medium MS4s (populations over 100,000) were permitted during Phase I of the NPDES stormwater program. Under EPA's Phase II program, the definition of "municipal" includes Massachusetts communities, U.S. military installations, state or federal owned facilities such as hospitals, prison complexes, state colleges or universities and state highways. An MS4 is a system that: discharges at one or more a point sources; is a separate storm sewer system (not designed to carry combined stormwater and sanitary waste water); is operated by a public body; discharges to the Waters of the United States or to another MS4; and, is located in an "Urbanized Area". The NPDES Phase II General Permit requires operators of regulated MS4s to develop and implement a stormwater management program that prevents harmful pollutants from being washed or dumped directly into the storm sewer system which is subsequently discharged into local waterbodies. The NPDES Stormwater Phase II General Permit requires operators of regulated small municipal separate storm sewer systems (MS4s) to develop a stormwater management program that prevents harmful pollutants from being washed or dumped directly into the storm sewer system, and then discharged into local waterbodies. Certain

Figure 8. Urbanized Areas in the South Shore Coastal Watersheds



Massachusetts communities were automatically designated (either in full or part) by the Phase II rule based on the urbanized area delineations from the 2000 U.S. Census.

As a result of the census mapping, all 16 communities in the South Shore Coastal Watersheds were located either totally or partially in the regulated Urbanized Area (Figure 8 and Appendix E, Table E4). Municipalities that are totally regulated must implement the requirements of the Phase II permit in the entire town, while communities that are partially regulated need to comply with the Phase II permit only in the mapped Urbanized Areas. All South Shore Coastal drainage area communities applied to EPA and MassDEP for coverage under the Phase II stormwater general permit, issued on 1 May 2003, with the exception of Plympton. The Town of Plympton received a waiver of the Phase II stormwater requirements on May 16, 2003 since the area subject to jurisdiction has a population under 1,000 and otherwise satisfies the criteria identified at 40 CFR 123.35(d) 1 (Murphy 2003). EPA issued stormwater general permits to all other South Shore Coastal Watersheds municipalities after administrative review and, in coordination with MassDEP, will complete a thorough review of the communities' stormwater management program during the five-year permit term. Phase II stormwater general permits will expire on 1 May 2008 (Domizio 2004). For detailed community maps see http://www.epa.gov/region01/npdes/stormwater/ma.html.

Site specific evaluations of other water quality issues in South Shore Coastal Watersheds related to either wastewater discharges and/or water withdrawals were conducted by MassDEP DWM either through field investigations (where resources could be allocated) or through the review of discharge monitoring reports and annual water withdrawal reports submitted by the permittees.

A list of registered and permitted Water Management Act (WMA) withdrawals (both public water suppliers and other industrial users) is provided in Appendix F, Table F4, with the exception of cranberry growers (LeVangie 2002). Registration and permit files (both public water suppliers and other industrial users excluding the cranberry growers) were reviewed to determine where stream segments might be affected by water withdrawal activities. The information is summarized in the segments where the withdrawals occur.

The cranberry industry is an important part of the economy and character of Southeastern Massachusetts. Massachusetts ranks second in the nation in cranberry production with more 14,000 acres in production (UMass 2005). Many of the numerous wetlands in the South Shore Coastal Watersheds are used to cultivate cranberries (approximately 3,327 acres although not necessarily in production) and many of these growers have WMA registrations/permits for their water use. However, for the purpose of this report, water use for cranberry cultivation within the recharge area has been estimated by using a volume of 10 acre-feet of water per acre of bog per year (1 acre-foot = 325,900 gallons). The acreage of cranberry bog within the recharge area has been estimated by using the *cranberry bog* category of the MassGIS Land-Use data layer. The figure of 10 acre-feet of water per acre of bog per year is based on a study conducted by the Cape Cod Cranberry Growers Association for the Massachusetts Water Management Act Program. It should be noted that this figure is used for “old style” bogs, those bogs that do not employ best management practices (BMPs) that conserve water. Most bogs constructed today, and many renovated older bogs, use BMPs, such as laser leveling, on-site reservoirs, tailwater recovery, etc., which result in reduced water usage (between 5 and 6 acre-feet of water per acre of bog per year). Therefore, the estimate of water usage within the subwatershed for cranberry cultivation is a conservative number (O’Shea 2002). It should be noted here that the *Cranberry Bog Phosphorous Dynamics TMDL Project* (DeMoranville 2001) has been completed. There are several recommended BMPs that have resulted from this TMDL and they should be considered for implementation.

There are no Federal Energy Regulatory Commission (FERC) licensed hydroelectric power plants in the South Shore Coastal Watersheds. A FERC-exempt power-generating facility is located at Russell Mills Pond (P-6429 MA).

The United States Army Corps of Engineers (ACOE) is charged with reducing flood damage and implementing controls, preparing for and responding to natural disasters, remediating and restoring the environment, protecting stream banks and shorelines, maintaining navigation on the country’s waterways, as well as supporting the military. In the South Shore Coastal Watersheds, the ACOE maintain

navigation through the Cape Cod Canal and have restored the Sagamore wetland at the mouth of the canal Cape Cod Bay.

The United States Geologic Survey (USGS) maintains two stream gages in the South Shore Coastal Watersheds on the Jones River (01105870) at Kingston and on Indian Head River (01105730) at Hanover. The period of record for these gages is 1966 to the current year.

A 50-acre wetland restoration project was completed in 2001 at the Sagamore Marsh located at the mouth of the Cape Cod Canal. During the reconstruction of the Cape Cod Canal in the 1930s, 175 acres at the southern end of the 350-acre Sagamore Marsh were filled and separated by a dike from the rest of the marsh. The filling and restricted flow over the last 70 years resulted in vast areas of *Phragmites*-dominated marsh. The ACOE, in partnership with the MA DEM (now MA DCR) and MA Wetlands Restoration Program, replaced existing degraded culverts under the two service roads with 6 foot high by 6 foot wide box culverts installed tide gates with manual back up systems and widened and lengthened the man-made channel. In order to avoid flooding impacts to adjacent homes only 50 of the 175 impacted acres were restored to full tidal flushing (EOEA 2002).

Of the EPA Designated Superfund sites in South Shore Coastal Watersheds, the most notable is the Weymouth Naval Air Station in the headwaters of the North River subwatershed. Other sites include the former CM Brackett & Company in Plympton, Norfolk Conveyor in Cohasset, and the Cannon Engineering Corp. site in Cordage Industrial Park, Plymouth. Two sites in the Cohasset Harbor sub-watershed are classified by MassDEP as Tier IA sites - the Beechwood Dump and Hingham Naval Ammunition Depot Annex both located in the Wompatuk State Park in Cohasset and Hingham. The Former Burning Area in Wompatuk State Park, Hingham, is classified by MassDEP as a Tier IC site.

As part of the Greenbush Railroad Renovation, the MBTA proposes to restore commuter rail service on the existing Greenbush railroad right of way that runs through the municipalities of Braintree, Weymouth, Hingham, Cohasset and Scituate before terminating at the Greenbush Station in Scituate (MBTA 2002). Project components in the South Shore Coastal Watersheds include the complete replacement of tracks, signal systems, grade crossing warning systems, stormwater infrastructure and 20 culverts restored or replaced. In addition construction will include three new passenger stations with parking and a layover facility for the trains at the final Greenbush Station. Variances of the Wetland Protection Act regulations were issued by the MassDEP for the project alignment in Hingham on December 26, 2003 (MassDEP 2003b), in Cohasset on March 19, 2004 (MassDEP 2004a), and in Scituate on March 5, 2004 (MassDEP 2004b). The Braintree and Weymouth project components were approved in the final Superseding Orders of Conditions issued by the Department on July 27, 2004 (MassDEP 2004c). Both the Cohasset and Scituate variances are presently under appeal (Rhodes 2004). The project-wide Water Quality Certification was issued by the Department on July 16, 2004 and is presently under appeal (MassDEP 2004d). The wetland impacts that necessitated the variances include: 1.83 acres of temporary impacts to saltmarsh, alteration of 2,971 square feet of bank; 2,259 square feet of land under water; as well as permanent and temporary impacts to freshwater wetlands, bordering lands subjects to flooding, and wetland wildlife habitat of special concern. The layover station was moved to the north side of The Driftway during the MEPA review process to avoid impacts to over 74,000 square feet of salt marsh bordering the Herring River. A variance of the Water Quality Certification regulations (314 CMR 9.06(3) is presently under review for placing fill material in ORWs including vernal pools in vegetated wetlands and vegetated wetlands that are tributaries to public water supplies. The specific proposed impacts within the South Shore Coastal Watersheds are - in Cohasset (13 vernal pools totaling 19,000 square feet) and in Scituate (permanent and temporary impacts totaling 11,200 square feet of Brushy Hill Swamp, an ORW that is a tributary to Old Oaken Bucket Pond (MA94113), and a total of 7,000 square feet in 3 vernal pools). Mitigation proposed for these and other permitted wetland impacts will take place on the "Rousseau property" and includes the restoration of 1.83 acres of salt marsh on the First Herring Brook and the replication of an adjacent 2.73 acres of formerly filled wetlands. This wetland site provides 2:1 mitigation for the 1.24 acres of permanent impacts to bordering vegetated wetlands, salt marsh and land under water along the Scituate corridor. There is another 2.79 acres of impacts to bordering vegetated wetlands, salt marsh and land under water that will be restored in place. Stormwater runoff from the proposed project is being mitigated through the use of best management practices and treatment units. Three South Shore Coastal segments will be receiving stormwater runoff or will otherwise by impacted

from proposed project components -- the James Brook tributary to Cohasset Cove (MA94-32), Bound Brook (MA94-18) and Herring River (MA94-07).

MASSACHUSETTS YEAR 2002 INTEGRATED LIST OF WATERS

Section 305(b) of the federal Clean Water Act (CWA) defines the process whereby states monitor and assess the quality of their surface and groundwater and report on the status of those waters every two years. Section 303(d) of the CWA requires states to periodically identify and list those waterbodies for which existing controls on point and non-point sources of pollutants are not stringent enough to attain or maintain compliance with applicable surface water quality standards. Through the year 2000 MassDEP fulfilled the 305(b) and 303(d) reporting requirements in two completely separate documents. In 2001 the EPA released guidance that provided states with the option of preparing a single Integrated List of Waters to be submitted in 2002; this list would meet the reporting requirements of both sections 305(b) and 303(d) of the CWA.

The Massachusetts Year 2002 Integrated List of Waters was published by MassDEP in September 2003 (MassDEP 2003a). In this report each waterbody or segment thereof was placed in one of five major categories. Category 1 included those waters that were meeting all designated uses. No Massachusetts waters were listed in Category 1 because a state-wide health advisory pertaining to the consumption of fish precludes any waters from being in full support of the *Fish Consumption Use*. Waters listed in Category 2 were found to support the uses for which they were assessed, but other uses were unassessed. Category 3 contained those waters for which insufficient or no information was available to assess any uses.

According to the EPA guidance, waters exhibiting impairment for one or more uses were placed in either Category 4 or Category 5. Category 4 waters are impaired but do not require the development of Total Maximum Daily Loads (TMDLs) while Category 5 waters are impaired but do require TMDL(s). A TMDL is the greatest amount of a pollutant that a waterbody can accept and still meet water quality standards. Category 4 was further divided into three sub-categories – 4A, 4B and 4C – depending upon the reason that a TMDL was not needed for a particular waterbody. Category 4A included waters for which the required TMDL(s) had already been completed and approved by the EPA. However, since segments could only appear in one category, waters that had an approved TMDL for some pollutants but not others remained in Category 5. Category 4B was to include waters for which other pollution control requirements were reasonably expected to result in the attainment of the designated use before the next listing cycle (i.e., 2004). Because of the uncertainty related to making predictions about conditions in the future MassDEP made a decision not to utilize Category 4B in the 2002 Integrated List. Finally, waters impaired by factors such as flow modification or habitat alteration that are not subjected to TMDL calculations because the impairment is not related to one or more pollutants were included in Category 4C. While the EPA's guidance for the preparation of the Integrated List provided an overall framework for a five-part list of waters, the development, submittal, and review of Category 5 was subject to the prevailing regulation governing the implementation of Section 303(d) of the CWA and, as such, this category was approved as the Massachusetts 2002 303(d) List of Impaired Waters by the EPA on October 1, 2003. Table 2 identifies those waterbodies in the South Shore Coastal Watersheds that were included in Categories 4 and 5 on this list.

Table 2. 2002 Integrated List of Waters in the South Shore Coastal Watersheds (Categories 4 and 5).

Waterbody (Segment)	Location	Cause of Impairment*
Category 4A - TMDL is completed		
Little Harbor (MA94-20)	Cohasset	Pathogens (TMDL completed 9-12-02)
Category 4C - Impairment not caused by a pollutant:		
Beaver Dam Pond (MA94006)	Plymouth	Exotic Species
Black Mountain Pond (MA94009)	Marshfield	Exotic Species
Briggs Reservoir (MA94019)	Plymouth	Exotic Species

Table 2 continued. 2002 Integrated List of Waters in the South Shore Coastal Watersheds.

Waterbody (Segment)	Location	Cause of Impairment
Briggs Reservoir (MA94020)	Plymouth	Exotic Species
Cooks Pond (MA94027)	Plymouth	Exotic Species
Island Creek Pond (MA94073)	Duxbury	Exotic Species
Island Pond (MA94075)	Plymouth	Exotic Species
Jacobs Pond (MA94077)	Norwell	Exotic Species
Beaver Dam Pond (MA94006)	Plymouth	Exotic Species
Long Island Pond (MA94088)	Plymouth	Exotic Species
Lorings Bogs Pond (MA94089)	Duxbury	Exotic Species
Lower Chandler Pond (MA94091)	Duxbury/Pembroke	Exotic Species
Oldham Pond (MA94114)	Pembroke	Exotic Species
Pembroke Street South Pond (MA94117)	Kingston	Exotic Species
Reeds Millpond (MA94126)	Kingston	Exotic Species
Reservoir (MA94127)	Pembroke	Exotic Species
Smelt Pond (MA94184)	Kingston	Exotic Species
Tack Factory Pond (MA94152)	Scituate	Exotic Species
Upper Chandler Pond (MA94165)	Duxbury/Pembroke	Exotic Species
Category 5 - Waters requiring a TMDL:		
Cohasset Harbor (MA94-01)	Cohasset/Scituate	Pathogens
Drinkwater River (MA94-21)	Source at Whiting Street and Hanover High School through Forge Pond to inlet Factory Pond, Hanover.	Metals
Duxbury Bay (MA94-15)	Duxbury/Kingston/Plymouth	Pathogens
French Stream (MA94-03)	Headwaters on southeast side of Naval Air Station, Rockland through Studleys Pond to confluence with Drinkwater River, Hanover.	Pathogens Unknown Toxicity Nutrients Organic Enrichment/Low DO
Green Harbor (MA94-11)	Marshfield	Pathogens
Herring River (MA94-07)	Outlet Old Oaken Bucket Pond to confluence with North River.	Pathogens
Indian Head River (MA94-04)	Outlet Factory Pond, Hanover/Hanson to Curtis Crossing Dam (also called Ludhams Ford Dam) west of Elm Street, Hanover/Pembroke.	Metals; Nutrients; Organic Enrichment/Low DO
Jones River (MA94-14)	Elm Street, Kingston to mouth at Duxbury Bay, Kingston.	Pathogens
North River (MA94-06)	Route 3A (Main Street), Marshfield/Scituate to mouth at Massachusetts Bay, Scituate.	Pathogens
North River (MA94-05)	Confluence of Indian Head River and Herring Brook, Hanover/Pembroke to Route 3A (Main Street) Marshfield/Scituate.	Pathogens
Plymouth Bay (MA94-17)	Plymouth	Pathogens

Table 2 continued. 2002 Integrated List of Waters in the South Shore Coastal Watersheds.

Waterbody (Segment)	Location	Cause of Impairment
Plymouth Harbor (MA94-16)	Plymouth	Pathogens
Scituate Harbor (MA94-02)	Scituate	Pathogens
South River (MA94-09)	Main Street, Marshfield to confluence with North River.	Pathogens
Aaron River Reservoir (MA94178)	Cohasset	Metals
Billington Sea (MA94007)	Plymouth	Noxious aquatic plants Turbidity
Crossman Pond (MA94032)	Kingston	Noxious aquatic plants
Factory Pond (MA94175)	Hanson/Hanover	Metals
Forge Pond (MA94037)	Hanover	Noxious aquatic plants Turbidity (Exotic Species **)
Foundry Pond (MA94038)	Kingston	Turbidity
Furnace Pond (MA94043)	Pembroke	Organic enrichment/Low DO
Great Herring Pond (MA94050)	Bourne/Plymouth	Metals
Great South Pond (MA94054)	Plymouth	Metals
Musquashcut Pond (MA94105)	Scituate	Noxious aquatic plants
Old Oaken Bucket Pond (MA94113)	Scituate	Noxious aquatic plants Turbidity
Russell Millpond (MA94132)	Plymouth	Noxious aquatic plants
Torrey Pond (MA94157)	Norwell	Noxious aquatic plants Turbidity (Exotic Species **)
Wampatuck Pond (MA94168)	Hanson	Noxious aquatic plants

*Exotic species is equivalent to non-native aquatic plants or macrophytes.
**This impairment is considered a non-pollutant and does not require development of a TMDL.

Massachusetts is currently not assigning waters to Category 1 – "Waters attaining all designated uses" – of the Integrated List due to the 1994 issuance by the Massachusetts Department of Public Health (MDPH) of a state-wide health advisory pertaining to the consumption of fish. This advisory precludes any waters from being in full support of the *Fish Consumption Use*. The MDPH fish consumption advisory named mercury as the associated stressor/pollutant and was aimed at pregnant women only; the general public was not considered to be at risk from fish consumption and the advisory encompassed all freshwaters in Massachusetts (MDPH 1994).

In July 2001 MDPH issued a new, more inclusive, fish consumption advisory for both fresh and salt waters in the Commonwealth (MDPH 2001). Within the last decade, the northeastern United States has been identified as receiving elevated rates of mercury deposition from the atmosphere and high levels of mercury contamination in non-commercial freshwater fish (Tatsutani 1998). Mercury is a trace metal that exists in the earth's crust. It is a toxicant that, once mobilized in the environment, can be transformed into methylmercury, a particularly toxic form that can bioaccumulate. Most of the mercury contamination in the northeastern United States has been linked to air emissions (incinerators, fossil fuel combustion facilities) from both local and mid-western sources.

The MDPH produces a fish consumption advisory list that contains the status of each water body for which an advisory has been issued. If a water body is not on the list, it may be because either an advisory was not warranted or the water body has not been sampled. The most current advisories are

available online at http://db.state.ma.us/dph/fishadvisory/. MDPH's statewide advisory encompasses all freshwaters in Massachusetts with the exception of fish stocked by the state Division of Fisheries and Wildlife or farm-raised fish sold commercially.

As of April 2004, there are site-specific freshwater fish consumption advisories for six water bodies in the South Shore Coastal Watersheds because of elevated mercury concentrations in fishes (MDPH 2004a). Refer to the lakes section or specific river segment for more information on the fish advisories for the following waterbodies:

Aaron River Reservoir in Cohasset/Hingham/Scituate (MA94178)
Great Herring Pond in Plymouth/Bourne (MA94050)
Great South Pond in Plymouth (MA94054)
Factory Pond in Hanover/Hanson (MA94175) and its adjacent river segments:
Drinkwater River (MA94-21) downstream of the Forge Pond Dam in Hanover and
Indian Head River (MA94-04) to the Luddam's Ford Dam in Hanover/Pembroke

OBJECTIVES

This report summarizes information generated in the South Shore Coastal Watersheds through *Year 1* (information gathering in 2000) and *Year 2* (environmental monitoring in 2001) activities established in the "Five-Year Cycle" of the Watershed Approach. Data collected by DWM in 2001 are provided in Appendices A through E of this report. Together with other sources of information (identified in each segment assessment) these data were used to assess the status of water quality conditions of rivers, estuaries and lakes in accordance with EPA's and MassDEP's use assessment methods. Not all waters in the South Shore Coastal Watersheds are included in the MassDEP/EPA databases (either the waterbody system database -- WBS, or the newer assessment database – ADB) or this report.

The objectives of this water quality assessment report are to:

1. evaluate whether or not surface waters in the South Shore Coastal Watersheds, defined as segments in the WBS database, currently support their designated uses (i.e., meet surface water quality standards);
2. identify water withdrawals (habitat quality/water quantity) and/or major point (wastewater discharges) and non-point (land-use practices, stormwater discharges, etc.) sources of pollution that may impair water quality conditions;
3. identify the presence or absence of any non-native macrophytes in lakes;
4. identify waters (or segments) of concern that require additional data to fully assess water quality conditions;
5. recommend additional monitoring needs and/or remediation actions in order to better determine the level of impairment or to improve/restore water quality; and
6. provide information for the development of an action plan.

REPORT FORMAT

RIVERS AND ESTUARIES

The rivers and estuaries assessed in the South Shore Coastal Watersheds are presented in the River and Estuary Segment Assessment section of this report. Each river and estuary segment assessment is formatted as follows:

SEGMENT IDENTIFICATION

Name, waterbody identification number (WBID), location, size, classification.

Sources of information: coding system (waterbody identification number e.g., MA94-01) used by MassDEP to reference the stream segment in databases such as 305(b) and 303(d); the Massachusetts SWQS (MassDEP 1996); and other descriptive information.

SEGMENT DESCRIPTION

Major land-use estimates (the top three uses for the recharge area and % impervious cover) and other descriptive information.

Sources of information: descriptive information from USGS topographical maps, base geographic data from MassGIS, land use statistics from a geographic information system (GIS) analysis using the MassGIS land use coverage developed at a scale of 1:25,000 and based on aerial photographs taken in 1999 (UMass Amherst 1999).

Cranberry Bog Cultivation:

For the purpose of this report, water use for cranberry cultivation within the recharge area has been estimated by using a volume of 10 acre-feet of water per acre of bog per year (1 acre-foot = 325,900 gallons). The acreage of cranberry bog within the recharge area has been estimated by using the *cranberry bog* category of the MassGIS Land-Use data layer. The figure of 10 acre-feet of water per acre of bog per year is based on a study conducted by the Cape Cod Cranberry Growers Association for the Massachusetts Water Management Act Program. It should be noted that this figure is used for "old style" bogs, those bogs that do not employ best management practices (BMPs) that conserve water. Most bogs constructed today, and many renovated older bogs, use BMPs, such as laser leveling, on-site reservoirs, tailwater recovery, etc., which result in reduced water usage (between 5 and 6 acre-feet of water per acre of bog per year). Therefore, the estimate of water usage within the subwatershed for cranberry cultivation is a conservative number (O'Shea 2002).

SEGMENT LOCATOR MAP

Subbasin map, major river location, and segment drainage area (shaded area).

Sources of information: MassGIS data layers (stream segments and quadrangle maps from MassGIS 2002).

WATER WITHDRAWALS AND WASTEWATER DISCHARGE PERMIT INFORMATION

Water withdrawal, NPDES wastewater discharge

Sources of information: WMA Database Printout (LeVangie 2002); open permit files located in the Worcester and Lakeville Regional MassDEP Offices (MassDEP 2003c, MassDEP 2005a, and Domizio 2004).

USE ASSESSMENT

Aquatic Life, Fish Consumption, Drinking Water (where applicable – see note below), Primary Contact Recreation, Secondary Contact Recreation, and Aesthetics.

Sources of information include: MassDEP DWM 1996 and 2001 survey data (Appendices A through E) and the MassDEP DWM Toxicity Testing Database "TOXTD". The MDPH Freshwater Fish Consumption Advisory Lists (MDPH 2001 and MDPH 2002) were used to assess the *Fish Consumption Use*. MA DMF shellfish area classifications were used to assess the *Shellfish Harvesting Use*. Where other sources of information were used to assess designated uses, citations were included.

[Note: Although the *Drinking Water Use* is not assessed in this water quality assessment report, the Class A waters were identified.]

SUMMARY

Use summary table (Designated uses, status, and causes and sources of impairment).

RECOMMENDATIONS

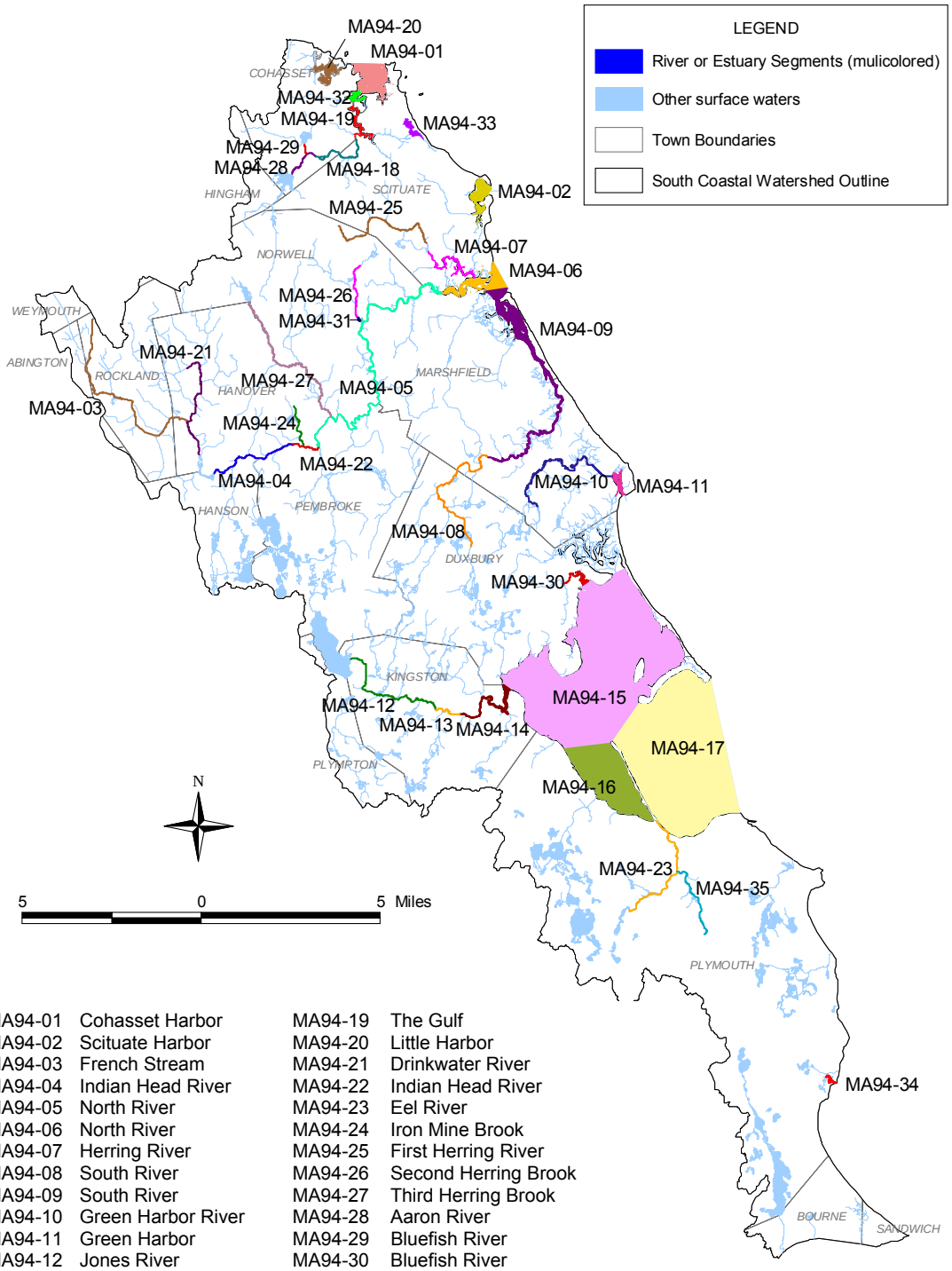
Additional protection, monitoring and implementation needs.

LAKES

The assessed lakes, identified with their WBID code numbers, are listed alphabetically in the Lake Assessment section of this report (Table 3). The location, acreage, trophic status, use assessments, and causes and sources of impairment, are then summarized for each individual lake.

SOUTH SHORE COASTAL WATERSHEDS – RIVER AND ESTUARY SEGMENTS

The river and estuary segments identified below are included in this report.



MA94-01	Cohasset Harbor	MA94-19	The Gulf
MA94-02	Scituate Harbor	MA94-20	Little Harbor
MA94-03	French Stream	MA94-21	Drinkwater River
MA94-04	Indian Head River	MA94-22	Indian Head River
MA94-05	North River	MA94-23	Eel River
MA94-06	North River	MA94-24	Iron Mine Brook
MA94-07	Herring River	MA94-25	First Herring River
MA94-08	South River	MA94-26	Second Herring Brook
MA94-09	South River	MA94-27	Third Herring Brook
MA94-10	Green Harbor River	MA94-28	Aaron River
MA94-11	Green Harbor	MA94-29	Bluefish River
MA94-12	Jones River	MA94-30	Bluefish River
MA94-13	Jones River	MA94-31	Second Herring Brook
MA94-14	Jones River	MA94-32	Cohasset Cove
MA94-15	Duxbury Bay	MA94-33	Musquashcut Pond
MA94-16	Plymouth Harbor	MA94-34	Ellisville Harbor
MA94-17	Plymouth Bay	MA94-35	Unnamed tributary to Eel River
MA94-18	Bound Brook		

Figure 9. River and Estuary Segments in the South Shore Coastal Watersheds.

ISOLATED HARBORS

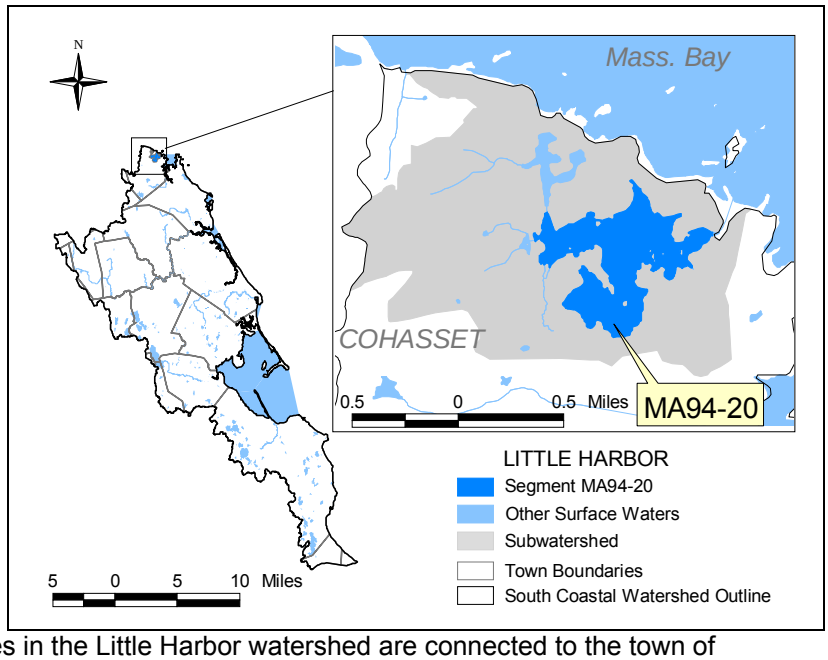
There are three isolated harbors that represent individual subbasins that do not have extensive river systems or drainage areas; Little Harbor (MA94-20), Scituate Harbor (MA94-02), and Ellisville Harbor (MA94-34).

LITTLE HARBOR (SEGMENT MA94-20)

Location: Cove south of Nichols Road, west of Atlantic Avenue, and north of Cohasset center, Cohasset.
Size: 0.24 square miles
Classification: Class SA

Land-use estimates (top 3, excluding water) for the 1.7 mi^2 subwatershed (map inset, gray shaded area):

Residential 43%
Forest..... 31%
Open Land 5%



Little Harbor is listed on the 2002 Integrated List of Waters in Category 4A. This segment is impaired due to pathogens; a TMDL was completed and approved by EPA on September 12, 2002 (MassDEP 2003a).

According to the TMDL study, most of the residential and commercial properties in the Little Harbor watershed are connected to the town of Cohasset public water supply. All the properties are serviced by on site sewage disposal systems (MassDEP 2002). The current sewer plan for this area should be completed by 2009 (Nye 2005).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

There are no Water Management Act withdrawals or NPDES permitted discharges in this segment.

USE ASSESSMENT

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Area MB11.0 (which contains this entire segment) is prohibited (MA DFG 2000 and Appendix G, Table G3). MassDEP used bacterial data collected by Camp, Dresser & McKee in 1999 and by the Division of Marine Fisheries between 1986 and 1995 to develop the TMDL for Little Harbor (MassDEP 2002). According to the TMDL, the DMF data identified violations of water quality standards for shellfish harvesting along the perimeter of the harbor and fecal coliform bacteria were consistently high around Gammons Road. The TMDL also stated that the CDM wet-weather sampling event, on September 30, 1999, "shows clearly that fecal coliform is high in the stormwater entering Little Harbor and results in water quality violations." In addition to stormwater, possible sources of fecal coliform bacteria were identified as failing or inadequate septic systems, domestic animals or wildlife (MassDEP 2002).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired because of elevated bacteria. Likely sources of bacteria include wet weather discharges from non-point sources as well as municipal separate storm sewer systems. Other potential sources include failed or inadequate septic systems and domestic animals or wildlife.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

Weekly testing for *Enterococci* bacteria during the swimming season was conducted at the Little Harbor public beach near Atlantic Ave, Cohasset. No postings were reported in either the 2002 or 2003 beach seasons (MDPH 2003 and 2004b). This beach is located near the outlet of Little Harbor and is not considered to be representative of the water quality in the harbor overall.

The *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses are not assessed for Little Harbor

because too limited data are available.

Little Harbor (MA94-20) Use Summary Table

Designated Uses		Status
Aquatic Life		NOT ASSESSED
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Fecal coliform bacteria Source: Wet weather discharges and discharges from municipal separate storm sewer systems (Suspected sources: Failing or inadequate septic systems and domestic animals or wildlife)
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		NOT ASSESSED

RECOMMENDATIONS

To meet the more stringent shellfish harvesting water quality standards, the Town of Cohasset should complete the Wastewater Facilities Plan Supplement and implement its recommendations for community sewage treatment in the Little Harbor and Atlantic Avenue area as required in the MassDEP Amended Final Judgment.

Design and implement a bacteria monitoring program to document effectiveness of bacteria source reduction activities associated with the Phase II community stormwater management program and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Implement Little Harbor TMDL recommendations (see http://www.mass.gov/dep/brp/wm/files/litlharb.doc).

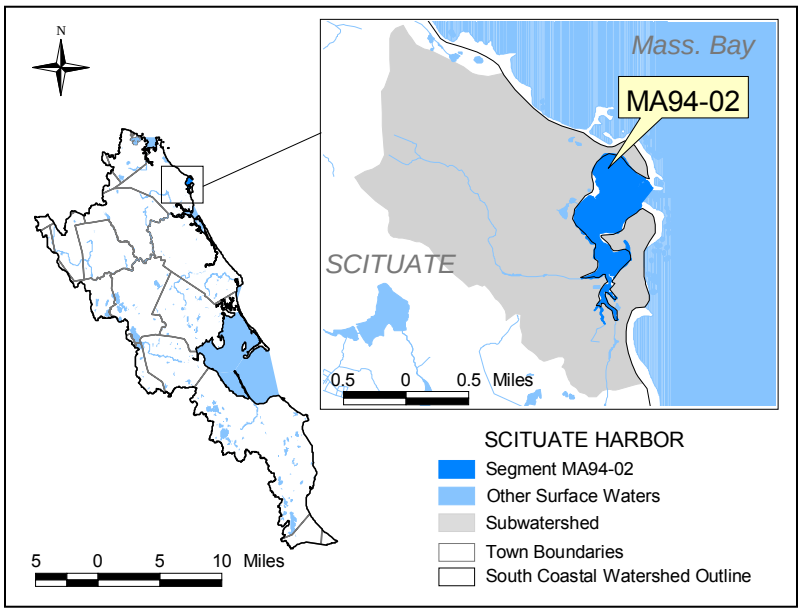
Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

SCITUATE HARBOR (SEGMENT MA94-02)

Location: The waters west of a line across the mouth of Scituate Harbor, from the elbow of the jetty southeast off Lighthouse Point, to the jetty northeast of the U.S. Coast Guard station, Scituate.
Segment Length: 0.32 square miles
Classification: Class SA

Land-use estimates (top 3, excluding water) for the 3.5 mi^2 subwatershed (map inset, gray shaded area):

Residential 60%
Forest..... 24%
Open Land 7%



Scituate Harbor is listed on the 2002 Integrated List of Waters in Category 5. This segment is impaired due to pathogens and a TMDL is required (MassDEP 2003a).

There are two locations for general boat access on Scituate Harbor, at a boat ramp on Jericho Road and at Town Pier on Cole Parkway. The Town of Scituate manages a concrete boat ramp with 2 launching lanes at Jericho Road for general access that has parking for 43 trailers and 12 vehicles (MA DFG 2003). The Town also operates a boat pump-out facility located at the Town Pier on Cole Parkway that includes a shore-side facility and a pump-out boat. Both were funded by the Clean Vessel Act to provide free pump-outs. Waterline Mooring has a second pump-out boat that was funded by the Clean Vessel Act to provide free pump-outs (MA DMF 2003, Burtner 2003, Scituate Harbormaster Office 2003). This harbor also supports a commercial fishing fleet.

The ACOE performed maintenance dredging of the Scituate Harbor federal channel and anchorage area from September 2002 through February 2003. Approximately 235,000 cubic yards of silt and clay were disposed at the Massachusetts Bay Disposal Area. Maintenance repairs were also performed on the two breakwaters. The work at South Breakwater off First Cliff was completed in June 2003 while work at the North Breakwater off Cedar Point was completed in September 2003 (ACOE 2003).

WMA WATER WITHDRAWAL SUMMARY

There are no WMA water withdrawals in this segment.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX E, TABLE E1)

Stellwagen Bank National Marine Sanctuary is permitted (MA0090531) to discharge from their facility located at 175 Edward Foster Road in Scituate an average monthly flow of 0.002 MGD of treated sanitary wastewater via one outfall to Scituate Harbor (permit was transferred in June 2002 from the US Coast Guard). According to the permit reapplication dated April 2004, the average monthly flow of the facility (wastewater treatment described as a septic tank, sand filtration, and chlorination prior to discharge) is 0.00023 MGD. The fecal coliform bacteria counts have been extremely high on occasion (too numerous to count or TNTC) and the TRC concentrations have been as high as 2.2 mg/L. Both of these pollutants have exceeded the facility's monthly average permit limits (14 MPN/100 ml for fecal coliform and 0.0075 mg/L for TRC).

OTHER

Scituate Harbor supports a commercial fishing fleet. When fish and fish products are loaded and unloaded from these vessels steps should be taken to minimize fish waste runoff directly into the harbor.

USE ASSESSMENT

AQUATIC LIFE

Eelgrass Bed Habitat

MassDEP's Wetlands Conservancy Program (WCP) identified the presence of eelgrass in Scituate Harbor from historic 1951 black and white aerial photography (Costello 2003). In 1998 MassDEP WCP performed field verification of 1995 aerial photography and mapped the extent of eelgrass bed habitat in Scituate Harbor. Total areal coverage of Scituate Harbor from the 1998 survey was approximately 6% of the harbor. In 2001 MassDEP WCP performed field verification of 2001 aerial photography and mapped the extent of eelgrass bed habitat in Scituate Harbor. There was almost no change in the total coverage of eelgrass beds between 1998 and 2001. There has been some loss in eelgrass beds since 1951.

Too limited data are available so the *Aquatic Life Use* is not assessed for Scituate Harbor.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Area MB7.0 (which contains this entire segment) is prohibited (MA DFG 2000 and Appendix G, Table G3 and Appendix G, Table G3). The area is prohibited due to bad water quality and lack of a current sanitary survey (Churchill 2000a).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired presumably because of elevated fecal coliform bacteria. In addition to the point source discharge, potential sources of bacteria include discharges from municipal separate storm sewer systems, marina/boating sanitary on-vessel discharges, failing or inadequate septic systems, and wet weather discharges from non-point sources.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

There is one semi-public beach, Scituate Light Beach, along the northeastern shore of Scituate Harbor, Scituate. No data/posting information are available for this beach in either of the MDPH 2002 or 2003 annual reports (MDPH 2003 and 2004b).

There have been no visual observations of aesthetically objectionable conditions (e.g., oils, odors, deposits, etc.) reported for Scituate Harbor (DeCesare 2005).

The *Primary* and *Secondary Contact Recreational* uses are currently not assessed for Scituate Harbor. The *Aesthetics Use* is assessed as support.

Scituate Harbor (MA94-02) Use Summary Table

Designated Uses		Status
Aquatic Life		NOT ASSESSED
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Fecal coliform bacteria Source: Municipal point source discharge (Suspected sources: Discharges from municipal separate storm sewer systems, marina/boating sanitary on-vessel discharges, on-site septic systems, wet weather discharges from non-point sources)
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		SUPPORT

RECOMMENDATIONS
Conduct an updated sanitary survey for the DMF shellfish area MB7.0.

The Stellwagen Bank National Marine Sanctuary permit (MA0090531) should be reissued with appropriate limits and monitoring requirements. If permit limits are not met actions (compliance and/or enforcement) should be taken as deemed necessary. If at all possible, the discharge should be eliminated via use of an alternative disposal/treatment method.

Conduct bacteria sampling to evaluate effectiveness of point (NPDES and Phase II stormwater permits) and non-point source pollution control activities and other actions and to assess the status of the *Recreational* uses.

Bacteria sampling at the Scituate Light Beach should be conducted in accordance with the 2001 Massachusetts "Beaches Bill". These data should be reported to MDPH for inclusion in their annual reports. Review of these data/postings should be conducted to evaluate the status of the recreational uses in Scituate Harbor.

Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the Primary and Secondary Contact Recreational uses.

Minimize direct fish waste runoff into the harbor when fish and fish products are loaded and unloaded from commercial fishing vessels.

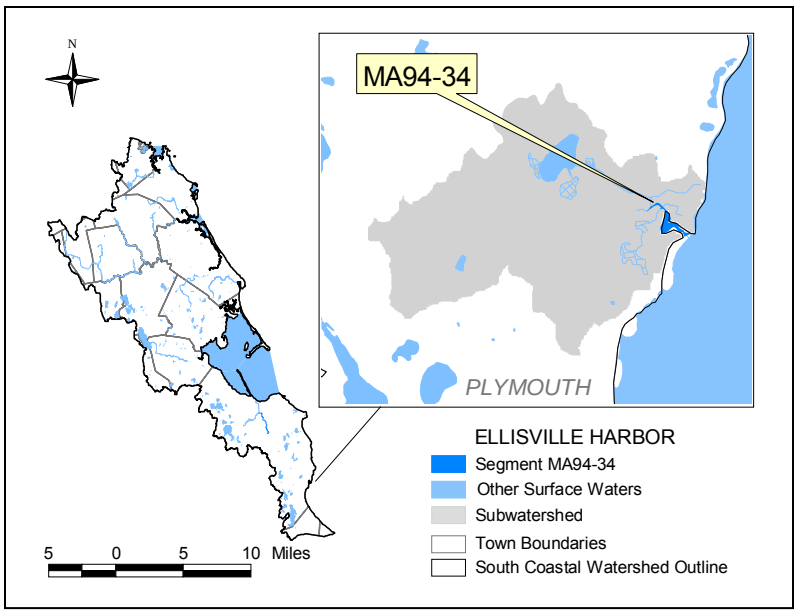
ELLISVILLE HARBOR (SEGMENT MA94-34)

Location: Plymouth.
Size: 0.01 square miles
Classification: Class SA

Land-use estimates (top 3, excluding water) for the 1.97 mi^2 subwatershed (map inset, gray shaded area):

Forest..... 60%
Residential..... 17%
Open Land..... 11%

This waterbody is listed as part of the Massachusetts Estuaries Project in Appendix 1 of the 2002 Integrated List of Waters (MassDEP 2003a). It is a designated ACEC (MA DCR 2003b).



WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Source	Authorized Withdrawal (MGD)
Plymouth DPW	9P42123901	N/A	4239000-11G Savery Pond Well	6.0*

*System-wide withdrawal, all sources are not necessarily within this segment.

Additionally, there are 48 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 0.43 MGD.

NPDES WASTEWATER DISCHARGE SUMMARY

There are no NPDES wastewater discharges into this segment.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Ellisville Harbor is primarily a tidal salt marsh system with a tidal inlet that is susceptible to occlusion and migration resulting from coastal sediment transport processes (Howes and Samimy 2005). Due to dynamic coastal processes, the entrance channel to the harbor had migrated to the south, and had restricted the tidal exchange. The depth of the entrance channel had decreased significantly over the past several years and the barrier beach had caused elevation difference of several feet between the bay and the harbor. This difference resulted in restricting incoming tidal water to the last two hours of flood tide. This restricted exchange was considered to be one of the major reasons for poor water quality within the harbor (Churchill 1994). As recently as 2003, the historic inlet was reopened which has already resulted in restoration of salt marsh grass habitat in the upper wetland (Howes and Samimy 2005).

Biology

One small productive shellfish area (approximately 85 feet by 100 feet in size) supports a small population of soft shelled clam, *Mya arenaria* (Churchill 1994).

Chemistry – water

According to the sampling and analysis plan for the *South Coastal Basin Estuaries Monitoring Project*, four stations in Ellisville Harbor were proposed for sampling: near the head of the Harbor (Station EVH3), upper middle harbor (Station EVH4), lower middle harbor (Station EVH5) and near

the mouth of the Harbor (Station EVH6) (Appendix F, Project 03-04/604; and Howes and Samimy 2004). *In-situ* measurements of DO and temperature, as well as nutrient samples (inorganic and organic nitrogen), at these locations were to be taken six times between June and September 2003 and 2004. Samples were to be collected at approximately two-week intervals during the falling tide (2 hours before and after mid-ebb tide) during the morning hours (0600 to 0900 hours). Water quality samples and *in-situ* measurements were taken from the four sites on five occasions between July and September 2003 and again in 2004 (Howes and Samimy 2005). Although the actual quality assurance data has not been released to MassDEP, data validation is required as part of this Estuaries Monitoring Project and was conducted prior to the release of the data, which are summarized below.

Water quality samples have also been collected from a freshwater creek (Station EVH1) draining into Ellisville Harbor on a weekly basis since July 2003 (sampling is still being conducted) for use in determining nitrogen loading to the bay from the Jones River as part of the *South Coastal Basin Estuaries Monitoring Project* (Howes and Samimy 2005). Between July 2003 and April 2005, samples (n=83) were analyzed for nutrients (total nitrogen and phosphorus) and these data are summarized below.

Dissolved oxygen
The surface and bottom DOs ranged from 4.5 to 11.0 mg/L at the four sampling locations. All but two of the measurements taken during the summer of 2004 were > 6.0 mg/L, whereas in 2003 many of the measurements were <6.0 mg/L, particularly at the farthest upstream sampling locations.

Temperature
The maximum temperature was 22 ºC.

Total nitrogen
The concentrations of total nitrogen ranged from 0.148 to 0.553 mg/L at the four sampling locations. The average concentration in 2003 was 0.386 mg/L and in 2004 was 0.293 mg/L. The average concentration of total nitrogen in the freshwater creek draining into Ellisville Harbor (Station EVH1) was 0.504 mg/L (n=83 measurements between July 2003 and April 2005).

Total phosphorus
The average concentration of total phosphorus in the freshwater creek draining into Ellisville Harbor (Station EVH1) was 0.050 mg/L (n=83 measurements between July 2003 and April 2005).

While water quality conditions in Ellisville Harbor appear to be improving as a result of changes in tidal flushing, too limited data are currently available to evaluate these changes so the *Aquatic Life Use* is not assessed.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Area CCB40.0 (which contain this entire segment) is prohibited (MA DFG 2000 and Appendix G, Table G3).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired because of elevated fecal coliform bacteria levels, but the source(s) of the bacteria are currently unknown.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

Four stations within Ellisville Harbor were proposed for sampling as part of the *South Coastal Basin Estuaries Monitoring Project* (Appendix F, Project 03-04/604; and Howes and Samimy 2004). These sites included: near the head of the Harbor (Station EVH3), upper middle harbor (Station EVH4), lower middle harbor (Station EVH5) and near the mouth of the Harbor (Station EVH6) (Howes and Samimy 2004). Secchi disk depth at these locations were to be taken six times between June and September 2003 and 2004. Samples were to be collected at approximately two-week intervals during the falling tide (2 hours before and after mid-ebb tide) during the morning hours (0600 to 0900 hours).

Fecal coliform bacteria samples were collected from the four sites on five occasions between July and September 2003 and again in 2004. The fecal coliform bacteria data ranged from <10 to 530

cfu/100 ml (n=40). Ninety percent of the samples were ≤200 cfu/100 ml. It should be noted that elevated counts were only found at one sampling location (Station EVH4) and only in the summer of 2003 (counts ranged from 160 to 530 cfu/100 ml; Howes and Samimy 2005).

With the exception of the most upstream sampling site (Station EVH3), the Secchi depth data were all reported as being "visible on the bottom", however the depth at the sampling sites was often less than 1.2 m (recommended transparency). Secchi depths at Station EVH3 were less than 1.2 m during most of the summer of 2003. Very limited Secchi depth data are available for the four sampling locations in the harbor in 2004, however. It is noteworthy that chlorophyll *a* concentrations were elevated at the two most upstream sampling locations in the harbor during the summer of 2003 (corresponding to some degree with the low transparency measurements) but were low at all four stations during the summer of 2004 (Howes and Samimy 2005).

The *Primary* and *Secondary Contact Recreational* uses are assessed as support in Ellisville Harbor based primarily on the low fecal coliform bacteria counts. The *Aesthetics Use* is not assessed for Ellisville Harbor because of the limited Secchi depth dataset and the lack of any other observational data.

Ellisville Harbor (MA94-34) Use Summary Table

Designated Uses		Status
Aquatic Life		NOT ASSESSED
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Unknown (Suspected sources: Septic systems, wet weather discharges, waterfowl, and poor tidal flushing)
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		NOT ASSESSED

RECOMMENDATIONS

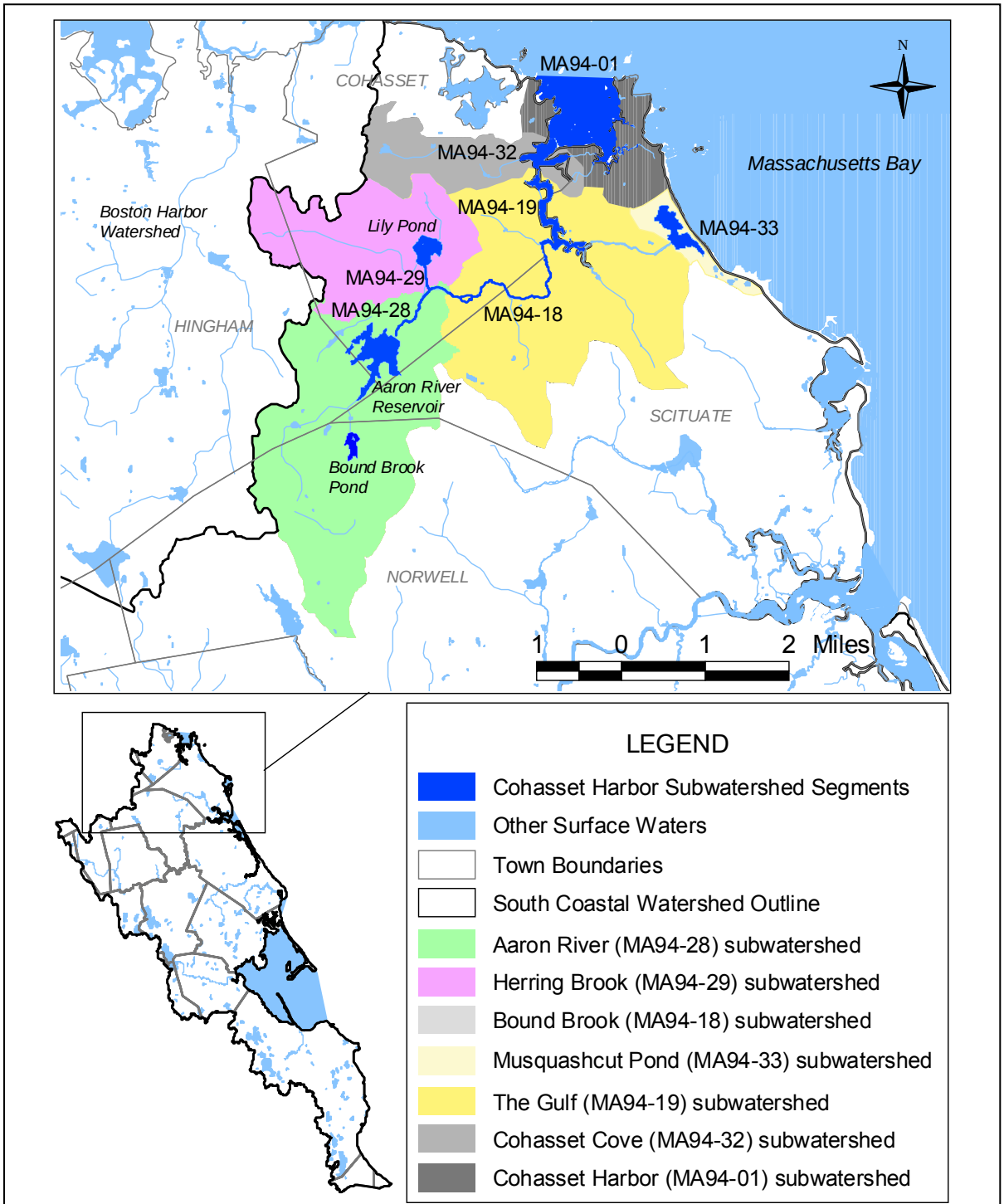
Implement recommendations in the DMF shellfish management plans for Area CCB40.0.

Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Evaluate data collected in Ellisville Harbor as part of *South Coastal Basin Estuaries Monitoring Project*. Implement recommendations as deemed necessary to control nutrient inputs into this tidal salt marsh system if warranted.

COHASSET HARBOR SUBWATERSHED

The Cohasset Harbor Subwatershed includes the following segments: Aaron River (MA94-28), Herring Brook (MA94-29), Bound Brook (MA94-18), Musquashcut Pond (MA92-33), The Gulf (MA94-19), Cohasset Cove (MA94-32), and Cohasset Harbor (MA94-01).



Note: Complete subwatershed areas are cumulative as follows:
Aaron River includes the shaded Herring Brook subwatershed area;
Bound Brook includes the shaded subwatersheds for both Aaron River and Herring Brook;
The Gulf includes the shaded subwatersheds for Musquashcut Pond, Bound Brook, Aaron River, and Herring Brook;
Cohasset Cove includes all of the shaded subwatershed areas except Cohasset Harbor; and
Cohasset Harbor includes all of the shaded subwatersheds.

Figure 10. Locations of segments in the Cohasset Harbor Subwatershed.

AARON RIVER (SEGMENT MA94-28)

Location: Outlet Aaron River Reservoir, Cohasset to flow control structure near Beechwood Street, Cohasset.
Segment Length: 1.0 miles
Classification: Class A

Land-use estimates (top 3, excluding water) for the 8.8 mi^2 subwatershed:

Forest..... 76%
Residential..... 13%
Open Land..... 3%

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Source	Authorized Withdrawal (MGD)
Cohasset Water Department	N/A	32106501	3065000-01S Aaron River Reservoir	0.65*

*System-wide withdrawal, all sources are not necessarily within this segment; however, Cohasset Water Department reported no water was drawn from the groundwater wells between 2000 and 2002 - all water was withdrawn from Lily Pond (MassDEP 2003c).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Denil-type fishways have been installed at the Aaron River Reservoir Dam and the Beechwood Street Dam. Both of these fishways are reported to be in excellent condition (Reback *et al.* 2004).

There is a flow control structure at the upstream side of Beechwood Street, Cohasset. When the boards at this flow control structure are raised (part of the public water supply system operations), the flow of Aaron River diverts into Herring Brook and into Lily Pond.

The poorly designed, deteriorating notched weir-pool fish ladder at Hunters Pond is impassable (Reback *et al.* 2004).

Biology

Dense growth of the non-native aquatic macrophyte *Cabomba caroliniana* was observed in the Aaron River upstream from the Beechwood Street Dam (MassDEP 2001a).

Chemistry – water

In 2001 DWM conducted water quality sampling at one station (AR101) on Aaron River upstream from the outlet control structure at Beechwood Street, Cohasset (Appendix A). *In-situ* measurements of DO, % DO saturation, temperature, pH, conductivity, and TDS were recorded on seven occasions from June to October. Samples were collected on five occasions for total phosphorus, ammonia-nitrogen, nitrate-nitrite nitrogen, chloride, alkalinity, and hardness. The results are summarized below.

Dissolved oxygen and percent saturation

DO measurements by DWM ranged from 2.0 to 5.9 mg/L with the percent saturation ranging from 24 to 56%. Only one of six measurements did not meet the water quality standard of 5.0 mg/L.

Temperature

Temperature measurements ranged from 13.9ºC in October to 28.0ºC in June.

pH, alkalinity and hardness

pH was low ranging from 5.5 to 6.1 SU as were alkalinities (4 to 7 mg/L) and hardness (14 to 18 mg/L).

Conductivity
Specific conductance measurements ranged from 119 to 130 µS/cm.

Total dissolved solids
TDS measurements ranged from 76.1 to 83.3 mg/L.

Nutrients
Total phosphorus concentrations ranged from 0.031 to 0.059 mg/L. Ammonia-nitrogen concentrations were <0.02 mg/L for all unqualified samples and nitrate-nitrite nitrogen concentrations ranged from <0.06 to 0.08 mg/L.

The *Aquatic Life Use* is assessed as impaired for the entire length of this segment of the Aaron River based on the presence of the barrier to anadromous fish migration and the presence of a dense infestation of a non-native macrophyte species (*Cabomba caroliniana*), which compromises the native, naturally diverse community of aquatic flora in the lower 0.2 mile reach of this segment (downstream from the confluence with Herring Brook). The low DO/saturation, pH, alkalinity, and hardness conditions are considered to be naturally-occurring given the large amount of upstream wetland areas. Flow alterations from the water supply diversion may affect some of these water quality conditions and are also of concern.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

In 2001 DWM conducted bacteria sampling at one station (AR101) on Aaron River upstream from the flow control structure at Beechwood Street, Cohasset, on three occasions during the primary contact season and on one additional date, 24 October 2001 (Appendix A). Samples were analyzed for fecal coliform, *E. coli* and *Enterococcus* sp. None of the fecal coliform bacteria counts exceeded 170 cfu/100 ml.

Although DWM field survey crews noted no objectionable odors or oils, dense growths of aquatic vegetation, including the non-native aquatic macrophyte *Cabomba caroliniana,* and algal mats were observed in the brook upstream from the flow control structure throughout the summer of 2001 (MassDEP 2001a). During one sampling occasion after significant rain, the water was described as being brownish and very turbid. Usually the water was slightly tea-stained.

Although fecal coliform bacteria counts were low, the *Recreational* and *Aesthetics* uses are not assessed for the upper 0.8-mile reach of this segment of the Aaron River but are identified with an Alert Status because of the high potential for being heavily infested with a non-native aquatic macrophyte. These uses are assessed as impaired downstream from the confluence with Herring Brook because of the overabundant growth of a non-native aquatic macrophyte and the presence of algal mats frequently noted near the flow control structure. Turbidity associated with wet weather conditions is also of concern.

Aaron River (MA94-28) Use Summary Table

Designated Uses		Status
Aquatic Life		IMPAIRED Causes: Fish barriers entire length of segment and non-native aquatic macrophyte lower 0.2 mile reach of segment Sources: Hydrostructure impacts on fish passage and unknown
Fish Consumption		NOT ASSESSED
Primary Contact		NOT ASSESSED* upper 0.8 mile reach IMPAIRED lower 0.2 mile reach Causes: Non-native aquatic macrophyte and excess algal growth Source: Unknown
Secondary Contact		
Aesthetics		

*Alert Status issues identified, see details in use assessment

RECOMMENDATIONS

The fishway at Hunters Pond should be redesigned and replaced (Reback *et al.* 2004).

Further investigate/define the extent of the infestation of *Cabomba caroliniana.*

In order to maintain the integrity of aquatic life in this segment of the Aaron River flow regimes should be maintained as close to a natural regime as possible (i.e., the flashboards near Beechwood Street should be used as little as possible to reverse the flow of Aaron River and Herring Brook back into Lily Pond). If changes are implemented monitoring designed to document changes in water quality conditions should be conducted.

HERRING BROOK (SEGMENT MA94-29)

Location: Outlet Lily Pond, Cohasset to confluence with Aaron River, Cohasset.
Segment Length: 0.3 miles
Classification: Class A

Land-use estimates (top 3, excluding water) for the 3.0 mi^2 subwatershed:

Forest..... 77%
Residential..... 11%
Open Land..... 4%

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Source	Authorized Withdrawal (MGD)
Cohasset Water Department	N/A	32106501	3065000-02S Lily Pond	0.65*

*System-wide withdrawal, all sources are not necessarily within this segment; however, Cohasset Water Department reported all water was withdrawn from Lily Pond between 2000 and 2002 (MassDEP 2003c).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX E, TABLES E1 AND E2)

There are no direct NPDES wastewater discharges to Herring Brook, but a NPDES permit (MA0103098) was issued to the Cohasset Water Department to discharge from the public water supply treatment plant to Lily Pond, which is in the subwatershed of this segment. EPA terminated this permit when the general permit for the Lily Pond Water Treatment Plant (MAG640070) was issued in May 2005.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

The poorly designed, deteriorating notched weir-pool fish ladder at Hunters Pond is impassable (Reback *et al.* 2004).

Biology

Dense growth of the non-native aquatic macrophyte *Cabomba caroliniana* was observed in both Lily Pond (ENSR 2003) and the Aaron River upstream from the Beechwood Street Dam (MassDEP 2001a).

Based on the presence of the barrier to anadromous fish migration and the presumed infestation of Herring Brook with a non-native macrophyte, the *Aquatic Life Use* is assessed as impaired. Flow alterations from the water supply diversion are also of concern.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

Dense growth of the non-native aquatic macrophyte *Cabomba caroliniana* was observed in both Lily Pond (ENSR 2003) and the Aaron River upstream from the Beechwood Street Dam (MassDEP 2001a).

The *Recreational* and *Aesthetic* uses are assessed as impaired for Herring Brook based on the presumed dense infestation of Herring Brook with a non-native aquatic macrophyte.

Herring Brook (MA94-29) Use Summary Table

Designated Uses		Status
Aquatic Life		IMPAIRED Causes: Fish barriers and non-native aquatic macrophyte Sources: Hydrostructure impacts on fish passage and unknown
Fish Consumption		NOT ASSESSED
Primary Contact		IMPAIRED Cause: Non-native aquatic macrophyte Source: Unknown
Secondary Contact		
Aesthetics		

RECOMMENDATIONS

The fishway at Hunters Pond should be redesigned and replaced (Reback *et al.* 2004).

Further investigate/define the extent of the infestation of *Cabomba caroliniana.*

In order to maintain the integrity of aquatic life in Herring Brook flow regimes should be maintained as close to a natural regime as possible (i.e., the flashboards near Beechwood Street should be used as little as possible to reverse the flow of Aaron River and Herring Brook back into Lily Pond). If changes are implemented monitoring designed to document changes in water quality conditions should be conducted.

BOUND BROOK (SEGMENT MA94-18)

Location: Flow control structure near Beechwood Street, Cohasset to outlet Hunters Pond, Scituate.
Segment Length: 2.2 miles
Classification: Class B

Land-use estimates (top 3, excluding water) for the 11.3 mi^2 subwatershed:

Forest..... 75%
Residential 16%
Open Land 3%

Bound Brook is listed on the 2002 Integrated List of Waters in Category 3. This segment had insufficient information to make assessments for any of the designated uses (MassDEP 2003a).

WMA WATER WITHDRAWAL SUMMARY

See Aaron River (Segment MA94-28) and Herring Brook (Segment MA94-29) segments for upstream water withdrawals.

OTHER

According to the Wetland Protection Act Regulations Variance for the Greenbush Commuter Rail Restoration Project in Scituate, a bridge crossing of Bound Brook will need to be replaced with a box culvert, new abutments and improved stormwater management. Scour protection is proposed at the mouth of the culverts in Bound Brook. Stormwater runoff also will be discharged into Bound Brook from the proposed North Scituate Station. Under present conditions (commercial buildings, parking and public open space), the stormwater is not detained and receives little or no water quality treatment. Under the proposed conditions (the North Scituate Railroad Station), MBTA will use best management practices including street sweeping, deep-sump hooded catch basins and Downstream Defenders® treatment units (MassDEP 2004b).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

There is a flow control structure at the upstream side of Beechwood Street, Cohasset. When the boards are raised, the flow of Aaron River is diverted into Herring Brook and into Lily Pond (public water supply system operations).

The poorly designed, deteriorating notched weir-pool fish ladder at Hunters Pond is impassable (Reback *et al.* 2004).

Chemistry – water

In 2001 DWM conducted water quality sampling at one station (AR101) on Aaron River upstream from the outlet control structure at Beechwood Street, Cohasset (Appendix A). *In-situ* measurements of DO, % DO saturation, temperature, pH, conductivity, and TDS were recorded on seven occasions from June to October. Samples were collected on five occasions for total phosphorus, ammonia-nitrogen, nitrate-nitrite nitrogen, chloride, alkalinity, and hardness. The results are summarized below.

Dissolved oxygen and percent saturation

DO measurements by DWM ranged from 2.0 to 5.9 mg/L with the percent saturation ranging from 24 to 56%. Only one of six measurements did not meet the water quality standard of 5.0 mg/L.

Temperature

Temperature measurements ranged from 13.9ºC in October to 28.0ºC in June.

pH, alkalinity and hardness

pH was low ranging from 5.5 to 6.1 SU as were alkalinities (4 to 7 mg/L) and hardness (14 to 18 mg/L).

Conductivity
Specific conductance measurements ranged from 119 to 130 µS/cm.

Total dissolved solids
TDS measurements ranged from 76.1 to 83.3 mg/L.

Nutrients
Total phosphorus concentrations ranged from 0.031 to 0.059 mg/L. Ammonia-nitrogen concentrations were <0.02 mg/L for all unqualified samples and nitrate-nitrite nitrogen concentrations ranged from <0.06 to 0.08 mg/L.

The *Aquatic Life Use* is assessed as impaired for Bound Brook based on the barrier to anadromous fish migration. *Cabomba caroliniana* is also a threat to this brook but was not observed at any of the downstream road crossings (DeCesare 2005). The low DO/saturation and pH, alkalinity, hardness conditions are considered to be naturally occurring as a result of the large upstream wetland areas.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

In 2001 DWM conducted bacteria sampling at one station (AR101) on Aaron River upstream from the flow control structure at Beechwood Street, Cohasset, on three occasions during the primary contact season and on one additional date, 24 October 2001 (Appendix A). Samples were analyzed for fecal coliform, *E. coli* and *Enterococcus* sp. None of the fecal coliform bacteria counts exceeded 170 cfu/100 ml.

Although DWM field survey crews noted no objectionable odors or oils, dense growths of aquatic vegetation and algal mats were observed in the brook upstream from the flow control structure throughout the summer of 2001 and more recently in the Hunters Pond impoundment (MassDEP 2001 and DeCesare 2005). During one sampling occasion after significant rain in 2001, the water was described as being brownish and very turbid although usually the water was slightly tea-stained and slightly turbid. The water column was again found to be highly turbid following a period of dry weather conditions along the entire segment of Bound Brook during a recent field reconnaissance visit (DeCesare 2005)

The *Recreational* and *Aesthetics* uses are assessed as impaired for Bound Brook based primarily on the objectionable turbidity. These conditions were associated with both wet and dry weather conditions. The presence of algal mats frequently noted near the flow control structure and in the impounded reach of the river in Hunters Pond. The potential for *Cabomba* infestation is also of concern.

Bound Brook (MA94-18) Use Summary Table

Designated Uses		Status
Aquatic Life		IMPAIRED Cause: Fish barriers Source: Hydrostructure impacts on fish passage
Fish Consumption		NOT ASSESSED
Primary Contact		IMPAIRED Cause: Turbidity Source: Unknown
Secondary Contact		
Aesthetics		

RECOMMENDATIONS

Evaluate the operation of the flow control structure in Bound Brook near Beechwood Street, Cohasset. To the extent possible optimize the operations of the structure to mimic a natural flow regime in the brook (i.e., the flashboards near Beechwood Street should be used as little as possible to reverse the flow of Aaron River and Herring Brook back into Lily Pond). If changes are implemented monitoring designed to document changes in water quality conditions should be conducted.

Evaluate sources of nutrients to this system that contribute to the prolific growth of macrophytes and algae.

Investigate the source(s) of turbidity during both dry and wet weather sampling periods. Develop and implement BMPs as deemed appropriate to improve water clarity.

Track infestation of *Cabomba caroliniana* and identify remediation efforts to prevent further spreading to downstream areas.

Continue to conduct bacteria sampling to evaluate effectiveness of non-point source pollution control activities and other actions and to assess the status of the *Recreational* uses.

Continue to conduct monitoring (biological, habitat and water quality) to evaluate conditions from non-point source pollution in Bound Brook and to better assess the status of the *Aquatic Life Use*.

The removal of Hunter Pond dam could provide a substantial opportunity for increasing the amount of smelt spawning habitat and improve river herring passage in this subwatershed Chase (in preparation). In lieu of dam removal the fishway at Hunters Pond should be redesigned and replaced (Reback *et al.* 2004).

MUSQUASHCUT POND (SEGMENT MA94-33)

Location: Scituate.
Size: 0.11 square miles
Classification: Class SA
This segment was formerly identified as MA94105 (a 69-acre pond).

Land-use estimates (top 3, excluding water) for the 0.33 mi^2 subwatershed:

Residential 70%
Open Land 15%
Forest..... 10%

Musquashcut Pond is listed on the 2002 Integrated List of Waters in Category 5. This segment is impaired due to noxious aquatic plants and a TMDL is required (MassDEP 2003a).

Musquashcut Pond is designated as a Great Pond [brackish] separated from Massachusetts Bay by North Scituate barrier beach. It is surrounded by residential development on two other sides.

In 1999 Comprehensive Environmental Inc. (CEI) prepared a lake watershed management plan that included delineating the watershed, hydrologic budget and three rounds of water quality sampling for *E. coli* and a suite of nitrogen compounds (see MA DCR Lakes and Ponds Program grant in Appendix F). As early as the 1930's, there were reports of midge problems in the pond (Lefebvre *et al*. 2003). Various methods of midge control have been conducted including flow alteration (flooding), oil, and insectide applications (Lefebvre *et al*. 2003). Though controversial, the insect growth regulator Strike® (active ingredient methoprene), as recommended in the CEI report, was applied in April 2005, while Altocid® (a larvacide) was applied in July (POP 2001 and Scituate PWA 2005).

Scituate DPW is currently involved in a three-phase sewer expansion program. The third phase of the project would sewer the Musquashcut Pond area (Rowland 2005).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER SUMMARY

There are no WMA water withdrawals or NPDES wastewater discharges in this segment.

USE ASSESSMENT

AQUATIC LIFE

Habitat and flow

There are electric tide gates on two 7-foot box culverts located at Hatherly Road at the pond's outlet to Musquashcut Brook. The original gates were installed during the 1930s in order to maintain adequate water depth in Musquashcut Pond in an effort to control a midge problem. Water was exchanged in Musquashcut Pond once per month on a full moon tide, which remains the general practice today (Lefebvre *et al*. 2003). In the mid-1990s gates were installed to maintain sufficient water depth and to address flooding issues (ACOE 2004). According to the ACOE tidal flushing study, approximately 75% of the pond water is replaced during the monthly tide gate operations. The following conclusions were also drawn (ACOE 2004).

-- Even with the tide gates left fully open there is no flooding along Musquashcut Pond during spring and normal tides. During the May 2003 spring tide "gates fully-open" period, there were no reports of flooding by Musquashcut Pond area residents. In addition our field observations indicate that flooding most likely does not occur until water levels are at least 1.5 - 2 feet higher than the highest water level observed. We, therefore, assume that flooding does not occur below elevation 5.5 feet National Geodetic Vertical Datum (NGVD). [Note: According to the Flood Insurance Study for the Town of Scituate, Massachusetts dated 29 September 1986, flood levels at Musquashcut Pond are 7.4 feet NGVD, 8.2 feet NGVD, 11.5 feet NGVD, and 12.4 feet NGVD for the 10, 50, 100, and 500-year floods, respectively].

-- Approximately 95% of the water volume in Musquashcut Pond is emptied from the pond into the Gulf during a spring flood tide cycle with the tide gates left fully open. Flushing in the Gulf itself was not quantified however, nor was the expected improvement in Musquashcut Pond water quality.

-- Assuming 5.5 feet NGVD as the beginning of flooding, cursory calculations indicate that, with the tide gates left open, the pond will be able to accommodate at least 2 inches of runoff from the surrounding watershed on top of the peak spring tide water levels occurring in Musquashcut

Pond, without flooding being caused.
-- Leaving the tide gates open evidently does not result in extended periods of low water, exposed tidal flats, and odor problems as indicated by a lack of complaints of such problems during the May 2003 open-gate "experiment".

It has been suggested that organic nutrient enrichment from failing septic systems contributes to the midge problem in Musquashcut Pond (Lefebvre 2003).

Aquatic vegetation

A heavy growth of algae and one hyperdominant macrophyte (likely *Potamogeton pectinatus* or *Ruppia maritima*) were observed by DWM biologists in Musquashcut Pond during the summer of 2001. Similar conditions were observed in the summer of 1996 where a heavy growth of red/brown algae covered the entire pond (Appendix C, Table C1).

Chemistry – water

In 2001 DWM conducted three baseline lake surveys in Musquashcut Pond. Monitoring included profile measurements of DO, percent saturation of DO, pH, salinity and temperature; Secchi disk transparency; samples of total phosphorus and chlorophyll *a* at the deep hole (Station A); and detailed macrophyte mapping as well as total phosphorus sampling in the unnamed inlet to Musquashcut Pond at Mann Hill Road (Station B; Appendix C, Tables C2 and C3).

Dissolved oxygen/percent saturation

While DO concentrations ranged from 6.4 to 9.3 mg/L, supersaturation occurred during two of the three surveys (as high as 130%).

Temperature

Temperatures ranged between 26.2 and 28.1°C

pH and alkalinity

pH ranged from 7.4 to 8.3 SU and alkalinity ranged from 69 to 88 mg/L.

Total phosphorus

The concentrations of total phosphorus ranged from 0.041 to 0.11 mg/L at the deep hole station. Higher concentrations were measured in the samples collected from the unnamed tributary (ranged from 0.13 to 0.26 mg/L).

Chlorophyll a

The concentration of chlorophyll *a* ranged from 4.1 to 25.0 mg/m^3.

The *Aquatic Life Use* is assessed as impaired because of the excessive algal growth, supersaturation, high chlorophyll *a* concentrations, elevated total phosphorus concentrations, and flow regime alterations (i.e., restricted tidal flushing). Sources include changes in tidal circulation/flushing as a result in operation of the tide gates. Source(s) are currently unknown however, failing septic systems are suspected.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Area MB10.1 (which contains this entire segment) is prohibited (MA DFG 2000 and Appendix G, Table G3). Although no sampling was conducted by DMF in the pond, DMF reports that the river (downstream) has elevated bacteria (Churchill 2005a).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired presumably due to elevated fecal coliform bacteria counts. Suspected sources of bacteria, which are based on best professional judgment, include discharges from municipal separate storm sewer systems, wet weather discharges from non-point sources and failing septic systems.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

During both the 2001 and the 1996 DWM surveys heavy algae growth covered almost the entire pond (MassDEP 2001 field sheets and Appendix C, Table C1). The source of impairment is thought to be associated with the flow regulation (tide gate restriction).

The *Recreational* and *Aesthetic* uses for Musquashcut Pond are assessed as impaired because of the excessive algal growth likely the result of poor tidal circulation/flushing.

Musquashcut Pond (MA94-33) Use Summary Table

Designated Uses		Status
Aquatic Life		IMPAIRED Causes: Excess algal growth, chlorophyll *a*, dissolved oxygen saturation, total phosphorus, and other flow regime alterations Source: Changes in tidal circulation/flushing (Suspected source: Failing septic systems)
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Fecal coliform bacteria Source: Unknown (Suspected sources: Failing or inadequate septic systems, discharges from municipal separate storm sewer systems, wet weather discharges from non-point sources)
Primary Contact		IMPAIRED Causes: Excess algal growth and other flow regime alterations Source: Changes in tidal circulation/flushing (Suspected sources: Failing or inadequate septic systems)
Secondary Contact		
Aesthetics		

RECOMMENDATIONS

Leave tide gates open except for times during tidal flooding conditions to improve tidal flushing/circulation in Musquashcut Pond.

Conduct water quality monitoring to evaluate effectiveness of generally unrestricted tidal flushing in improving water quality conditions in the pond.

Implement recommendations in the DMF shellfish management plan for area MB10.1.

THE GULF (SEGMENT MA94-19)

Location: Headwaters, outlet Hunters Pond, Scituate to confluence with Cohasset Cove just north of Border Street, Cohasset.
Size: 0.13 square miles
Classification: Class SB

Land-use estimates (top 3, excluding water) for the 15.0 mi^2 subwatershed (including the subwatersheds for MA94-18 and MA94-33):

Forest..... 64%
Residential..... 24%
Wetlands..... 5%

The Gulf is listed on the 2002 Integrated List of Waters in Category 3. This segment had insufficient information to make assessments for any of the designated uses (MassDEP 2003a).

The Natural Resources Inventory of The Gulf River Estuary provides a summary of existing information for The Gulf (Lefebvre *et al*. 2003).

Within the Gulf River subwatershed all of the properties in Scituate have on-site sewage disposal systems. In 2001 and 2002, some of the properties in Cohasset near to The Gulf were tied into the municipal sewerage system and other properties were scheduled for connection. It should also be noted that the Center for Student Coastal Research (CSCR) received a grant to conduct an assessment of non-point source pollution in The Gulf (Appendix F, Coastal Nonpoint Source Grant Program and Buckley 2005). This project is currently underway.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX E, TABLE E1)

The Golden Rooster Restaurant in North Scituate is authorized (NPDES permit MA005797 issued in September 1999) to discharge 0.0028 MGD of treated wastewater via one outfall to The Gulf. EPA terminated the permit effective 6 August 2004 because there no longer is a surface discharge (Vergara 2004). The outfalls were cemented over and the current system (now operated as The River Club) discharges to the ground. The Title 5 system (an innovative/alternative system) is below the threshold requiring a groundwater discharge permit (Burns 2006).

OTHER

The restoration of the Greenbush commuter railroad service is proposing to shift the tracks approximately 10 feet to the north of the existing right of way to avoid impacts with an existing sewer line. This will result in approximately 7,434 ft^2 of permanent fill in the saltmarsh on the banks of Musquashcut Brook (the waterway between the pond and the Gulf) along with temporary alterations to the marsh and waterway. The wetlands variance for Cohasset requires wetland replication and enhancement at two sites bordering the Great Swamp in Cohasset (Special Conditions #30-49), erosion and sedimentation plans (Special Condition #22), and replanting all disturbed areas (Special Condition #23) (MassDEP 2004b).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

There is a weir pool fishway at the outlet of Hunter Pond that should allow passage for anadromous fish, such as alewife and herring, access to upstream spawning areas. Occasionally heavy spring flows inundate the steps of the fishway making it extremely difficult for the anadromous fish to pass (Lefebvre *et al*. 2003).

Smelt spawning habitat was documented below Hunters Pond dam for approximately 166 m downstream from the face of the dam and in the mill channel. Several stretches of clean gravel and cobble were found along this reach (Chase in preparation).

The dam at the mouth of The Gulf (downstream from Border Street in Cohasset) is partially breached (ACOE 2004).

Biology

Rainbow smelt spawn in The Gulf below Hunter Pond (Reback *et al.* 2004). Large numbers of glass

eels were seen during April in 1993 and 1994 (Chase in preparation). The observations of glass eels relative to other river systems in this study indicate that Bound Brook may be a productive river system for eel.

Too limited data are available and therefore the *Aquatic Life Use* for The Gulf is not assessed.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Area MB10.1 (which contains this entire segment) is prohibited (MA DFG 2000 and Appendix G, Table G3). Potential pollution sources identified by DMF include septic systems and stormwater runoff.

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired presumably because of elevated fecal coliform bacteria.

AESTHETICS

No objectionable deposits, odors, or any other conditions were identified by DWM biologists in the Gulf (DeCesare 2005).

The *Aesthetics Use* for The Gulf is assessed as support.

The Gulf (MA94-19) Use Summary Table

Designated Uses		Status
Aquatic Life		NOT ASSESSED
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Unknown (Suspected sources: Septic systems, discharges from municipal separate storm sewer systems, and wet weather discharges from non-point sources)
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		SUPPORT

RECOMMENDATIONS

Implement recommendations in the DMF shellfish management plan for area MB10.1.

Develop a monitoring plan and conduct bacteria sampling to evaluate effectiveness of point (Phase II stormwater permits) and non-point source pollution control activities and other actions and to assess the status of the *Recreational* uses.

Review results of the CSCR non-point source pollution assessment project for the Gulf when available and support the Center's efforts to develop a quality assurance project plan and future projects to control non-point source pollution, promote water quality stewardship and public education.

Implement recommendations in the Natural Resources Inventory for The Gulf River Estuary (Lefebvre *et al*. 2003).

Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Support the following actions identified by DMF to study/protect/remediate smelt spawning habitat (Chase in preparation).

Identify the cause(s) of low pH and identify possible remedial options.

Since water depth fluctuations may be contributing to elevated smelt egg mortality, a volunteer streamflow gauge station should be established near the smelt spawning habitat in The Gulf to evaluate streamflow conditions in relation to the habitat requirements of smelt and other diadromous species.

Increase the amount of shading (planting with appropriate vegetation) provided by the riparian zone along The Gulf where a former mill property was converted to condominiums. The removal of Hunter Pond dam could provide a substantial opportunity for increasing the amount of smelt spawning habitat and improve river herring passage in this subwatershed Chase (in preparation).

In lieu of dam removal the fishway at Hunters Pond should be redesigned and replaced (Reback *et al.* 2004).

COHASSET COVE (SEGMENT MA94-32)

Location: The waters south of a line drawn from the Bassing Beach jetty, Scituate westerly to the opposite shore, Cohasset excluding Baileys Creek and The Gulf.
Size: 0.09 square miles
Classification: Class SA

Land-use estimates (top 3, excluding water) for the 16.5 mi^2 subwatershed (including the subwatersheds for MA94-18, MA94-19 and MA94-33):

Forest..... 61%
Residential..... 26%
Wetlands..... 5%

Cohasset Cove (formerly included as part of segment MA94-19--The Gulf) is on the 2002 Integrated List of Waters in Category 3. This segment had insufficient information to make assessments for any of the designated uses (MassDEP 2003a).

There is a pump-out boat that was funded by the Clean Vessel Act to provide free pump-outs to service the marinas in Cohasset Harbor (MA DMF 2003). During the 2003 boating season the town pumped over 1,600 gallons of sewage (Churchill 2003a). There is a paved boat ramp at the end of Parker Avenue to Cohasset Cove (http://www.sailingmassachusetts.com/landing1.htm)

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Sources	Authorized Withdrawal (MGD)
Cohasset Water Department	N/A	32106501	3065000-01G Sohier Well #1 3065000-02G Ellms Meadow Well 3065000-03G Sohier Well #2	0.65*

*System-wide withdrawal, all sources are not necessarily within this segment; however, Cohasset Water Department reported no water was drawn from the groundwater wells between 2000 and 2002 - all water was withdrawn from Lily Pond (MassDEP 2003c).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX E, TABLE E1)

The Town of Cohasset is authorized (MA0100285 issued in October 2000) to discharge from the Cohasset Wastewater Treatment Plant (WWTP) a flow of 0.3 MGD (average monthly) of treated municipal wastewater via Outfall #001 to Cohasset Cove. This facility was upgraded in 2000 with a Zenon® Membrane Filtration process (Nye 2004) (Appendix F, SRF Projects Cohasset). The permit requires effluent limits for BOD_5, TSS, pH and fecal coliform bacteria and requires reporting of ammonia-nitrogen and total nitrogen concentrations. The ammonia-nitrogen concentrations in the effluent between November 2000 and August 2004 ranged from <0.1 to 5.0 mg/L (n=19)(TOXTD database). The pH (6.5 to 8.5 SU limit) of the effluent between November 2000 and August 2004 ranged from 6.5 to 7.4 SU (n=20)(TOXTD database). The TRC measurements in the effluent (ultraviolet disinfection) between November 2000 and August 2004 were all below the detection limit <0.05 mg/L (n=19)(TOXTD database). The whole effluent toxicity limits are $LC_{50} \geq 100\%$ using *Mysidopsis bahia* and *Menidia beryllina.* Toxicity testing for this facility is required four times/year.

OTHER

According to the Wetland Protection Act variance and Water Quality Certification variance, the design/build drawings for the Greenbush Commuter Rail Restoration Project will result in several culverts over James Brook (a tributary of Cohasset Cove) being either replaced or abandoned. Culverts generally will be designed so as not to restrict flow, flood stage or fish passage. Furthermore, no culvert can be abandoned or removed without MassDEP approval of a hydrologic and hydraulic analysis detailing the effects (see Special Condition #27 of the Cohasset Wetlands Variance; MassDEP 2004a). Stormwater runoff will be discharged into a culverted portion of James Book (approximately 1200 linear feet in length and located from Smith Place to past South Main Street Cohasset) from the proposed replacement parking facility near Pleasant Street (Maguire 2005). The Greenbush plan indicated that the Town of Cohasset placed a ditch that discharged to James Brook near Smith Place in a 60" reinforced concrete pipe and the pipe was connected to James Brook. The proposed Greenbush changes to the James

Brook culverted section have been permitted by the Wetlands Program through variances but have not yet been constructed. It is planned that two drainage manholes will drain track drainage and parking lot runoff to James Brook. The track drainage is proposed to be in a perforated pipe and only drain to the drainage manhole when the track drainage system reaches capacity. The other drainage manhole is proposed to pick up drainage from a parking lot to be located northeast of Pleasant Street and west of South Main Street (Maguire 2005). Deep sump catch basins and vortex style separators will provide water quality treatment (MassDEP 2004a).

USE ASSESSMENT

AQUATIC LIFE

Toxicity

Ambient

Water from Cohasset Cove was collected at the Tourist Pavilion Harbor-side Dock approximately 50 feet away from the Cohasset WWTP Outfall #001(referred to as the "Duck Bills")(Nye 2004) for use as dilution water in the facility's whole effluent toxicity tests. Between November 2000 and August 2004, survival of *M. bahia* results exposed (48 hours) to the Cohasset Cove water ranged from 80 to 100% (n=16) and survival of *M. beryllina* ranged from 78 to 100% except for one test event 60% (August 2002) (n=18).

Effluent

Whole effluent toxicity tests were conducted on the Cohasset WWTP effluent between November 2000 and August 2004. No acute toxicity was detected by either *M. bahia* or *M. beryllina* (LC_{50}>100% effluent in all valid tests).

Chemistry-water

Water from Cohasset Cove was collected at the Tourist Pavilion Harbor-side Dock approximately 50 feet away from the "Duck Bills" (Nye 2004) for use as dilution water in the facility's whole effluent toxicity tests. Between November 2000 and August of 2004, data from these toxicity reports were entered into the DWM TOXTD database and the results are summarized below.

pH

The pH measurements ranged from 7.2 to 7.9 SU (n=19)(TOXTD database).

Nitrogen

The ammonia-nitrogen concentrations were all $\leq$ 0.18 mg/L (n=17)(TOXTD database).
The total nitrogen concentration from the Cohasset wastewater treatment plant outfall ranged from a low of 3.05 mg/L (September 2002) to a high of 8.52 mg/L (June 2002) during the time period between January 2002 and July 2003 according to the Daily Monitoring Reports (Golden 2003).

Total residual chlorine(TRC)

The TRC measurements were all below the minimum quantification level of 0.05 mg/L (n=18)(TOXTD database).

Too limited data (poor spatial coverage) are available and therefore the *Aquatic Life Use* is not assessed. The effects, if any, of the Cohasset WWTP discharge are unknown.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Area MB10.1 (which contains this entire segment) is prohibited (MA DFG 2000; Appendix G, Table G3; and Appendix G, Table G3).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired presumably due to elevated fecal coliform bacteria. Pollution sources identified by DMF in this closed safety zone area include the Cohasset WWTP discharge. Additionally, the marinas, septic systems, and stormwater runoff are also potential sources.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

Weekly testing for *Enterococci* bacteria during the swimming season was conducted at the Bassing Sailing Club semi-public beach along the eastern shore of Cohasset Cove, Cohasset/Scituate. Only one posting in the 2002/2003 beach seasons was reported (in 2003) although apparently not related to elevated bacteria counts (MDPH 2003 and 2004b). No objectionable conditions were observed by DWM biologists (DeCesare 2005).

The *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses are assessed as support in Cohasset Cove since the beach was open for the majority of the 2002 and 2003 bathing seasons and no objectionable conditions were noted.

Cohasset Cove (Segment MA94-32) Use Summary Table

Designated Uses		Status
Aquatic Life		NOT ASSESSED
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Municipal point source discharge (Suspected sources: Marina/boating sanitary on-vessel discharges, septic systems and discharges from municipal separate storm sewer systems)
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

RECOMMENDATIONS

Implement recommendations in the DMF shellfish management plan for area MB10.1.

Develop a monitoring plan and conduct bacteria sampling to evaluate effectiveness of point (Phase II stormwater permits) and non-point source pollution control activities and other actions and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Continue to review/evaluate the operation of the Town of Cohasset WWTP. Their permit MA0100285 should be reissued with appropriate limits and monitoring requirements.

Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

COHASSET HARBOR (SEGMENT MA94-01)

Location: The waters south of a line drawn from the northwestern point of Scituate Neck, Scituate to just north of Quarry Point, Cohasset not including Cohasset Cove, Cohasset/Scituate.
Size: 0.70 square miles
Classification: Class SA

Land-use estimates (top 3, excluding water) for the 17.6 mi^2 subwatershed (including the subwatersheds for MA94-18, MA94-19, MA94-32 and MA94-33):

Forest..... 58%
Residential..... 27%
Wetlands..... 7%

Cohasset Harbor is listed on the 2002 Integrated List of Waters in Category 5. This segment is impaired due to pathogens and a TMDL is required (MassDEP 2003a).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Source	Authorized Withdrawal (MGD)
Hatherly Country Club	N/A	V42126402	1 ground	0.06

NPDES WASTEWATER SUMMARY

There are no NPDES wastewater discharges in this segment.

USE ASSESSMENT

AQUATIC LIFE

Eelgrass Bed Habitat

MassDEP's Wetlands Conservancy Program (WCP) identified the presence of eelgrass in Cohasset Harbor from historic 1951 black and white aerial photography (Costello 2003). In 1998 MassDEP WCP performed field verification of 1995 aerial photography and mapped the extent of eelgrass bed habitat in Cohasset Harbor. Total areal coverage of Cohasset Harbor from the 1998 survey was approximately 20% of the harbor. In 2001 MassDEP WCP performed field verification of 2001 aerial photography and mapped the extent of eelgrass bed habitat in Cohasset Harbor. There was a very slight increase in the total coverage of eelgrass beds between 1998 and 2001 including two new areas. There has been no apparent overall loss in eelgrass beds since 1951.

Too limited data are available so the *Aquatic Life Use* for Cohasset Harbor is not assessed.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that area MB10.0 is approved (which contains 0.63 mi^2 of this segment), and the following areas totaling 0.07 mi^2 are prohibited: Sandy Cove (Area MB10.2), Whales Cove (Area MB10.4), and the Briggs Harbor system (Areas MB10.3 and MB10.5) (MA DFG 2000; Appendix G, Table G3; and Churchill 2003a). Potential pollution sources identified by DMF in Sandy Cove (Area MB10.2) include a pipe draining Treat Pond, which is contributing elevated bacteria. Potential pollution sources to Whales Cove (Area MB10.4) include stormdrains. Unknown sources contribute to the Briggs Harbor system (Churchill 1994 and 2005a).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as support for 0.63 mi^2 of this segment and impaired for 0.07 mi^2 of this segment presumably due to elevated fecal coliform bacteria.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

Weekly testing for *Enterococci* bacteria during the swimming season was conducted at the Bassing Sailing Club semi-public beach along the southern shore of Cohasset Cove, Cohasset/Scituate. Only one posting in the 2002 and 2003 beach seasons was reported (in 2003), although apparently not related to elevated bacteria counts (MDPH 2003 and 2004b). Weekly testing for *Enterococci* bacteria during the swimming season was conducted at the Sandy Cove public beach in Cohasset. No postings were reported in either the 2002 or 2003 beach seasons (MDPH 2003 and 2004b). No objectionable conditions were noted by DWM biologists (DeCesare 2005).

The *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses are assessed as support in Cohasset Harbor. The beaches were open for the majority of the 2002/2003 bathing seasons and no objectionable aesthetic conditions were noted.

Cohasset Harbor (MA94-01) Use Summary Table

Designated Uses		Status
Aquatic Life		NOT ASSESSED
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		SUPPORT - 0.63 mi^2 IMPAIRED - 0.07 mi^2 Cause: Elevated fecal coliform bacteria Source: Unknown (Suspected source: Discharges from municipal separate storm sewer systems)
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

RECOMMENDATIONS

Implement recommendations in the DMF shellfish management plan for Areas MB10.0, M10.2, M10.3, MB10.4, and MB10.5.

Develop a monitoring plan and conduct bacteria sampling to evaluate effectiveness of point (Phase II stormwater permits) and non-point source pollution control activities and other actions and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

NORTH AND SOUTH RIVERS SUBWATERSHEDS

The North and South Rivers Subwatersheds include 14 river and estuarine segments. The North River includes the following river segments, listed from the headwaters then continuing downstream.

- French Stream (MA94-03)
- Drinkwater River (MA94-21)
- Indian Head River (MA94-04)
- Iron Mine Brook (MA94-24)
- Indian Head River (MA94-22)
- Third Herring Brook (MA94-27)
- Second Herring Brook (MA94-26)
- Second Herring Brook (MA94-31)
- North River (MA94-05)
- First Herring Brook (MA94-25)
- Herring River (MA94-07)
- North River (MA94-06)

The South River joins the North River just before it empties into Massachusetts Bay and includes the following two segments.

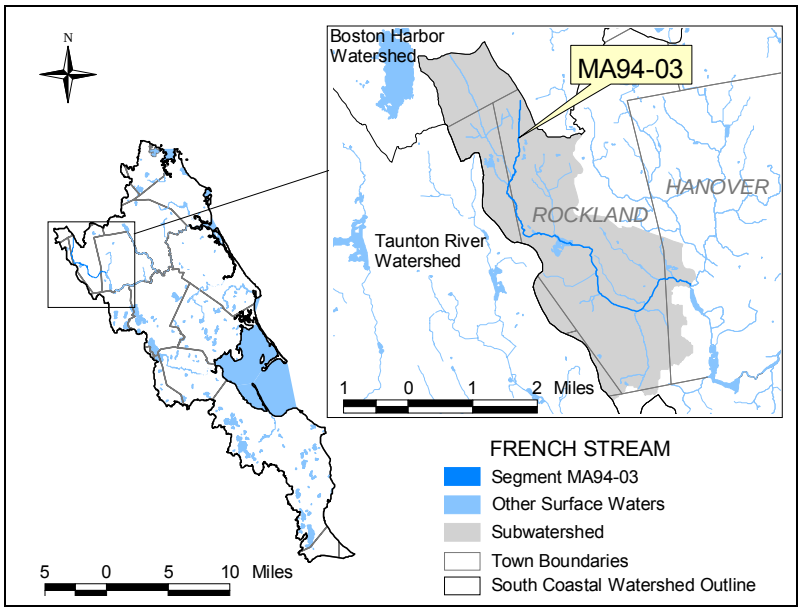
- South River (MA94-08)
- South River (MA94-09)

FRENCH STREAM (SEGMENT MA94-03)

Location: From the headwaters on the southeast side of the South Weymouth Naval Air Station, Rockland, through Studleys Pond to the confluence with Drinkwater River, Hanover.
Segment Length: 6.1 miles
Classification: Class B, Warm Water Fishery.

Land-use estimates (top 3, excluding water) for the 8.7 mi^2 subwatershed (map inset, gray shaded area):

Forest..... 39%
Residential..... 32%
Open Land..... 10%



French Stream is listed on the 2002 Integrated List of Waters in Category 5. This segment was impaired due to pathogens, unknown toxicity, nutrients and organic enrichment/low DO. Therefore, a TMDL is required (MassDEP 2003a).

There is one site awaiting a National Priorities List (NPL) decision located in this subwatershed. The site description was excerpted from the EPA website (EPA 2005).

The South Weymouth Naval Air Station (SOWEY NAS) was administratively closed on September 30, 1997 under the Defense Base Closure and Realignment Act of 1990 (BRAC), Public Law 101-510, as part of the BRAC Commission's 1995 Base Closure List (BRAC IV). The facility was operationally closed on September 30, 1996. Activities performed at the site included aircraft maintenance, refueling, personnel training and housing, and administrative support services. In addition, the U.S. Coast Guard operates a buoy maintenance depot on the property through an agreement with the Navy. The wastes generated by the facility were reportedly disposed of in three on-site landfills. The West Gate landfill operated from 1969 to 1972, and the Rubble Disposal area and the Small Landfill operated from 1972 until the mid-1980s. Flammable liquid wastes reportedly were burned in the on-site fire training area, and small amounts of waste battery acid, possibly containing lead, may have been disposed of in a tile leachfield. At the Coast Guard's buoy depot, lead-based paint from buoys was reportedly sandblasted from 1972 until 1986. A Phase I Remedial Investigation was completed in July 1998. Field work for a Phase II RI was completed in June 2000. The Navy has completed the Final Phase II Remedial Investigation (RI) reports for all seven CERCLA sites which include the Small Landfill, Rubble Disposal Area, West gate Landfill, Fire Fighting Training Area, Tile Leach Field, Sewage Treatment Area, and Abandoned Bladder Tank Fuel Storage Area.

[*NOTE: Two of the RI sites are located in the Old Swamp River drainage area – the Rubble Disposal Area and the Small Landfill. Four RI sites are located along an unnamed tributary to French Stream. From upstream to downstream these sites include the Sewage Treatment Area, the Abandoned Bladder Tank Fuel Storage Area, the West Gate Landfill, and the Tile Leach Field. The remaining RI site, the Fire Fighting Training Area (FFTA), is located on French Stream. The Navy considers the FFTA to be adequately characterized based on an assessment of analytical data collected over the past decade and site-specific risk calculations (Tetra Tech 2001).*]

Two additional sites, Building 81 and Building 82 were being investigated as petroleum sites under the Massachusetts Contingency Plan. In August, 2001, because chlorinated solvents were detected in soil and groundwater samples, both sites were transferred to CERCLA. An innovative technology (Fenton's reagent for chlorinated solvents) pilot study was unsuccessful at Building 81.The Navy completed draft Remedial Investigation Work Plans for both sites in September 2002.

AOC 108 was transferred from the Environmental Baseline Survey (EBS) program to the CERCLA program because chlorinated solvents were detected in groundwater samples. The Navy planned to submit a draft Remedial Investigation Work Plan in June 2005.

A Draft Final RI was completed by the United States Coast Guard (USCG) in December 2000 for the USCG Buoy Depot as well as a draft FS in March 2001 and an Engineering Evaluation/Cost. The USCG completed the stormwater system and was supposed to start the swale removal and restoration in mid-December 2004.

Within the last two years, The Village Center Plan has been developed by Lennar Partners, through a planning process with the communities of Abington, Rockland and Weymouth, the Tri-Town Development Corporation and local, regional, state and federal planning experts, agencies and elected officials, for redeveloping the former South Weymouth Naval Air Station. This mixed-use, smart growth re-use plan is a twelve-year plan for redeveloping the former South Weymouth Naval Air Station.

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

There are no WMA water withdrawals in this segment. However, there is one acre of land that is classified in the Land-Use theme as cranberry bog in this subwatershed (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is less than 0.01 MGD.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX E, TABLE E1)

The Town of Rockland is authorized (MA0101923 issued in August 1999) to discharge from the Rockland Wastewater Treatment Plant (WWTP) a flow of 2.5 MGD (average monthly) of treated sanitary and industrial wastewater via Outfall #001 to the French Stream. This advanced activated sludge facility performs nitrification for seasonal ammonia-nitrogen reduction (May 1 to 31, 7.5 mg/l and June 1 to September 30, 1.5 mg/l) and total phosphorus reduction by chemical addition (May 1 to September 30, 1.5 mg/l). The ammonia-nitrogen concentrations in the effluent between September 1999 and June 2004 ranged from <0.05 to 11.00 mg/L (n=22)(TOXTD database). The pH (6.5 to 8.3 SU) of the effluent between September 1999 and June 2004 ranged from 6.8 to 7.8 SU (n=24)(TOXTD database). The Rockland WWTP uses sodium hypochlorite for disinfection. The TRC [0.0124 mg/L (average monthly) and 0.0214 mg/L (maximum daily) permit limits] measurements in the effluent between September 1999 and June 2004 were all <0.05 mg/L (n=24)(TOXTD database). The facility's whole effluent toxicity limits are $LC_{50} \geq 100$ and C-NOEC $\geq$ 88% effluent using *Ceriodaphnia dubia*. Toxicity testing for this facility is required four times/year.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

MDFW and DWM noted that in-stream habitat quality in the upper reach of French Stream near North Avenue, Rockland, was limited (the overall habitat assessment score was 94/200) (MA DFWELE 2001). None of the habitat parameters scored in the optimal category. Alteration was present in the form of channelization, both bank vegetative cover and riparian zone widths were only marginal, sediment deposition and embeddedness were noted, and the somewhat limited channel flow status resulted in limited velocity/depth combinations and only occasional riffle habitat.

Downstream from Summer Street in Rockland the character of French Stream changes from a riffle/run dominated system to a slow moving deeper flat water system as it meanders through a large wetland area. For a short distance upstream from its confluence with the Drinkwater River, French Stream returns to a riffle/run type habitat.

Biology

MDFW and DWM conducted backpack electrofishing at one station (#387) in French Stream, at North Avenue, in September 2001 (Richards 2003). Sampling at this station, yielded two species of fish, 16 American eel (*Anguilla rostrata*) and seven redfin pickerel (*Esox americanus americanus*). Both species are considered macrohabitat generalists. Redfin pickerel are moderately tolerant to water quality degradation but are considered by DWM biologists to be tolerant to habitat degradation. While the lack of fish species diversity in French Stream is consistent with the findings of some other coastal plain streams it is unclear whether this is a natural condition or the result of habitat and water quality degradation. The absence of fluvial or intolerant species should be noted. Although no RBP III analysis was conducted, a cursory evaluation of the benthic community in French Stream near North Avenue, Rockland (Station FRS-B), in May 2000 revealed low abundance and diversity (SaintOurs 2005).

Toxicity

Ambient

The Rockland WWTP staff collected French Stream water approximately 0.4 miles upstream from the WWTP's discharge at the Summer Street bridge for use as dilution water in the facility's whole effluent toxicity tests (Kotouch 2004). Survival of *C. dubia* exposed (7-day) to the river water between September 1999 and June of 2004 (n=22 tests) ranged from 80 to 100% with the exception of one test event (survival =60% in September 2002 test event). It should be noted, however, that when whole effluent toxicity testing of the Rockland WWTP discharge was also being tested with *Pimephales promelas*, survival of *P. promelas* was $\leq$ 75% in 14 of the 23 tests conducted between March 1994 and June 2000 with survivals ranging from 18 to 73%.

Effluent

A total of 22 whole effluent toxicity tests were conducted on the Rockland WWTP effluent (Outfall #001) between September 1999 and June 2004 using *C.dubia.* The LC_{50}s ranged from 36.6 to 100% effluent. Acute toxicity was detected in six tests of the 22 tests with LC_{50}s ranging from 36.6 to 73.6% effluent. Of the 18 valid chronic tests, the C-NOECs ranged from 12.5 to 100% effluent and 10 of the tests (including the six acutely toxic events) had C-NOEC results <88% effluent.

Chemistry-water

DWM conducted water quality monitoring (DO and % saturation, temperature, pH, conductivity, alkalinity, hardness, chlorides, nitrate-nitrite-nitrogen, ammonia-nitrogen and/or total phosphorus) at the following four locations in French Stream between June and October 2001 (Appendix A, Tables A6 and A7 and Appendix C, Table C3).

at North Avenue crossing, Rockland (Station FS103)
at Summer Street crossing, Rockland (Station FS102)
approximately 300 feet downstream/northeast from Rockland WWTP discharge canal confluence, Rockland (Station FS101)
approximately 30 feet upstream from the confluence with Drinkwater River, Hanover (Station FS104)

Additionally, one sample was collected by DWM and analyzed for nitrate-nitrite-nitrogen, ammonia-nitrogen, and total phosphorus from the unnamed tributary receiving the Rockland WWTP discharge (Station FS105). These data are summarized below.

The Rockland WWTP staff collected French Stream water approximately 0.4 miles upstream from the WWTP's discharge at the Summer Street bridge for use as dilution water in the facility's whole effluent toxicity tests (Kotouch 2004). Test results spanning between September 1999 and June of 2004, maintained by DWM in the TOXTD database, are also summarized below.

DO and % saturation

The DO in French Stream upstream from the Rockland WWTP discharge (Stations FS103 and FS102) ranged from 6.1 to 8.9 mg/L with saturations between 72 and 91%. These data represent both mid-day and pre-dawn measurements. The DO in the river downstream from the Rockland WWTP discharge (Station FS101) ranged from 5.4 to 7.4 mg/L with saturations between 62 to 86%. These data, however, do not represent pre-dawn conditions.

Temperature

While the maximum temperature of French Stream at the most upstream sampling location (Station FS103) was only 18.0°C, higher temperatures (up to 27°C) were found further downstream (Station FS102), which likely reflects the effect of the Studleys Pond impoundment.

pH, hardness, and alkalinity

The pH of French Stream measured by DWM ranged from 6.5 to 6.9 SU while pH of the stream at Summer Street reported in the Rockland toxicity test reports ranged from 6.6 to 7.6 SU (n=24) (TOXTD database). Hardness and alkalinity of French Stream upstream from the Rockland WWTP discharge ranged from 31 to 46 mg/L and 13 to 22 mg/L, respectively. Alkalinity of the stream at Summer Street reported in the Rockland toxicity test reports ranged from 11 to 23 mg/L (n=22). Downstream from the discharge the hardness measured by DWM ranged from 60 to 97 mg/L while alkalinity ranged from 22 to 41 mg/L.

Conductivity

Specific conductance of French Stream upstream from the Rockland WWTP discharge (Stations FS103 and FS102) ranged from 183 to 282 μS/cm. Downstream from the discharge specific conductance was higher ranging from 356 to 578 μS/cm (Station FS101).

Suspended Solids
The suspended solids concentrations ranged from <1.0 to 16.0 mg/L (n=22) (TOXTD database).

Ammonia-nitrogen
With the exception of two samples (exclusive of qualified data), no detectable concentrations of ammonia-nitrogen were found in French Stream. The two samples with detectable levels of ammonia-nitrogen (0.06 and 0.08 mg/L) were collected downstream from the Rockland WWTP discharge (Station FS101). The ammonia-nitrogen concentrations in the stream at Summer Street reported in the Rockland toxicity test reports ranged from <0.10 to 0.16 mg/L (n=22) (TOXTD database).

Total Phosphorus
The concentration of total phosphorus in French Stream upstream from the Rockland WWTP discharge (Stations FS103 and FS102) ranged from 0.024 to 0.10 mg/L (average concentration = 0.05 mg/L). The total phosphorus in the stream downstream from the Rockland WWTP discharge (Station FS101) ranged from 0.10 to 1.3 mg/L (average concentration = 0.34 mg/L). Near the mouth of French Stream (Station FS104) the concentration of total phosphorus ranged from 0.076 to 0.084 mg/L. The concentration of total phosphorus collected in the unnamed tributary receiving the Rockland WWTP discharge (Station FS105) ranged from 0.15 to 0.26 mg/L.

Total residual chlorine (TRC)
The total residual chlorine measurements were all <0.05 mg/L (n=24) (TOXTD database).

Chemistry-sediment
Surficial sediment samples were collected in June/July 2004 at five locations in the upper reach of French Stream in the vicinity of Spruce Street in Rockland (near the South Weymouth Naval Air Station) as part of the Phase II Environmental Baseline Survey to assess potential impacts of solid waste (construction and demolition debris) to French Stream and its sediments (Stone & Webster 2004). These samples were all analyzed for acid volatile sulfide (AVS), simultaneously extracted metals (SEM), total organic compounds (TOC), polycyclic aromatic hydrocarbons (PAHs), grain size, and other target analytes and compounds. At the most upstream sampling point just upstream from Spruce Street (Station SD03-301(0-0.5)) the surficial sediment was comprised primarily of fines (53.81%) and sand (45.19%) with a 46.1% solids content. Surficial sediments in French Stream as far as approximately 500' downstream from Spruce Street (stations SD03-302(0-0.5), SD03-303(0-0.5), and SD03-304(0-0.5)) were dominated by sand (>59%) and fines (ranging between 10.91 and 40.36%). These samples ranged from 50.2 to 73.3% solids. One sampling location (Station SD03-305(0-0.5)) downstream from Spruce Street but just upstream from a culvert along the western side of French Stream was comprised primarily fines (62.98%) and sand (34.86%) and was comprised of 39.8% solids. The SEM/AVS ratios were all less than 1 (ratios less than 1 indicate the metals are not likely be toxic to aquatic organisms) with the exception of one sample where sulfides were below detection (SEM/AVS ratio = 1.12 for station SD03-303(0-0.5) (Stone & Webster 2004). Several analytes (primarily PAH contaminants in sediment sample from Station SD03-303(0-0.5) exceeded ecological benchmark values and corresponding site background data (Stone & Webster 2004).

The *Aquatic Life Use* for French Stream is assessed as impaired based primarily on best professional judgment. The in-stream habitat quality in the upper reach of the river was fairly poor (deposition and embeddedness were noted) and both the fish and benthic communities were observed to have low abundance and diversity. Although there has been good survival of *C. dubia* exposed to the river water, historically there was often poor survival of *P. promelas*. *P. promelas* have not been utilized in recent whole effluent toxicity tests for the Rockland WWTP, however. While the *in-situ* water quality data did not indicate impairment, elevated levels of total phosphorus were detected in the river downstream from the Rockland WWTP discharge and the presence of acute and chronic toxicity in the Rockland WWTP discharge is also of concern.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) at three locations in French Stream between June and October 2001 (Appendix A, Table A7). The stations and fecal coliform bacteria data are summarized below.

- at North Avenue crossing, Rockland (Station FS103)
- at Summer Street crossing, Rockland (Station FS102)
- approximately 300 feet downstream/northeast from Rockland WWTP discharge canal confluence, Rockland (Station FS101)

All of the fecal coliform bacteria samples (excluding duplicate samples) analyzed during the primary contact recreational season (1 April to 15 October) (n=9) collected from the French Stream exceeded 200 cfu/100 ml (ranging from 230 to 2,000 cfu/100 ml). Six of the nine samples (67%) exceeded 400 cfu/100 ml. The geometric mean of all the fecal coliform bacteria data (excluding duplicate samples) was 403 cfu/100 ml (n=12 with counts ranging from 71 to 2,000 cfu/100 ml). The higher bacteria counts were both associated with wet weather sampling conditions. It should also be noted that there is a cow pasture along the French Stream in the vicinity of the Rockland WWTP discharge. Cows in the pasture have direct access to the stream and discharge canal (MassDEP 2001a).

Field observations were made by DWM personnel during the surveys conducted in French Stream between June and October 2001. With the exception of isolated areas of trash/debris no objectionable conditions (odors, oils) were noted during any of the surveys upstream from the Rockland WWTP discharge (Stations FS103 and FS102) (MassDEP 2001a and MA DFWELE 2001). Chlorine/septic odors were occasionally noted by survey crews at the two stations (FS101 and FS104) downstream from the discharge.

The *Primary Contact Recreational Use* is assessed as impaired for French Stream because of elevated fecal coliform bacteria counts. The *Secondary Contact Recreational* and *Aesthetics* uses are assessed as support but are identified with an Alert Status because of the occasional chlorine/septic odors in the river downstream from the Rockland WWTP discharge.

French Stream (MA94-03) Use Summary Table

Designated Uses		Status
Aquatic Life		IMPAIRED Cause: Unknown (Suspected causes: Habitat degradation upper 5.1 miles, elevated total phosphorus lower 1.0 miles, unknown toxicity entire length) Sources: Unknown and municipal point source discharge (lower 1 mile) (Suspected sources: Discharges from municipal separate storm sewer systems, loss of riparian habitat, post-development erosion and sedimentation, and impacts from stormwater in urbanized area)
Fish Consumption		NOT ASSESSED
Primary Contact		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Unknown (Suspected sources: Grazing in riparian zone and discharges from municipal separate storm sewer systems)
Secondary Contact		SUPPORT*
Aesthetics		SUPPORT*

* Alert Status issues identified, see details in use assessment section.

RECOMMENDATIONS

Conduct monitoring (biological, habitat and water quality) to:

- evaluate impacts to French Stream from point and potential sources of pollution (e.g., South Weymouth Naval Air Station property, Rockland WWTP, golf course, developments),
- address the documented chronic toxicity to *Pimephales promelas*, and
- assess more fully the status of the *Aquatic Life Use*.

Conduct bacteria sampling to evaluate effectiveness of non-point source pollution control activities and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

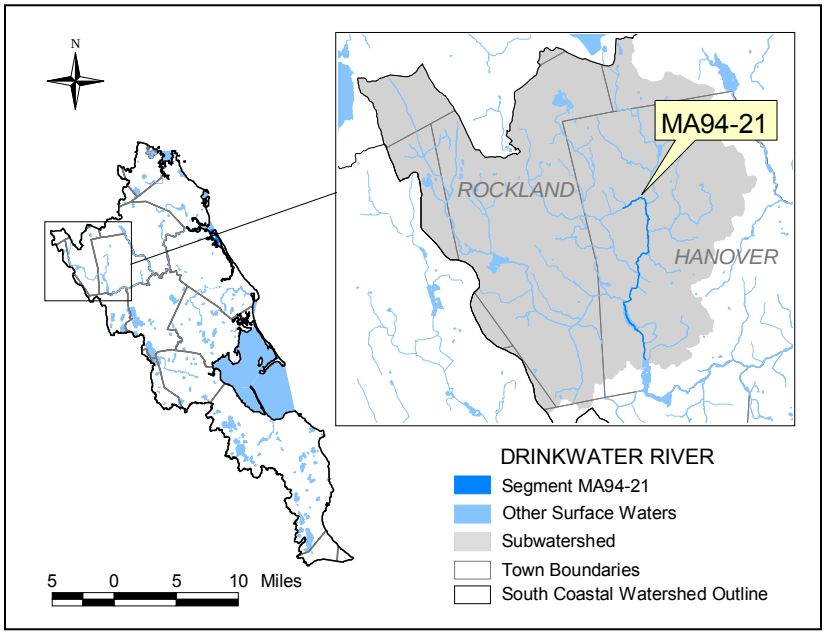
The Rockland WWTP NPDES permit should be reissued with appropriate limits and monitoring requirements. If acute and chronic toxicity continue to be detected in the effluent, a toxicity identification and reduction evaluation (TIE/TRE) should be required.

DRINKWATER RIVER (SEGMENT MA94-21)

Location: From Whiting Street, Hanover through Forge Pond to the inlet of Factory Pond, Hanover.
Segment Length: 3.5 miles
Classification: Class B, Warm Water Fishery

Land-use estimates (top 3, excluding water) for the 21.0 mi^2 subwatershed (map inset, gray shaded area):

Forest..... 44%
Residential..... 35%
Open Land..... 7%



The Drinkwater River is listed on the 2002 Integrated List of Waters in Category 5. This segment is impaired due to metals and a TMDL is required (MassDEP 2003a).

The MassDEP is supervising the "Fireworks Site" investigation through the Massachusetts Contingency Plan (MCP). The following information was taken from the North and South Rivers Watershed Association website (NSRWA 2005a).

> The Fireworks Site is 240 acres of property generally located between King and Winter Streets in the Town of Hanover. The Site is bounded on the east by Winter Street, on the west by King Street and the Drinkwater River wetland, on the north by First Street and on the South by Factory Pond. Factory Pond discharges to the Indian Head River, which flows eastward to the North River. Historical activities at the Site included the research and development and manufacture of munitions and pyrotechnics for the U.S. Government between approximately 1907 and 1970 and commercial manufacture of civilian fireworks for some period. Lead, mercury, and various organic solvents, among other chemicals, were used in certain manufacturing processes and research and development activities during the facility's operational lifetime. Following closure of the facility, U.S. military personnel destroyed government-owned raw materials and explosives at the Site. Several years later, the Town of Hanover purchased approximately 130 acres of the Site in the general area of Factory Pond. The Town continues to maintain the area for conservation purposes and has also built the Municipal Garage for the DPW on a parcel off of Ames Way. The remaining acreage was sold in May 1983 to Drinkwater Investment Corporation. It was subsequently subdivided and portions sold, creating a multi-tenant, commercial/industrial park. After conducting surface water, sediment, and fish tissue sampling for mercury, lead, and other metals, MassDEP issued Notices of Responsibility for the Fireworks Site on October 20, 1995 to Kerr-McGee Chemical LLC, Massachusetts Institute of Technology, National Coating Corporation, Susquehanna Corporation, and the U.S. Department of Defense based on their alleged status as either former owners, operators, generators, or transporters, or successors to former site owners, operators, generators, or transporters. The cooperating parties completed a Phase I Investigation and the site was classified as a Tier 1A site (which requires direct oversite by MassDEP) in October 1997. Because of the complexity and size of the site, the Phase II Comprehensive Site Investigations are being conducted in phases (e.g., Phase IIA, IIB, etc.).

The Phase II site work. which provides the investigation of the environmental conditions at the Site, was initiated in 1998. The Phase IIA and IIB investigations provided data related to groundwater and upland soils. Phase IIC focused primarily on surface water bodies. This sampling was conducted between November 2001 and April 2002. The field program mapped the location of lead and mercury in stream and pond sediments. The Phase IID investigations were to further assess the presence of metals (primarily lead and mercury) in sediment and potential ecological effects on various local species and determine whether any mercury has migrated off Site, below Factory Pond Dam (TetraTech 2003). MDFW conducted backpack electrofishing in Ben Mann Brook in September 2001. Sampling yielded only four redfin pickerel (Richards 2003).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Source	Authorized Withdrawal (MGD)
Abington-Rockland Joint Water Works	N/A	42125101	4001000-02S Hingham Street Reservoir	2.21*

*System-wide withdrawal, all sources are not necessarily within this segment.

Additionally, there are 5.4 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 0.05 MGD.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX E, TABLE E2)

The Abington-Rockland Joint Water Works is authorized (permit MAG640010 issued in April 2001) to discharge backwash from the Hingham Street Water Treatment Plant in Rockland into the wetlands of Ben Mann Brook, a tributary to Cushing Brook which is a tributary to Drinkwater River. Chlorine is used in the water treatment process but is not added to the supernatant. The facility is equipped with a lagoon for backwash water.

An application was received for Electro Signal Lab in October 1995 (MA0036587); no other information is known.

TACC International MA0031852 to Cushing Brook which flows to Drinkwater River (as indicated in MassGIS).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

MDFW and DWM noted that in-stream habitat quality in an upper reach of the Drinkwater River downstream from Cedar Street Bridge was limited (the overall habitat assessment score was 103/200) (MA DFWELE 2001). Habitat quality was limited most by the extremely poor bank stability, limited vegetative protection and channel sinuosity. Epifaunal substrate, sediment deposition, and channel flow were also noted as being marginal. Similar observations were reported by SaintOurs (2000).

Biology

MDFW and DWM conducted backpack electrofishing in the Drinkwater River downstream from Cedar Street Bridge, Hanover (Station #483), in September 2001. Sampling at this station yielded five species of fish. In order of abundance, these species were 19 redfin pickerel (*Esox americanus americanus*), 12 American eel (*Anguilla rostrata*), two largemouth bass (*Micropterus salmoides*), and an individual each of black crappie (*Pomoxis nigromaculatus*) and pumpkinseed (*Lepomis gibbosus*). These species are all considered macrohabitat generalists. Although redfin pickerel are classified as being moderately tolerant to water quality degradation, they are considered by DWM biologists to be tolerant to habitat degradation. The absence of fluvial or intolerant species should be noted. Although benthic macroinvertebrate sampling was also conducted by SaintOurs (2005) in the Drinkwater River near Cedar Street, Hanover (Station DWR-C), in May 2000 as part of a study of the impacts of increased development on stream benthic communities, these data did not lend themselves to RBP III analysis.

Chemistry – water

DWM conducted water quality monitoring (DO and % saturation, temperature, pH, conductivity, alkalinity, hardness, chlorides, nitrate-nitrite-nitrogen, ammonia-nitrogen and/or total phosphorus) at two locations in the Drinkwater River between June and October 2001 (Appendix A, Tables A6 and A7 and Appendix C, Tables C2 and C3).

- Circuit Street Bridge, Hanover (Station DW101) and
- near inlet to Forge Pond just upstream confluence with French Stream, Hanover (Station C)

These data are summarized below. Additional data were collected by DWM at the deep hole (Station A) in Forge Pond (see Forge Pond - MA94037- in Table 3 for data summary/information).

Dissolved oxygen and percent saturation
The DO in the Drinkwater River near the Circuit Street Bridge (Station DW101) ranged from 6.1 to 7.2 mg/L with saturations between 58 and 77%. These data represent daytime and a single pre-dawn measurement.

Temperature
The maximum temperature measured in the Drinkwater River (Station DW101) was 20.4°C.

pH, hardness, and alkalinity
The pH of the Drinkwater River was low ranging from 5.9 to 6.3 SU. Hardness ranged from 37 to 49 mg/L while alkalinity was also low ranging from 8 to 17 mg/L.

Conductivity
Specific conductance of Drinkwater River ranged from 299 to 451 µS/cm (station DW101).

Ammonia-nitrogen
No detectable concentrations of ammonia-nitrogen (exclusive of qualified data) were found in the Drinkwater River (Station DW101).

Total phosphorus
The total phosphorus concentrations measured in the Drinkwater River near Circuit Street bridge (Station DW101) ranged from 0.046 to 0.10 mg/L (average concentration = 0.07 mg/L). Similar concentrations were measured in the river near the inlet to Forge Pond (station C).

The *Aquatic Life Use* for the Drinkwater River is assessed as support upstream from the confluence with French Stream (upper 2.4 mile of reach) based on the *in-situ* water quality data. However, this use is identified with an Alert Status based on the fish community data and the slightly elevated levels of total phosphorus. Downstream from the confluence with French Stream (the lower 1.1 mile reach) the *Aquatic Life Use* for the Drinkwater River is assessed as impaired because of supersaturation of dissolved oxygen and elevated total phosphorus concentrations. Sources of impairment include the municipal point source discharge (the Rockland WWTP), although stormwater and agricultural runoff are also suspected. The impact(s) if any from the Fireworks Site on aquatic life in the Drinkwater River are currently being investigated as part of the MCP and these data should be available in the near future.

FISH CONSUMPTION

MassDEP personnel conducted fish toxics monitoring of Forge Pond in Hanover (an impoundment along this segment of the Drinkwater River) in August 1995 (Appendix D). Mercury concentrations in the five samples analyzed ranged from 0.097 to 0.403 mg/Kg wet weight and no PCB or pesticides were detected (Appendix D, Table D1). The mercury concentrations were all below the MDPH action level of 0.5 mg/Kg wet weight. However, due to higher concentrations of mercury detected in fish collected from Factory Pond in Hanover (Maietta 1994), the MDPH currently advises that the general public eat no fish from the Drinkwater River/Indian Head River between the Forge Pond Dam and the Luddam's Ford Dam, and includes Factory Pond because of elevated mercury concentrations (MDPH 2004a). The MassDEP Bureau of Waste Site Cleanup tested river sediments and determined that the former National Fireworks, Inc. site (the “Fireworks” site) located just upstream from Factory Pond is the most likely source of the mercury contamination.

The upper 3.0-mile portion of this segment of the Drinkwater River is not assessed for the *Fish Consumption Use*. However, the lower 0.5 miles of this segment is assessed as impaired for the *Fish Consumption Use* because of elevated levels of mercury that triggered a site-specific fish consumption advisory for the Drinkwater River. The source of the mercury contamination is the former National Fireworks, Inc. site.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) of the Drinkwater River near the Circuit Street Bridge, Hanover (Station DW101) between June and October 2001 (Appendix A, Table A7). All three of the fecal coliform bacteria samples collected during the primary contact recreational season (1 April to 15 October) exceeded 200 cfu/100 ml (ranging from 590 to 870 cfu/100 ml). The geometric mean of all of the fecal coliform bacteria counts was 416 cfu/100 ml (n=4 with counts ranging from 81 to 870 cfu/100 ml).

No objectionable odors, deposits or any other conditions were observed by DWM personnel near the Circuit Street Bridge, Hanover (Station DW101), during the surveys conducted in the Drinkwater River between June and October 2001 (MassDEP 2001a and MA DFWELE 2001). Low Secchi disk transparency on two of three dates, filamentous algal blooms and objectionable deposits were documented by DWM field survey crews in the deep hole (Station A) of Forge Pond (MassDEP 2001a).

The *Primary Contact Recreation Use* for the Drinkwater River is assessed as impaired because of elevated fecal coliform bacteria counts. The *Secondary Contact Recreation* and *Aesthetic* uses are assessed as support for the river upstream from the confluence with French Stream but are assessed as impaired downstream from the confluence with French Stream because of objectionable conditions (excess algal growth, low Secchi disk transparency. The Rockland Municipal WWTP discharge (85) is a known source of total phosphorus. Other suspected sources for these use impairments include stormwater and agricultural runoff.

Drinkwater River (MA94-21) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT upper 2.4 miles IMPAIRED lower 1.1 miles Causes: Dissolved oxygen saturation and elevated total phosphorus Source: Municipal point source discharge (Suspected sources: Grazing in riparian/shoreline zone)
Fish Consumption		NOT ASSESSED upper 3.0 miles IMPAIRED lower 0.5 miles Cause: Mercury Source: Former National Fireworks, Inc. waste site
Primary Contact		IMPAIRED Cause: Elevated fecal coliform bacteria entire length, excess algal growth and low Secchi disk transparency lower 1.1 mile of reach Source: Unknown entire length and municipal point source discharge in the lower 1.1 mile reach (Suspected sources: Discharges from municipal separate storm sewer systems for the entire length and grazing in riparian/shoreline zone in the lower 1.1 mile reach)
Secondary Contact		SUPPORT upper 2.4 miles IMPAIRED lower 1.1 miles Cause: Excess algal growth and low Secchi disk transparency Source: Municipal point source discharge (Suspected sources: Discharges from municipal separate storm sewer systems and grazing in riparian/shoreline zone)
Aesthetics		

RECOMMENDATIONS

Conduct monitoring (biological, habitat and water quality) to:

- evaluate impacts to the Drinkwater River from point and potential sources of pollution (e.g., Rockland WWTP, developments, Fireworks Site, agricultural runoff) and
- assess more fully the status of the *Aquatic Life Use*.

Conduct bacteria sampling to evaluate effectiveness of non-point source pollution control activities and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Continue to evaluate/monitor Fireworks site remediation efforts and mercury concentrations as they relate to both human and ecological health risks.

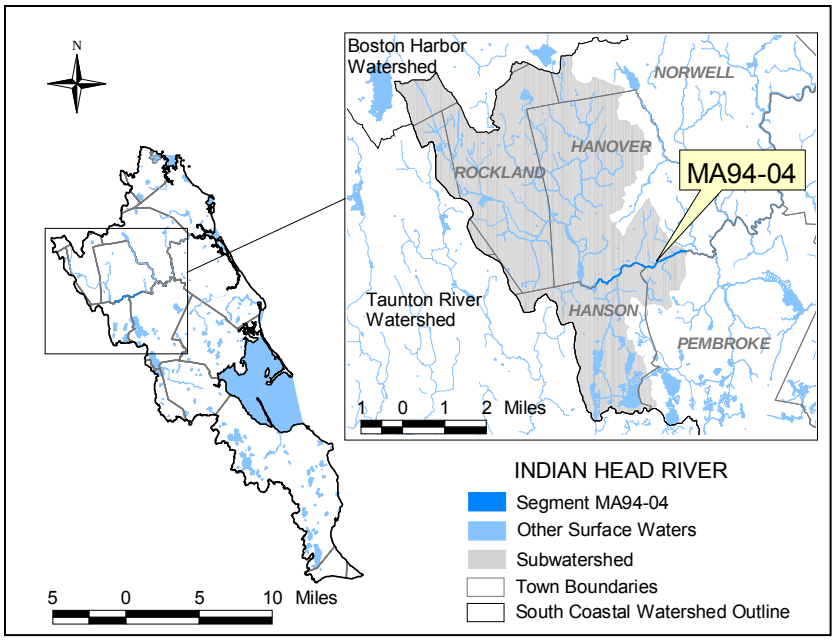
INDIAN HEAD RIVER (SEGMENT MA94-04)

Location: Outlet of Factory Pond, Hanover/Hanson to Curtis Crossing Dam (a.k.a. Ludhams Ford Dam) west of Elm Street, Hanover/Pembroke.
Segment Length: 2.9 miles
Classification: Class B, Warm Water Fishery.

Land-use estimates (top 3, excluding water) for the 30.1 mi^2 subwatershed (map inset, gray shaded area):

Forest..... 45%
Residential..... 34%
Open Land..... 8%

Indian Head River is listed on the 2002 Integrated List of Waters in Category 5. This segment is impaired due to metals, nutrients, and organic enrichment/low DO. Therefore a TMDL is required (MassDEP 2003a).



WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Source	Authorized Withdrawal (MGD)
Pembroke Country Club	N/A	42123107	1 ground 1 surface	0.13*

*Registered average withdrawal for a period of 240 days.
See also segment MA94-21 for additional withdrawals that may apply to this segment.

Additionally, there are 167 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 1.49 MGD.

NPDES WASTEWATER DISCHARGE SUMMARY

There are no NPDES wastewater discharges to this segment.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

USGS maintains one gage just downstream from this segment of the Indian Head River near the Elm Street Bridge in Hanover (gage 01105730). The average annual discharge at the gage is 63 cfs (period of record 1966 to 2004; Socolow *et al.* 2005). The 7Q10 estimate at this site is 1.66 cfs (Appendix A). The USGS remarks indicate that there is some regulation by mills and several ponds (Wampatuck, Indian Head, Maquan and others) upstream. In cooperation with the MA DCR and the MA DFG, the USGS investigated monthly flow-durations and low-flow statistics over a 25-year period (1976–2000) at this site (Armstrong *et al.* 2004). Flow-duration and low-flow statistics are available for this site. These were also compared to flow management targets and streamflow requirements for habitat protection using a variety of in-stream flow methods.

Biology

MDFW monitored the fish population assemblage at one station (481) near the Glass Factory on Water Street) in this segment of the Indian Head River in September 2001 (Richards 2003). Six species of fish were collected. In order of abundance, these species were 89 American eel (*Anguilla rostrata*), 17 bluegill (*Lepomis macrochirus*), 15 white sucker (*Catostomus commersoni*), 14 pumpkinseed (*Lepomis gibbosus*), seven largemouth bass (*Micropterus salmoides*), and a chain pickerel (*Esox niger*). Excluding the catadromous American eel, macrohabitat generalists dominated

the fish community. The proximity to the coast most likely contributes to the large number of American eels at this location. White sucker, while fluvial, are tolerant of low dissolved oxygen. The presence of large numbers of macrohabitat generalists is most likely related to the presence of impoundments both upstream and downstream from this reach. All fish species collected are considered tolerant to pollution.

Chemistry – water

DWM conducted water quality monitoring (DO and % saturation, temperature, pH, conductivity, alkalinity, hardness, chlorides, nitrate-nitrite-nitrogen, ammonia-nitrogen and/or total phosphorus) in this segment of the Indian Head River near Cross Street Bridge, Hanover/Hanson (Station IH102) between June and October 2001 (Appendix A, Tables A6 and A7). These data are summarized below.

Dissolved oxygen and percent saturation

The DO ranged from 4.9 to 7.4 mg/L with saturations between 59 and 81%. These data represent daytime and a single pre-dawn measurement. Five of the six measurements met water quality standards.

Temperature

The maximum temperature in this segment of the Indian Head River was 25.4°C.

pH, hardness, and alkalinity

The pH of the Indian Head River ranged from 6.5 to 6.7 SU (n=7). Hardness ranged from 44 to 57 mg/L while alkalinity ranged from 13 to 33 mg/L.

Conductivity

Specific conductance ranged from 301 to 396 µS/cm (n=7).

Ammonia-nitrogen

No detectable concentrations of ammonia-nitrogen (exclusive of qualified data) were found in this segment of the Indian Head River.

Total phosphorus

The total phosphorus concentrations measured in the Indian Head River ranged from 0.032 to 0.082 mg/L (n=5 with an average concentration = 0.05 mg/L).

The *Aquatic Life Use* for this segment of the Indian Head River is assessed as support based primarily on the *in-situ* water quality data. Since this segment of river is affected by impoundments and macrohabitat generalists dominated the fish community (fluvial specialist/dependant species were not well represented) and there were borderline indicators of enrichment (oxygen and total phosphorus data), the *Aquatic Life Use* is identified with an Alert Status. The impact(s) if any from the Fireworks Site (see details in segment MA94-21) on aquatic life in this segment of the Indian Head River are currently being investigated as part of the MCP and these data should be available in the near future.

FISH CONSUMPTION

In 1993, at the request of a concerned citizen, MassDEP sampled and analyzed fish from Factory Pond in Hanover (the impoundment just upstream from this segment). Highly elevated concentrations of mercury in the edible fish tissues were detected (mean = 1.45 mg/Kg wet weight; Maietta 1994). In August 1995 additional fish toxics monitoring was conducted downstream from Factory Pond at the Ludhams Ford Impoundment in Hanover/Pembroke (Appendix D). Mercury concentrations in the six samples analyzed ranged from 0.828 to 1.52 mg/Kg wet weight and no PCB or pesticides were detected (Appendix D, Table D1). The mercury concentrations were all above the MDPH action level of 0.5 mg/Kg wet weight. Additional sampling was conducted in the Ludhams Ford Impoundment in June 1996. No detectable concentrations of mercury were detected in the two three-fish brown trout composite samples (Appendix D, Table D2). The MDPH currently advises that the general public eat no fish from the Drinkwater River/Indian Head River between the Forge Pond and the Ludhams Ford Dam, including Factory Pond, because of elevated mercury concentrations (MDPH 2004a). The MassDEP Bureau of Waste Site Cleanup tested river sediments and determined that the former National Fireworks, Inc. site (the "Fireworks" site) located just upstream from Factory Pond is the most likely source of the mercury. As part of the ongoing site investigations/cleanup,

consultants working in conjunction with this effort resampled Ludhams Ford Impoundment as well as a number of other locations within the Indian Head River subwatershed. Preliminary results indicated that mercury concentrations in fish samples from Ludhams Ford Impoundment were lower than previously measured (Hobill 2005). In light of this discrepancy, DWM resampled Ludhams Ford Impoundment in May 2005 in an effort to clarify current conditions with regard to mercury in fish tissue. Results indicate that mercury concentrations continue to exceed the MDPH trigger level of 0.5 ppm in all fish species sampled (Appendix D, Table D5).

This segment of the Indian Head River is assessed as impaired for the *Fish Consumption Use* because of elevated levels of mercury that triggered a site-specific fish consumption advisory for the Drinkwater River. The major source of the mercury contamination is the former National Fireworks, Inc. site.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) of the Indian Head River near the Cross Street Bridge, Hanover/Hanson (Station IH102), between June and October 2001 (Appendix A, Table A7). The three fecal coliform bacteria samples collected during the primary contact recreational season (1 April to 15 October) ranged from 65 to 390 cfu/100 ml with a geometric mean of 198 cfu/100 ml. The geometric mean of all four fecal coliform bacteria counts was 185 cfu/100 ml.

With the exception of a minimal amount of trash and debris and a small sheen, no other objectionable odors, deposits or any other conditions were observed by DWM personnel near the Cross Street Bridge, Hanover/Hanson (Station IH102), during the surveys conducted in the Indian Head River between June and October 2001 (MassDEP 2001a).

The *Primary* and *Secondary Contact Recreational* and *Aesthetic* uses are assessed as support for this segment of the Indian Head River based on the limited fecal coliform bacteria data and the lack of aesthetically objectionable conditions.

Indian Head River (MA94-04) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT*
Fish Consumption		IMPAIRED Cause: Mercury Source: Former National Fireworks, Inc. waste site
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

* Alert Status issues identified, see details in use assessment

RECOMMENDATIONS

Conduct monitoring (biological, habitat and water quality) to:

- evaluate impacts to the Indian Head River from potential sources of pollution (e.g., Rockland WWTP, developments, Fireworks Site, agricultural runoff) and
- assess more fully the status of the *Aquatic Life Use*.

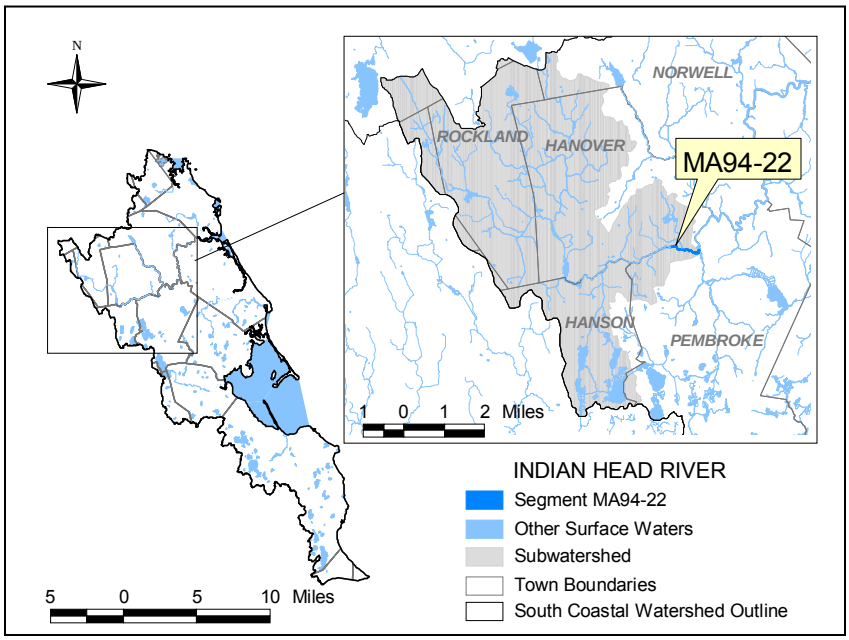
Continue to evaluate/monitor Fireworks site remediation efforts and mercury concentrations as they relate to both human and ecological health risks.

INDIAN HEAD RIVER (SEGMENT MA94-22)

Location: From Curtis Crossing Dam (a.k.a. Ludhams Ford Dam), west of Elm Street, Hanover/Pembroke to confluence with Herring Brook (forming headwaters of North River), Hanover/Pembroke.

Size: 0.9 miles

Classification: Proposed Class B, Warm Water Fishery, ORW. (It should be noted that this segment of the Indian Head River is currently listed in the MSWQS as a Class SA/ORW (0.01 square miles) but the corrected classification in the proposed revisions of the WQS are stated above.)



Land-use estimates (top 3, excluding water) for the 31.8 mi^2 subwatershed (map inset, gray shaded area):

- Forest..... 46%
- Residential..... 34%
- Open Land..... 7%

Indian Head River is listed on the 2002 Integrated List of Waters in Category 3. This segment had insufficient information to make assessments for any of the designated uses (MassDEP 2003a).

The Town of Hanover manages a cartop access point to Indian Head River on Riverside Drive in Hanover with parking for 15 vehicles (MA DFWELE 2003).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Sources	Authorized Withdrawal (MGD)
Hanover Water Department	9P342112201	42112202	4122000-09G Phillip Beal Well #1 4122000-10G Phillip Beal Well #2	1.27 registered 0.11 permitted 1.38 total*

*System-wide withdrawal, all sources are not necessarily within this segment.
See also segments MA94-21, MA94-04, and MA94-24 for additional withdrawals that may apply to this segment.

Additionally, there are 167 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 1.49 MGD. This cranberry acreage is entirely within the subwatershed for Segment MA94-04, which is the upper portion of this subwatershed.

NPDES WASTEWATER DISCHARGE SUMMARY

There are no NPDES wastewater discharges to this segment.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

USGS maintains one gage in this segment of the Indian Head River near the Elm Street Bridge in Hanover/Pembroke (Gage 01105730). The average annual discharge at the gage is 63 cfs (period of record 1966 to 2004) (Socolow *et al.* 2005). The USGS remarks indicate that there is some regulation by mills and several ponds (Wampatuck, Indian Head, Maquan and others) upstream. In cooperation with the MA DCR and the MA DFG, the USGS investigated monthly flow-durations and low-flow statistics over a 25-year period (1976–2000) for 23 index streamflow-gaging stations in Massachusetts, Connecticut, Rhode Island, and New Hampshire including the Indian Head River

gage (01105730) site (Armstrong *et al.* 2004). Flow-duration and low-flow statistics are available for this site. These were also compared to flow management targets and streamflow requirements for habitat protection using a variety of instream flow methods. A stormwater mitigation project was implemented at the Elm Street crossing of the Indian Head River (Appendix F, CRP Projects Hanover/Pembroke).

Biology

MDFW monitored the fish population assemblage at one station (398) downstream from Elm Street, Hanover/Pembroke in this segment of the Indian Head River in September 2001 (Richards 2003). Backpack shocking yielded nine species of fish. In order of abundance, these species were American eel (*Anguilla rostrata*) too numerous to count, 124 white sucker (*Catostomus commersoni*), 14 largemouth bass (*Micropterus salmoides*), 4 pumpkinseed (*Lepomis gibbosus*), 3 bluegill (*Lepomis macrochirus*), 2 brown bullhead (*Ameiurus nebulosus*), 2 banded killifish (*Fundulus diaphanus*), 1 chain pickerel (*Esox niger*), and 1 sea lamprey (*Petromyzon marinus*). Excluding the catadromous American eel, the fish community was dominated by a fluvial dependant species (white sucker). The proximity to the coast and the presence of a dam just upstream most likely contribute to the large number of American eels at this location. White sucker, while fluvial, are tolerant of low dissolved oxygen. The presence of small numbers of macrohabitat generalists is most likely related to the presence of the impoundment just upstream and the low gradient nature of the reach just downstream (North River). All fish species collected are considered tolerant to pollution. DMF biologists also observed American shad (*Alosa sapidissima*) and river herring (either alewife - *Alosa pseudoharengus* or blueback herring - *Alosa aestivalis*) in the river downstream from the Elm Street dam (Chase in preparation).

Chemistry – water

DWM conducted water quality monitoring (DO and % saturation, temperature, pH, conductivity, alkalinity, hardness, and chlorides) in this segment of the Indian Head River at the canoe ramp near Riverside Drive, Hanover (Station IH101), between June and October 2001 (Appendix A, Tables A6 and A7). These data are summarized below.

Dissolved oxygen and percent saturation

The DO ranged from 6.8 to 9.1 mg/L with saturations between 83 and 97%. These data represent daytime and a single pre-dawn measurement.

Temperature

The maximum temperature in this segment of the Indian Head River was 27.2°C.

pH, hardness, and alkalinity

The pH of the Indian Head River ranged from 6.9 to 7.2 SU (n=6). Hardness ranged from 45 to 56 mg/L while alkalinity ranged from 14 to 22 mg/L.

Conductivity

Specific conductance ranged from 328 to 402 µS/cm (n=6).

The *Aquatic Life Use* for this segment of the Indian Head River is assessed as support based primarily on the *in-situ* water quality data. The impact(s) if any from the Fireworks Site (see details in Segment MA94-21) on aquatic life in this segment of the Indian Head River may be investigated as part of the MCP and these data should be available in the near future.

FISH CONSUMPTION

In 2002, as the result of a public request, MassDEP sampled and analyzed fish from the Indian Head/North River in Hanover/Pembroke (downstream from the Ludhams Ford Dam). Two of the three samples collected were found to have elevated concentrations of mercury in the edible fish tissues (0.73 and 0.65 mg/Kg wet weight; Appendix D, Table D4). Trace concentrations of PCB and DDT metabolites (DDD and DDE) were also detected. Although the mercury concentrations were above the MDPH action level of 0.5 mg/Kg wet weight in two samples, no advisory has been issued to date. MDPH has indicated that they are in the process of reissuing the advisory to include this segment of the Indian Head River and possibly a portion or all of the North River.

This segment of the Indian Head River is currently not assessed for the *Fish Consumption Use*. This use is identified with an Alert Status because of elevated mercury concentrations in two composite fish samples although no site-specific advisory has been issued to date.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) of the Indian Head River at the canoe ramp near Riverside Drive, Hanover (Station IH101) between July and October 2001 (Appendix A, Table A7). The three fecal coliform bacteria samples collected during the primary contact recreational season (1 April to 15 October) ranged from 45 to 110 cfu/100 ml. The geometric mean of all four fecal coliform bacteria counts was 53 cfu/100 ml.

With the exception of a small amount of foam and very minimal debris, no other objectionable odors, deposits or any other conditions were observed by DWM personnel near the Cross Street Bridge, Hanover/Hanson (Station IH102) during the surveys conducted in the Indian Head River between June and October 2001 (MassDEP 2001a).

The *Primary* and *Secondary Contact Recreational* and *Aesthetic* uses are assessed as support for this segment of the Indian Head River based on the limited fecal coliform bacteria data and the lack of aesthetically objectionable conditions.

Indian Head River (MA94-22) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT
Fish Consumption		NOT ASSESSED*
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

* Alert Status issues identified, see details in use assessment section.

RECOMMENDATIONS

Conduct monitoring (biological, habitat and water quality) to:

- evaluate impacts to the Indian Head River from potential sources of pollution (e.g., Rockland WWTP, developments, Fireworks Site, agricultural runoff) and
- more fully assess the status of the *Aquatic Life Use*.

Continue to evaluate/monitor Fireworks site remediation efforts and mercury concentrations as they relate to both human and ecological health risks.

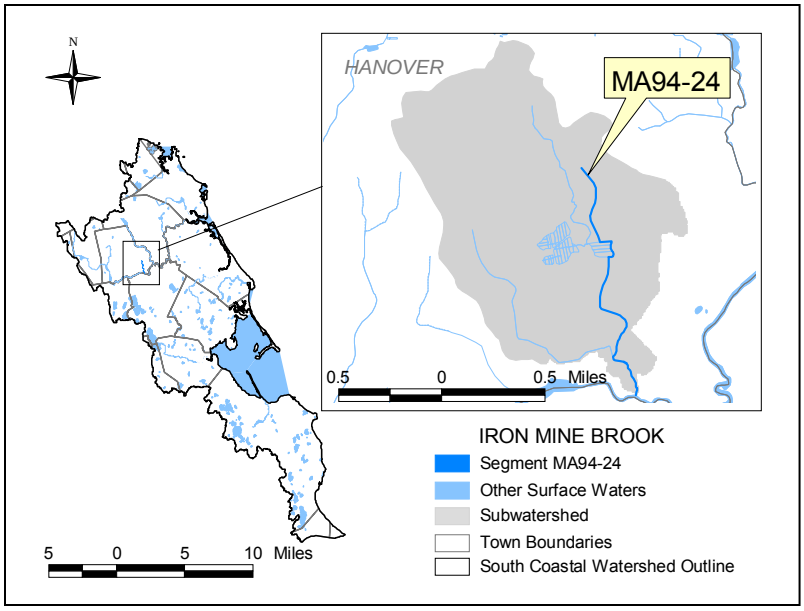
IRON MINE BROOK (SEGMENT MA94-24)

Location: Headwaters north of Route 139, Hanover to the confluence with Indian Head River, Hanover.
Size: 1.4 miles
Classification: B*
*Note: * indicates that a portion of this waterbody (wetlands contiguous with the North River wetlands) is an ORW under the North River Protective Order.*

Land-use estimates (top 3, excluding water) for the 1.3 mi^2 subwatershed (map inset, gray shaded area):

Forest..... 53%
Residential..... 29%
Commercial..... 6%

Iron Mine Brook was not evaluated as a segment in MassDEP's 2002 Integrated List of Waters.



WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Sources	Authorized Withdrawal (MGD)
Hanover Water Department	9P342112201	42112202	4122000-03G #1 Hanover Street 4122000-04G #2 Hanover Street 4122000-06G #1 Broadway 4122000-07G #2 Broadway	1.27 registered 0.11 permitted 1.38 total*

*System-wide withdrawal, all sources are not necessarily within this segment.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX E, TABLE E1)

Broadway Water Treatment Plant in Hanover is permitted (MAG640063) to discharge supernatant from their water treatment facility to wetlands and then to Iron Mine Brook. Backwash is typically discharged to a receiving basin and the supernatant discharged to the ground, however.

USE ASSESSMENT

AQUATIC LIFE

Chemistry – water

DWM conducted water quality monitoring (DO and % saturation, temperature, pH, conductivity, alkalinity, hardness, chlorides, nitrate-nitrite-nitrogen, ammonia-nitrogen and/or total phosphorus) in Iron Mine Brook Elm Street crossing, Hanover (Station IM101), between June and October 2001 (Appendix A, Tables A6 and A7). These data are summarized below.

Dissolved oxygen and percent saturation

The DO ranged from 7.3 to 8.7 mg/L with saturations between 69 and 91%. These data represent both daytime and pre-dawn measurements.

Temperature

The maximum temperature in Iron Mine Brook was 20.4°C.

pH, hardness, and alkalinity

The pH of Iron Mine Brook ranged from 6.7 to 7.0 SU (n=7). Hardness ranged from 65 to 90 mg/L while alkalinity ranged from 27 to 38 mg/L (n=4).

Conductivity

Specific conductance ranged from 458 to 763 µS/cm (n=6).

Ammonia-nitrogen
No detectable concentrations of ammonia-nitrogen (exclusive of qualified data) were found in Iron Mine Brook.

Total phosphorus
With the exception of one very high measurement (0.16 mg/L), the total phosphorus concentrations measured in samples collected from Iron Mine Brook ranged from 0.024 to 0.064 mg/L.

The *Aquatic Life Use* for Iron Mine Brook is assessed as support based primarily on the *in-situ* water quality data. This use is identified with an Alert Status, however, because of the very high total phosphorus measurement.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) in Iron Mine Brook Elm Street crossing, Hanover (Station IM101), between July and October 2001 (Appendix A, Table A7). The three fecal coliform bacteria samples collected during the primary contact recreational season (1 April to 15 October) ranged from 280 to 540 cfu/100 ml. The geometric mean of all four fecal coliform bacteria counts was 444 cfu/100 ml.

With the exception of a small amount trash near the roadside on one occasion, no other objectionable odors, deposits or any other conditions were observed by DWM personnel near the Elm Street crossing, Hanover (Station IM101), during the surveys conducted in Iron Mine Brook between June and October 2001 (MassDEP 2001a).

The *Primary Contact Recreational Use* for Iron Mine Brook is assessed as impaired because of elevated fecal coliform bacteria counts. Although the source(s) are currently unknown, elevated counts were found during both dry and wet weather sampling conditions. Suspected sources include discharges from municipal separate storm sewer systems. Both the *Secondary Contact Recreational* and *Aesthetic* uses are assessed as support, however, based on the limited fecal coliform bacteria data and the lack of aesthetically objectionable conditions.

Iron Mine Brook (MA94-24) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT*
Fish Consumption		NOT ASSESSED
Primary Contact		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Unknown (Suspected Source: Discharges from municipal separate storm sewer systems)
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

* Alert Status issues identified, see use assessment section

RECOMMENDATIONS

Conduct monitoring (biological, habitat and water quality) to evaluate impacts to Iron Mine Brook from potential sources of pollution (e.g., cranberry bog operations, developments) and to better assess the status of the *Aquatic Life Use*.

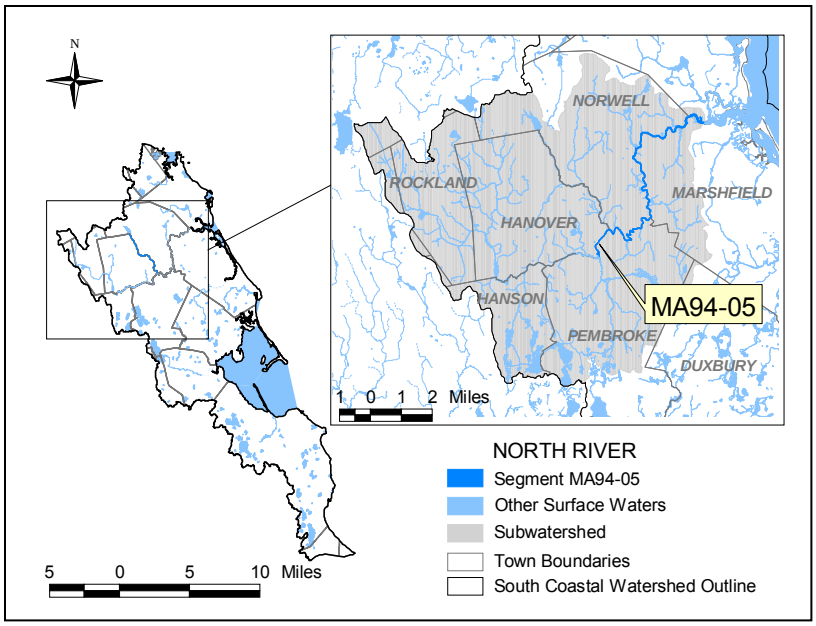
Conduct bacteria sampling to evaluate effectiveness of non-point source pollution control activities and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

NORTH RIVER (SEGMENT MA94-05)

Location: Confluence of Indian Head River and Herring Brook, Hanover/Pembroke to Route 3A (Main Street), Marshfield/Scituate.
Size: 0.30 square miles
Classification: Class SA
Outstanding Resource Water

Land-use estimates (top 3, excluding water) for the 73.7 mi^2 subwatershed (map inset, gray shaded area):

Forest..... 49%
Residential..... 31%
Open Land..... 6%



North River is listed on the 2002 Integrated List of Waters in Category 5. This segment is impaired due to pathogens and a TMDL is required (MassDEP 2003a).

The Town of Scituate was required by an Administrative Consent Order (ACO) issued by the Commonwealth of Massachusetts to meet several conditions centered on improving water quality in the North River and estuary (CEI 1998).

There is a pump-out facility at Mary's Boat Livery located on the south bank of the North River on the upstream side of Route 3A. According to the boatyard operator, this facility charges a fee for its services, although it was purchased with Clean Vessel Act funds (MA DMF 2003 and Burtner 2003).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Sources	Authorized Withdrawal (MGD)
Marshfield Water & Sewer Department**	9P42117101	42117105	4171000-14G Union St #1 4171000-15G Union St #2 4171000-16G Spring St	3.07 registered 0.23 permitted 3.29 total*
Pembroke Water Department	9P42123101	42123101	4231000-01G Hobomock 4231000-02G Center St 4231000-03G GPW #3 4231000-04G Bryantville 4231000-05G Windswept	0.99 registered 0.27 permitted 1.26 total
Abington-Rockland Joint WTP***	N/A	42125101	4001000-01S Great Sandy Bottom Pond	2.21*

*System-wide withdrawal, all sources are not necessarily within this segment.
** A wellhead protection project is underway (Appendix F, Project 01-11/WHP).
*** A project to make improvements to the water supply treatment plant system was recently funded (Appendix F, DWSRF - 1894)

Additionally, there are 436 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 3.89 MGD.

USE ASSESSMENT

AQUATIC LIFE

Toxicity Test

A 10-day static toxicity test was performed with *Ampelisca abdita (*amphipod) exposed to sediment collected on 9 July 2001 from the North River near Riverside Circle, Marshfield (MA01-0066-B), as part of the National Coastal Assessment Project (EPA 2003a). No significant toxicity was detected (EPA 2003a).

Chemistry – water

DWM conducted water quality monitoring (DO and % saturation, temperature, pH, conductivity, alkalinity, hardness, and chlorides) at three locations in this segment of the North River between June and October 2001 (Appendix A, Tables A6 and A7). From upstream to downstream these locations are as follows:

- at Route 53/139 bridge, Hanover/Pembroke (Station NR103)
- Bridge Street/Union Street bridge, Norwell/Marshfield (Station NR102), and
- from dock on southern shore upstream from Route 3A (Main Street), Marshfield (Station NR101).

One site on the river near Riverside Circle, Marshfield (MA01-0066-B), was sampled as part of the National Coastal Assessment Project on 9 July 2001 (EPA 2003b). These data are summarized below.

Dissolved oxygen and percent saturation

The DO in the North River near the Route 53/139 bridge (Station NR103) ranged from 4.8 to 7.5 mg/L with saturations between 57 and 93%. Further downstream, near the Bridge Street/Union Street bridge (Station NR102), DO ranged from 5.0 to 8.5 mg/L with saturations between 61 and 106%. The DO measurements taken in the North River upstream from the Route 3A bridge ranged from 7.5 to 10.7 mg/L with saturations between 86 and 132%. The highest DO/saturation readings represented the pre-dawn sampling event, but these conditions are considered to be likely associated with strong turbulent flows related to tidal action. The remaining data represent daytime measurements. Surface and bottom DO in the river near Riverside Circle on 9 July 2001 were 5.6 and 5.7 mg/L, respectively (EPA 2003b).

Temperature

The maximum temperature measured in this segment of the North River (26.8°C) was taken at the most upstream sampling location (Station NR103).

pH, hardness, and alkalinity

The pH of the North River was lowest at the most upstream sampling location (Station NR103) ranging from 6.5 to 6.7 SU and highest (7.5 to 7.9 SU) at the most downstream sampling location (NR101). Similarly, hardness was low at the upstream sampling location (46 to 480 mg/L) and much higher in the more saline sampling sites ranging from 3100 to 5300 mg/L. Alkalinity was also low at the upstream sampling location (high of 25 mg/L) but higher at the downstream sampling stations (up to 100 mg/L).

Conductivity

Specific conductance of the North River at the most upstream sampling location (Station NR103) ranged from 316 to 5,448 μS/cm. Further downstream specific conductance measurements were higher ranging from 12,265 to 44,243 μS/cm at Station NR102 and 44,526 to 49,449 μS/cm at Station NR101.

Ammonia-nitrogen

The ammonium-nitrogen concentration in the mid-depth sample of the river near Riverside Circle on 9 July 2001 was 0.084 mgN/L (EPA 2003b). No comparisons to instream chronic criterion for ammonia-nitrogen can be made, however, because of the lack of pH measurements at the time the sampling was conducted.

The *Aquatic Life Use* for this segment of the North River is assessed as support based on the *in-situ* water quality data and best professional judgment. Although the DO/saturations were low particularly in the upper reach of this segment, these conditions were considered to be naturally occurring as a result of the large amount of wetland area in the system (e.g., Herring Brook, Third Herring Brook).

FISH CONSUMPTION

In 2002, as the result of a public request, MassDEP sampled and analyzed fish from the Indian Head/North River in Hanover/Pembroke (downstream of the Luddums Ford Dam), which is just upstream from this segment of the North River. Two of the three samples collected were found to have elevated concentrations of mercury in the edible fish tissues (0.73 and 0.65 mg/Kg wet weight) (Appendix D, Table D4). Trace concentrations of PCB and DDT metabolites (DDD and DDE) were also detected (Appendix D, Table D4). Although the mercury concentrations were above the MDPH action level of 0.5 mg/Kg wet weight in two samples, no advisory has been issued to date. MDPH has indicated that they are in the process of reissuing the advisory for the Indian Head River and due to unrestricted fish passage may include portions or all of the North River (and possibly Herring Brook and other tributaries).

This segment of the North River is currently not assessed for the *Fish Consumption Use.* This use is identified with an Alert Status because of elevated mercury concentrations in two composite fish samples although no site-specific advisory has been issued to date.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Area MB5.2 (which contains 0.21 mi^2 of this segment) is prohibited and no recent changes to this classification status have been made (MA DFG 2000, Appendix G, Table G3 and Churchill 2005b). The remaining 0.09 mi^2 (the most upstream reach of this segment) are not designated by DMF as a shellfish growing area.

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired for 0.21 mi^2 presumably due to elevated fecal coliform bacteria and not a designated use for the remaining 0.09 mi^2 of this segment. The source(s) of bacteria are currently unknown. However, discharges from municipal separate storm sewer systems in some areas and other wet weather discharges from non-point sources as well as marina/boating sanitary on-vessel discharges are potential sources.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) at three locations in this segment of the North River between June and October 2001 (Appendix A, Table A7). The stations and fecal coliform bacteria data are summarized below.

- at Route 53/139 bridge, Hanover/Pembroke (Station NR103)
- Bridge Street/Union Street bridge, Norwell/Marshfield (Station NR102)
- from dock on southern shore upstream/west of Route 3A (Main Street) bridge, Marshfield (StationNR101).

Although no quality assured data are available, it should be noted that since 1994 NSRWA volunteers have also conducted bacteria sampling as part of their River Watch Monitoring Program on a weekly basis during the summer months. They sample at the same three stations as DWM as well as one additional station near Corn Hill Lane, Marshfield along this segment of the North River (NSRWA 2005b).

At the most upstream sampling location (Station NR103), the fecal coliform bacteria samples analyzed during the primary contact recreational season (1 April to 15 October) ranged from 160 to 790 cfu/100 ml and exceeded 200 cfu/100 ml on two of three sampling occasions. The geometric mean of all of the fecal coliform bacteria data at this station was 208 cfu/100 ml (n=4). The high bacteria counts were associated with wet weather sampling conditions. None of the fecal coliform bacteria counts exceeded 100 cfu/100 ml, however, at either of the two downstream sampling locations (Stations NR102 or NR101). Similar results were reported on the annual NSRWA River Watch Water Quality Testing Results reports between 2000 and 2004 (NSRWA 2005b).

Field observations were made by DWM personnel during the surveys conducted in the North River between June and October 2001. No objectionable conditions (odors, oils, trash/debris) were noted during any of the surveys (Stations NR103, NR102 and NR101; MassDEP 2001a). The Secchi disk depth reported for the river near Riverside Circle, Marshfield (MA01-0066-B), on 9 July 2001 was 1m (EPA 2003b). This measurement is slightly less than the recommended depth of 1.2 m.

The *Primary Contact Recreational Use* for this segment of the North River is assessed as impaired for the upper 0.02 mi^2 area because of elevated fecal coliform bacteria counts at the sampling site in the river in this area as well as in the two tributaries to this area. The *Primary Contact Recreational Use* is assessed as support in the reach of the river downstream from its confluence with Third Herring Brook (the lower 0.28 mi^2 area). Both the *Secondary Contact Recreational* and *Aesthetics* uses are assessed as support, however, for the entire area of this segment based on the fecal coliform bacteria data and the lack of aesthetically objectionable conditions.

North River (MA94-05) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT
Fish Consumption		NOT ASSESSED*
Shellfish Harvesting		Not a designated use for the upper 0.09 mi^2. IMPAIRED lower 0.21 mi^2 Cause: Elevated fecal coliform bacteria Source: Unknown (Suspected sources: Marina/boating sanitary on-vessel discharges, discharges from municipal separate storm sewer systems, and wet weather discharges from non-point sources)
Primary Contact		IMPAIRED upper 0.02 mi^2 Cause: Elevated fecal coliform bacteria Source: Unknown (Suspected sources: Discharges from municipal separate storm sewer systems) SUPPORT lower 0.28 mi^2
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

*Alert Status issues identified, see details in segment use assessment

RECOMMENDATIONS

Continue to conduct water quality monitoring including DO and % saturation to better evaluate the status of the *Aquatic Life Use* and determine the cause of low DO/%saturation. Sampling should also be conducted in Herring Brook.

Implement recommendations in the DMF shellfish management plan for Area MB5.2.

Develop a monitoring plan and conduct bacteria sampling to evaluate effectiveness of point (Phase II stormwater permits) and non-point source pollution control activities and other actions and to assess the status of the *Primary* and *Secondary Contact Recreational* uses. An additional sampling location is recommended between the Route 53/139 bridge, Hanover/Pembroke (Station NR103) and the Bridge Street/Union Street bridge, Norwell/Marshfield (Station NR102) to better define the area of the river potentially impacted by elevated bacteria.

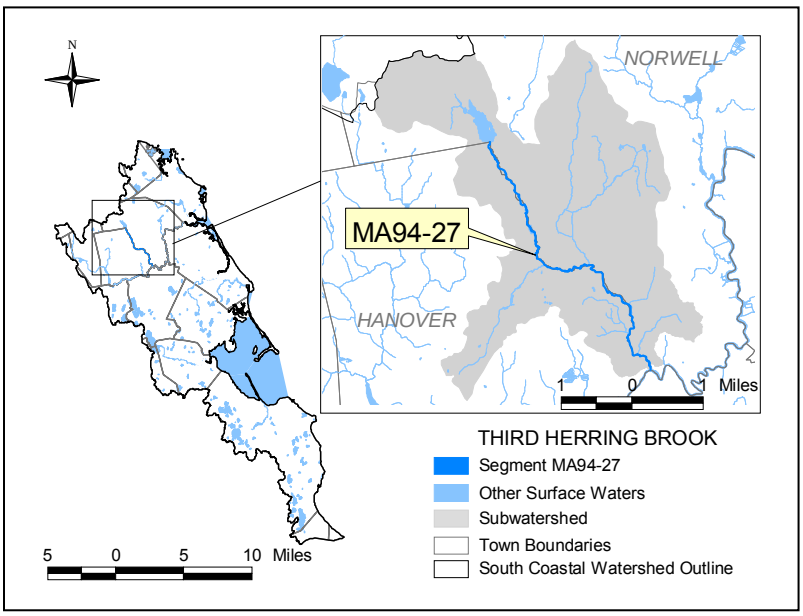
Support efforts of the Hanover Stream Team/NSRWA in their efforts to identify sources of contamination in the upper portion of this segment of the North River.

Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Collect and analyze estuarine and diadromous fishes from the North River to determine if mercury related to the Fireworks Site and the Indian Head River is impacting resident and migratory fishes.

THIRD HERRING BROOK (SEGMENT MA94-27)

Location: Headwaters, outlet Jacobs Pond, Norwell/Hanover to confluence with North River, Norwell/Hanover.
Size: 5.3 miles
Classification: Class B*
*Note: * indicates that a portion of this waterbody (wetlands contiguous with the North River wetlands) is an ORW under the North River Protective Order.*



Land-use estimates (top 3, excluding water) for the 10.8 mi^2 subwatershed (map inset, gray shaded area):

- Forest..... 57%
- Residential..... 27%
- Commercial..... 5%

Third Herring Brook was not evaluated as a segment in MassDEP's 2002 Integrated List of Waters.

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Sources	Authorized Withdrawal (MGD)
Hanover Water Department	9P342112201	42112202	4122000-01G #1 Pond St 4122000-05G #2 Pond St 4122000-08G #3 Pond St	1.27 registered 0.11 permitted 1.38 total*
Norwell Water Department**	9P42121901	42121902	4219000-01G Well 1 4219000-04G Well 4 4219000-06G Well 6 4219000-08G Well 7 4219000-09G Well 8 4219000-10G Well 9 4219000-12G Well 11	0.68 registered 0.4 permitted 1.08 total*

*System-wide withdrawal, all sources are not necessarily in this segment.
** A project to make improvements to the water supply was recently funded (Appendix F, DWSRF - 1697)

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX E, TABLE E2)

The Pond Street Water Treatment plant in Hanover is authorized to discharge filter backwash water to Old Pond Meadow to Third Herring Brook (MAG640043). This facility has two cement-lined lagoons to collect backwash water and usually only discharges when the lagoons are full and the sludge has settled (Billings 2005). The facility was required to monitor whole effluent toxicity tests as part of their general permit. Two tests were conducted (July 2001 and 2002) that indicated chronic toxicity and elevated concentrations of both aluminum and total residual chlorine. However, alterations to normal operating procedures to collect 24-hour composites resulted in test results that were non-representative of typical operations. Actual discharge duration and volume are currently unknown.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

In-stream habitat in Third Herring Brook near Tiffany Road/East Street, Norwell/Hanover (Station THB-C), was comprised primarily of runs with limited riffle area. The brook was channelized in the upper half of the stream reach sampled (SaintOurs 2000).

Smelt spawning habitat in Third Herring Brook includes the area downstream from River Street to the tidal zone (approximately 345m). The brook provided excellent spawning habitat – the channel provided a series of high quality riffles and pools, there were no passage impediments, the riparian

buffer was undisturbed and provided good canopy cover (Chase in preparation). An additional 200 m reach of the brook, although not being utilized in 1994/1995, was also identified as potential spawning habitat.

Biology

Although no RBP III analysis was conducted, relatively low macroinvertebrate abundance was documented in the brook near Tiffany Road (SaintOurs 2000). Smelt, adult lamprey, blueback herring and alewives were observed in Third Herring Brook in 1994 and/or 1995 (Chase in preparation). Benthic macroinvertebrate sampling was also conducted in Third Herring Brook near Tiffany Road/East Street, Norwell/Hanover (Station THB-C), in May 2000 (SaintOurs 2005).

Chemistry – water

In 2001 DWM conducted water quality sampling at one station (TH101) on Third Herring Brook at the Tiffany Road/East Street crossing, Norwell/Hanover (Appendix A). *In-situ* measurements of DO, % DO saturation, temperature, pH, conductivity, and TDS were recorded on seven occasions from June to October. Samples were collected on four occasions for total phosphorus, ammonia-nitrogen, nitrate-nitrite nitrogen, chloride, alkalinity, and hardness with one additional sampling event for the nutrients. The results are summarized below.

Dissolved oxygen and percent saturation

DO measurements ranged from 4.1 to 6.1 mg/L with the percent saturation ranging from 46 to 64%. These data represent both daytime and pre-dawn sampling events. Given the large wetland system upstream from the sampling reach, these conditions are considered to be naturally occurring.

Temperature

The maximum temperature was 22.5ºC.

pH, hardness, and alkalinity

The pH of Third Herring Brook was low ranging from 5.7 to 6.3 SU (n=7). Hardness ranged from 34 to 52 mg/L while alkalinity ranged from 8 to 20 mg/L. (n=4).

Conductivity

Specific conductance ranged from 293 to 369 µS/cm (n=7).

Ammonia-nitrogen

The concentration of ammonia-nitrogen in Third Herring Brook was low ranging from below detection to 0.13 mg/L (exclusive of qualified data).

Total phosphorus

The total phosphorus concentrations measured in samples collected from Third Herring Brook ranged from 0.040 to 0.062 mg/L (n=5 with an average concentration = 0.05 mg/L).

The *Aquatic Life Use* for Third Herring Brook is assessed as support based primarily on the *in-situ* water quality data, the excellent condition of spawning habitat and best professional judgment. Although DO, DO saturation and pH measurements were low, these conditions are considered to be naturally occurring.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) in Third Herring Brook at the Tiffany Road/East Street crossing, Norwell/Hanover (Station TH101), between July and October 2001 (Appendix A, Table A7). The three fecal coliform bacteria samples collected during the primary contact recreational season (1 April to 15 October) ranged from 410 to 730 cfu/100 ml. The geometric mean of all four fecal coliform bacteria counts was 309 cfu/100 ml.

With the exception of a metal cable from a fence noted during one of the surveys, no other objectionable odors, deposits or any other conditions were observed by DWM personnel near the Tiffany Road/East Street crossing, Norwell/Hanover (Station TH101), during the surveys conducted in Third Herring Brook between June and October 2001 (MassDEP 2001a).

The *Primary Contact Recreational Use* for Third Herring Brook is assessed as impaired because of elevated fecal coliform bacteria counts. Although the source(s) are currently unknown, elevated counts

were found during both dry and wet weather sampling conditions. Suspected sources include discharges from municipal separate storm sewer systems. Both the *Secondary Contact Recreational* and *Aesthetic* uses are assessed as support, however, based on the limited fecal coliform bacteria data and the lack of aesthetically objectionable conditions.

Third Herring Brook (MA94-27) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT
Fish Consumption		NOT ASSESSED
Primary Contact		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Unknown (Suspected Source: Discharges from municipal separate storm sewer systems)
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

RECOMMENDATIONS

Conduct monitoring (biological, habitat and water quality) to evaluate impacts to Third Herring Brook from potential sources of pollution (e.g., point source discharge, developments), and to better assess the status of the *Aquatic Life Use*.

Conduct bacteria sampling to evaluate effectiveness of non-point source pollution control activities and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Hanover's Pond Street WTP permit (MAG640043) should be reissued with appropriate limits and monitoring requirements. Issues to be addressed include determining frequency and duration of discharge, appropriate sampling to evaluate whole effluent toxicity, and determining whether TRC and Al limits are necessary to protect the receiving stream.

Support the following actions identified by DMF to study/protect/remediate smelt spawning habitat (Chase in preparation).

The smelt spawning habitat in Third Herring Brook is one of the few in Massachusetts that is found in a near natural state. Development of the watershed area should be carefully planned to protect the aquatic life/habitat and minimize any impact to the brook.

SECOND HERRING BROOK (SEGMENT MA94-26)

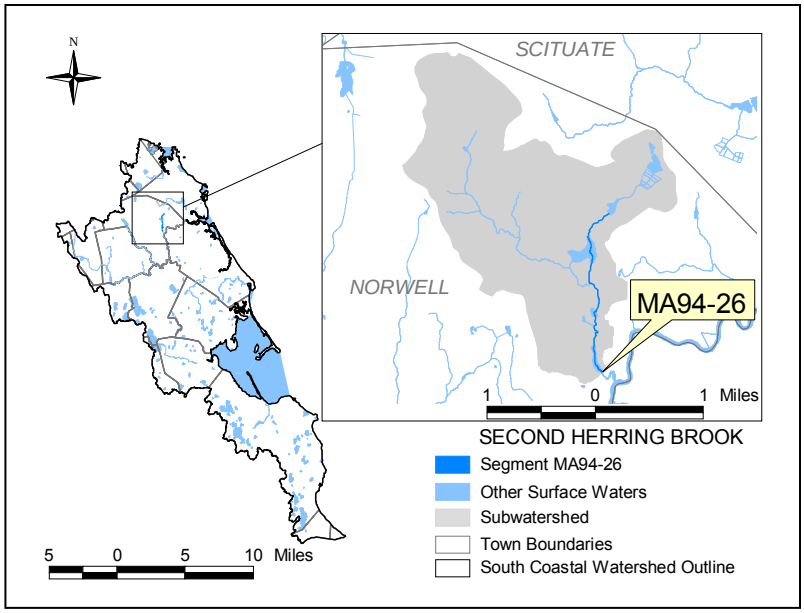
Location: Outlet of Turner Pond, Norwell (through Torrey Pond) to the Second Herring Brook Pond Dam, Norwell.
Size: 1.7 miles
Classification: Class B

Land-use estimates (top 3, excluding water) for the 3.6 mi^2 subwatershed (map inset, gray shaded area):

Forest..... 60%
Residential..... 28%
Open Land..... 5%

Second Herring Brook Pond Dam is also referred to as the Gordon Pond Dam (Reback *et al.* 2004).

Second Herring Brook was not evaluated as a segment in MassDEP's 2002 Integrated List of Waters.



MDFW sampled fish population assemblages at two stations (#470 and #471) on an unnamed tributary to Second Herring Brook in Norwell. One species of fish, redfin pickerel (n=28), was collected in the headwaters of the unnamed tributary, downstream from Mt. Blue Street (Station #470). Four species of fish, including 16 yellow perch, 15 redfin pickerel, 14 American eel, and 1 brown bullhead were collected from the unnamed tributary upstream from Central Street (Station 471).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

There are no Water Management Act withdrawals or NPDES permitted discharges in this segment. However, there are 48 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 0.43 MGD.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

The habitat in the brook upstream from the Route 123 Bridge station was considered excellent with a habitat assessment score of 154 out of 200 (MassDEP 2001b). Habitat was limited most by the low flow conditions that were encountered and the limited channel sinuosity.

Biology

MDFW and DWM sampled the fish population assemblage in Second Herring Brook, upstream from the Route 123 Bridge station (#472) in September 2001 (Richards 2003). Sampling at this station yielded seven species of fish. In order of abundance, these species were 48 American eel (*Anguilla rostrata*), 16 redfin pickerel (*Esox americanus americanus*), 3 pumpkinseed (*Lepomis gibbosus*), 2 brown trout (*Salmo trutta*), 1 brown bullhead (*Ameiurus nebulosus*), 1 chain pickerel (*Esox niger*), and 1 largemouth bass (*Micropterus salmoides*). With the exception of the two brown trout, which were stocked fish, the community was comprised primarily of macrohabitat generalists. Redfin pickerel are moderately tolerant to water quality degradation but are considered by DWM biologists to be tolerant to habitat degradation. The individual largemouth bass, bullhead, chain pickerel and the pumpkinseeds most likely originated from the pond upstream. The absence of fluvial or other native intolerant species should be noted. The abundance of American eel is associated with the stream's close proximity to the ocean. Benthic macroinvertebrate sampling was also conducted in Second Herring Brook downstream from the old mill dam in the Norris Reservation, Norwell (Station SHB-C), in May 2000 (SaintOurs 2005). Although no RBP III analysis was conducted, the benthic community was described as being diverse and comprised of numerous EPT taxa (SaintOurs 2000). These observations are typically indicative of good water quality.

Chemistry – water

In 2001 DWM conducted water quality sampling at one station (SH101) on Second Herring Brook at the Route 123 (Main Street) crossing, Norwell (Appendix A, Tables A6 and A7). *In-situ* measurements of DO, % DO saturation, temperature, pH, conductivity, and TDS, as well as water quality sampling (total phosphorus, ammonia-nitrogen, nitrate-nitrite nitrogen, chloride, alkalinity, and hardness) were recorded/collected on up to seven occasions from June to October. The results are summarized below.

Dissolved oxygen and percent saturation

DO ranged from 7.0 to 8.6 mg/L with saturations ranging from 82 to 91%.

Temperature

The maximum temperature recorded was 25.6ºC.

pH, hardness, and alkalinity

The pH of Second Herring Brook was slightly low ranging from 6.3 to 6.5 SU (n=7). Hardness ranged from 25 to 29 mg/L while alkalinity ranged from 7 to 9 mg/L (n=4).

Conductivity

Specific conductance ranged from 197 to 245 µS/cm (n=7).

Ammonia-nitrogen

No detectable concentrations of ammonia-nitrogen (exclusive of qualified data) were found in this segment of Second Herring Brook.

Total phosphorus

The total phosphorus concentrations measured in samples collected from Second Herring Brook ranged from 0.028 to 0.072 mg/L (n=5 with an average concentration = 0.05 mg/L).

The *Aquatic Life Use* for Second Herring Brook is assessed as support based primarily on the *in-situ* water quality data and best professional judgment. Although pH and alkalinity were low, these conditions are considered to be naturally occurring.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) in Second Herring Brook at Route 123 (Main Street) crossing, Norwell (Station SH101), between July and October 2001 (Appendix A, Table A7). The three fecal coliform bacteria samples collected during the primary contact recreational season (1 April to 15 October) ranged from 37 to 70 cfu/100 ml. The geometric mean of all four fecal coliform bacteria counts was 53 cfu/100 ml. (It should be noted that *Enterococcus* counts were elevated.)

No objectionable odors, deposits or any other conditions were observed by DWM personnel near the Route 123 (Main Street) crossing, Norwell (Station SH101), during the surveys conducted in Second Herring Brook between June and October 2001 (MassDEP 2001a).

The *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses for Second Herring Brook are assessed as support based on the limited fecal coliform bacteria data and the lack of aesthetically objectionable conditions.

Second Herring Brook (MA94-26) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT
Fish Consumption		NOT ASSESSED
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

RECOMMENDATIONS

Continue to conduct bacteria sampling to evaluate effectiveness of non-point source pollution control activities and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

SECOND HERRING BROOK (SEGMENT MA94-31)

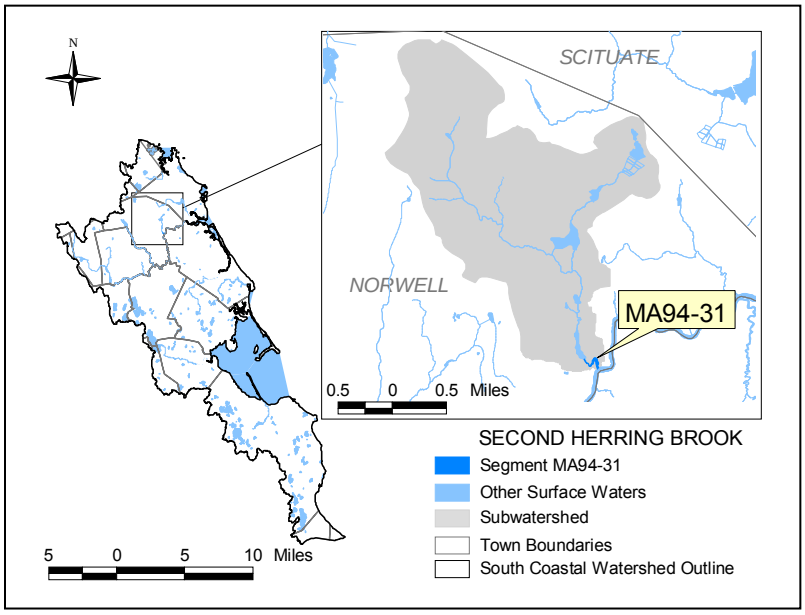
Location: From the Second Herring Brook Pond Dam, Norwell to the confluence with the North River, Norwell.
Size: 0.003 square miles
Classification: Class SA, Outstanding Resource Water

Land-use estimates (top 3, excluding water) for the 3.7 mi^2 subwatershed (map inset, gray shaded area):

Forest..... 60%
Residential..... 28%
Open Land..... 5%

Second Herring Brook Pond Dam is also referred to as the Gordon Pond Dam (Reback *et al.* 2004).

Second Herring Brook was not evaluated as a segment in MassDEP's 2002 Integrated List of Waters.



WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

There are no Water Management Act withdrawals or NPDES permitted discharges in this segment.

However, there are 48 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 0.43 MGD. This cranberry acreage is entirely within the subwatershed for Segment MA94-26, which is the upper portion of this subwatershed.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Smelt spawning habitat in Second Herring Brook includes the area downstream from the dam (locally known as the Gordon Pond dam) to the tidal zone near a wooden walk-bridge (approximately 205 m). The spawning area was well shaded and the riparian buffer was very good. However, rapidly decreasing flows during the spawning season resulted in exposure of substrate. Substrate degradation from increased growth of periphyton also corresponded to lower flow conditions. There are three widely spaced outlets at the dam that cause the flows over the spawning habitat to spread widely over a poorly-defined braided channel which provides good spawning habitat until flows decline. Low water depth in April 1995 also resulted in mortality to adult smelt because of stranding (Chase in preparation).

Biology

Both smelt and blueback herring eggs were observed in Second Herring Brook in 1994 and 1995 (Chase in preparation).

Water chemistry

Although no *in-situ* measurements or water quality samples were collected directly from this segment of Second Herring Brook, measurements taken from the river near Route 123 (Main Street) crossing, Norwell (just upstream from this segment of Second Herring Brook), indicated good water quality conditions (i.e., DO/ saturation), and while pH and alkalinity were low, these conditions are considered to be naturally occurring. *In-situ* measurements taken in the North River at Bridge/Union Street (near the confluence with Second Herring Brook) were also indicative of good water quality conditions (Appendix A, Table A6).

The *Aquatic Life Use* for this segment of Second Herring Brook is assessed as support based on the *in-situ* data collected both upstream and downstream from this segment and best professional judgment. This use is identified with an Alert Status, however, because the three widely-spaced outlets at the dam at Gordon Pond cause flows over the spawning habitat to spread widely over a poorly-defined channel and when flows decrease, otherwise good spawning habitat is lost.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Area MB5.2 (which includes this segment) is prohibited and no recent changes to this classification status have been made (MA DFG 2000; Appendix G, Table G3; and Churchill 2005b).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired for this segment. It is presumed that this closure is because of elevated bacteria counts. Although the source(s) of bacteria are currently unknown, discharges from municipal separate storm sewers are suspected.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

Although no bacteria samples were collected from this segment of Second Herring Brook, none of the four bacteria samples collected from the river near Route 123 (Main Street) crossing, Norwell (just upstream from this segment of Second Herring Brook), exceeded 70 cfu/100 ml. Additionally, none of the samples collected from the North River at Bridge/Union Street (near the confluence with Second Herring Brook) exceeded 100 cfu/100mls (Appendix A, Table A7). No objectionable odors, deposits or any other conditions were noted at either of these sampling locations either (MassDEP 2001a).

The *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses for this segment of Second Herring Brook are assessed as support based on the limited fecal coliform bacteria data collected both upstream and downstream from this segment and the lack of aesthetically objectionable conditions.

Second Herring Brook (MA94-31) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT*
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Unknown (Suspected Source: Discharges from municipal separate storm sewer systems)
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

* Alert Status issues identified, see details in use assessment

RECOMMENDATIONS
Implement recommendations in the DMF shellfish management plan for Area MB5.2.

Develop a monitoring plan and conduct bacteria sampling to evaluate effectiveness of point (Phase II stormwater permits) and non-point source pollution control activities and other actions and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

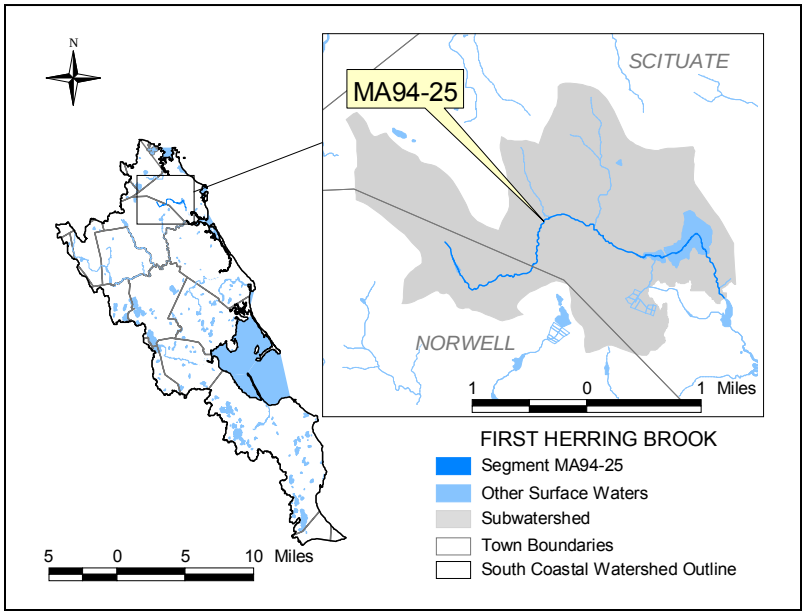
Support the following actions identified by DMF to study/protect/remediate smelt spawning habitat (Chase in preparation).

Evaluate options (e.g., dam removal, fishway, grooming cobble/boulder substrates in braided section into a more clearly defined channel) over Second Herring Brook Pond (Gordon Pond) dam to improve smelt spawning habitat and allow fish (river herring) passage.

There is a triple pipe culvert under a private bridge that should be replaced with a properly designed box culvert to eliminate low flow passage constraints, better distribute egg deposition and create new spawning substrate inside the culvert.

FIRST HERRING BROOK (SEGMENT MA94-25)

Location: From the headwaters in South Swamp, Norwell, (through Tack Factory Pond) to the inlet of Old Oaken Bucket Pond, Scituate.
Size: 3.9 miles
Classification: Class A, Outstanding Resource Water



First Herring Brook is a tributary to Old Oaken Bucket Pond, which is a Public Water Supply.

Land-use estimates (top 3, excluding water) for the 4.2 mi^2 subwatershed (map inset, gray shaded area):

- Forest..... 55%
- Residential..... 32%
- Open Land..... 6%

First Herring Brook was not evaluated as a segment in MassDEP's 2002 Integrated List of Waters.

The Town of Scituate was required by an Administrative Consent Order (ACO) issued by the Commonwealth of Massachusetts to meet several conditions centered on improving water quality in the North River and estuary (CEI 1998). One of the areas included in the plan was First Herring Brook, since the DMF Sanitary Survey concluded that stormwater adversely impacted water quality in the North River near the Herring River. The plan recommended developing and implementing best management practices (BMPs) to control stormwater runoff in the Herring River subwatershed (CEI 1998). A project to control non-point source pollution in First Herring Brook was funded and implemented between 1998 and 2001 (Appendix F, Project 98-08/319 and CPR Grant Projects in Scituate). Infiltration best management practices (BMPs) were installed to remediate the direct discharge of stormwater into the brook (Scituate DPW and CEI undated). Pre- and post-construction sampling was required for this project, but these data have not yet been reported to MassDEP. Additional BMPs will also be implemented (Appendix F, Project 2005-09/319).

"The First Herring Brook Watershed Initiative (FHBWI) is a Scituate-based citizen group affiliated with the nonprofit North and South Rivers Watershed Association and Maxwell Conservation Trust (FHBWI 2004). FHBWI has recently worked with Comprehensive Environmental Incorporated to create a *First Herring Brook Watershed Report* and members participated in the creation of the *2004 Water Study Committee Report* for the Town of Scituate. Additionally, members of FHBWI performed stream surveys using the Adopt-A-Stream Shoreline Survey assessment tool developed by the Riverways Program (Appendix F, Project 00-07/SWT and FHBWI undated). *A Surface Water Supply Protection Plan* has also recently been developed for Old Oaken Bucket Pond, The Reservoir and Tack Factory Pond (CEI 2003 and Appendix G, Project 00-14/SWT). An additional project to encourage low impact development BMPs on residential properties is currently ongoing (Appendix F, Project 00-17/319).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Sources	Authorized Withdrawal (MGD)
Scituate DPW Water Division	9P442126402	42126401	4264000-03G Well 17 4264000-05G Well 19 4264000-11G Well 22	1.49 registered 0.24 permitted 1.73 total*

*System-wide withdrawal, all sources are not necessarily within this segment.

There are also approximately 45 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 0.40 MGD.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

The habitat in the upper reach of First Herring Brook, downstream from First Parish Road in Scituate, was limited most by the low flow conditions that were encountered with a habitat assessment score of 134 out of 200 (MassDEP 2001b).

Stage height and streamflow data for First Herring Brook near both Old Forge Road and Eisenhower Lane are available as part of the Massachusetts Riverways Programs pilot River Instream Flow Stewards (RIFLS) project (MA DFG 2005). Both gages were found to have very low flows during the summer months. While these conditions may be natural given the very small size of the drainage area, the influence of groundwater withdrawals on streamflow and other manipulation(s) associated with the Scituate DPW Water Division is unknown at this time but is of concern (Kearns 2006).

Biology

MDFW and DWM conducted backpack electrofishing in First Herring Brook in September 2001 (near the headwaters of this segment) approximately 100 meters downstream from the small impoundment south of First Parish Road in Scituate (Station #473) (Richards 2003). Sampling at this station yielded two species of fish, 13 American eel (*Anguilla rostrata*) and three redfin pickerel (*Esox americanus americanus*). Both of these species are classified as tolerant of environmental stressors. American eel is a catadromous species, which spawns in the ocean but spends the majority of its life in freshwater systems. Given the small drainage area at this sampling station and the low gradient of this system, it is not unexpected to find low species diversity. The lack of any fluvial species, however, should be noted.

Chemistry – water

DWM conducted water quality monitoring (DO and % saturation, temperature, pH, conductivity, alkalinity, hardness, chlorides, nitrate-nitrite nitrogen nitrogen, ammonia nitrogen and/or total phosphorus) in First Herring Brook at the outlet of Tack Factory Pond near Route 3A, Scituate (Station FH101) between June and October 2001 (Appendix A, Tables A6 and A7). These data are summarized below.

Dissolved oxygen and percent saturation

The DO ranged from 4.3 to 8.4 mg/L with saturations between 47 and 82%. These data represent both daytime and pre-dawn measurements.

Temperature

The maximum temperature in First Herring Brook was 28.0°C.

pH, hardness, and alkalinity

The pH of First Herring Brook was low ranging from 5.6 to 6.1 SU (n=7). Hardness was also low ranging from 24 to 32 mg/L as was alkalinity 5 to 7 mg/L (n=4).

Conductivity

Specific conductance ranged from 183 to 218 µS/cm (n=7).

Ammonia-nitrogen

No detectable concentrations of ammonia-nitrogen (exclusive of qualified data) were found in First Herring Brook.

Total phosphorus

The total phosphorus concentrations measured in samples collected from First Herring Brook ranged from 0.046 to 0.069 mg/L (n=5 with an average concentration = 0.06 mg/L).

The *Aquatic Life Use* for First Herring Brook is assessed as support based primarily on the *in-situ* water quality data. Although low dissolved oxygen and/or saturation, low pH, and moderate concentrations of total phosphorus were documented, these conditions are considered to be naturally occurring as a result of wetland influence. The influence of groundwater withdrawals on streamflow and the Scituate DPW Water Division's practices related to flow manipulation at the reservoir just downstream from Tack Factory Pond to Old Oaken Bucket Pond are of concern so the *Aquatic Life Use* is identified with an Alert Status.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

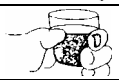
DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) in First Herring Brook at the outlet of Tack Factory Pond near Route 3A, Scituate (Station FH101), between July and October 2001 (Appendix A, Table A7). The three fecal coliform bacteria samples collected during the primary contact recreational season (1 April to 15 October) ranged from 25 to 410 cfu/100 ml (geometric mean = 104 cfu/100 ml) and only one of the three samples exceeded 200 cfu/100 ml. The geometric mean of all four fecal coliform bacteria counts was 53 cfu/100 ml.

With the exception of a small amount of algal and foam near the outlet structure on two occasions, no other objectionable odors, deposits or any other conditions were observed by DWM personnel at the outlet of Tack Factory Pond near Route 3A, Scituate (Station FH101), between July and October 2001 (MassDEP 2001a).

In December 2000 a shoreline survey of First Herring Brook was conducted as part of the First Herring Brook Watershed Initiative (FHBWI undated). No objectionable deposits, odors, scum or obvious signs of pollution were observed during the survey. The stream was described as flowing well with good clarity and aquatic habitat and well-vegetated banks.

The *Primary* and *Secondary Contact Recreational* and *Aesthetic* uses are assessed as support for First Herring Brook based on the limited fecal coliform bacteria data and the lack of aesthetically objectionable conditions.

First Herring Brook (MA94-25) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT*
Fish Consumption		NOT ASSESSED
Drinking Water		The MassDEP Drinking Water Program maintains current drinking water supply data.
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

*Alert Status issues identified, see details in use assessment.

RECOMMENDATIONS

Continue to conduct bacteria sampling to evaluate effectiveness of non-point source pollution control activities and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Evaluate potential inputs (e.g., development, cranberry bog operation, etc.) of nutrients (particularly total phosphorus) into this segment of First Herring Brook, as well as into Old Oaken Bucket Pond. Somewhat higher concentrations of total phosphorus were documented in Old Oaken Bucket Pond than at the outlet of Tack Factory Pond. It should be noted that flow to the stream draining the cranberry bog, south of Tack Factory Pond, has been altered by a concrete flow control structure, which diverts flow to a tributary of Old Oaken Bucket Pond (DeCesare 2005).

Support efforts of the Town of Scituate and the First Herring Brook Watershed Initiative (FHBWI) to protect this resource.

RECOMMENDATIONS CONTINUED

Investigate the influence of groundwater withdrawals on streamflow in the brook, particularly upstream from Tack Factory Pond.

Review Scituate DPW Water Division's practices related to flow manipulation at the reservoir just downstream from Tack Factory Pond to Old Oaken Bucket Pond. Minimize flow manipulation to the extent possible so that a natural flow regime in the brook is maintained.

Review pre- and post-construction monitoring data to evaluate effectiveness of BMPs installed to prevent stormwater runoff pollution into the brook (Scituate DPW and CEI undated).

Implement recommendations in the Source Water Assessment and Protection Report (SWAP) to protect Scituate's drinking water supply (MassDEP 2003e).

HERRING RIVER (SEGMENT MA94-07)

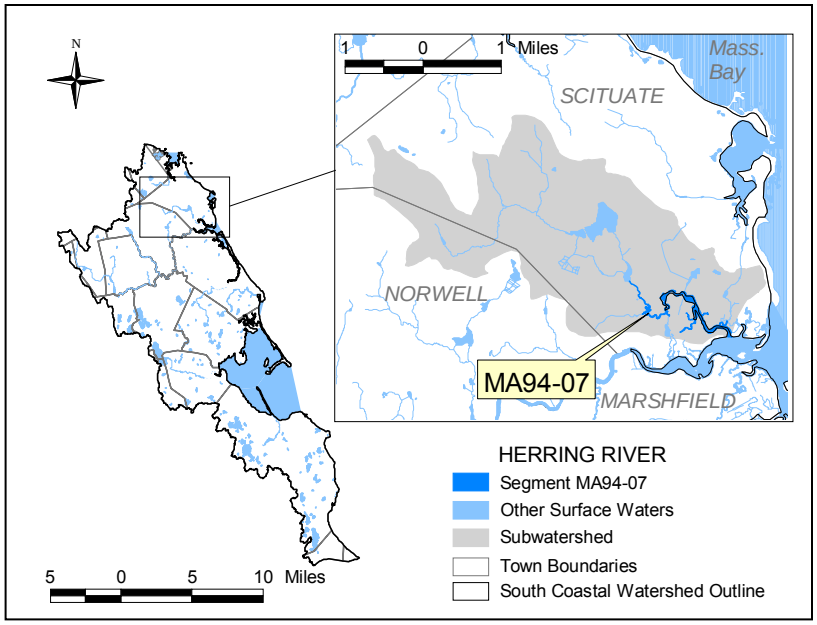
Location: Outlet Old Oaken Bucket Pond, Scituate to confluence with North River, Scituate.
Size: 0.08 square miles
Classification: Class SA

Land-use estimates (top 3, excluding water) for the 6.9 mi^2 subwatershed (map inset, gray shaded area):

Forest..... 44%
Residential..... 30%
Open Land..... 11%

Herring River is listed on the 2002 Integrated List of Waters in Category 5. This segment is impaired due to pathogens and a TMDL is required (MassDEP 2003a).

The Town of Scituate landfill located within 100 yards of Herring River was capped in 1999; this has lead to a marked decrease in the number of waterfowl in the area (Churchill 2003b).



The Town of Scituate was required by an Administrative Consent Order (ACO) issued by the Commonwealth of Massachusetts to meet several conditions centered on improving water quality in the North River and estuary (CEI 1998). One of the areas included in the plan was First Herring Brook since the DMF Sanitary Survey concluded that stormwater adversely impacted water quality in the North River near the Herring River. The plan recommended developing and implementing best management practices (BMPs) to control stormwater runoff in the Herring River subwatershed (CEI 1998).

A pumpout facility is located at the James Landing Marina on First Herring Brook off the Driftway (MA DMF 2003 and Burtner 2003).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Sources	Authorized Withdrawal (MGD)
Scituate DPW Water Division	9P442126402	42126401	4264000-01G Well 10 4264000-02G Well 11 4264000-12G Well 18B 4264000-01S Old Oaken Bucket	1.49 registered 0.24 permitted 1.73 total*
Widows Walk Golf Course	9P442126401	N/A	Kent Street well	0.09

*System-wide withdrawal, all sources are not necessarily within this segment.

Additionally, there are 48 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 0.43 MGD.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX E, TABLE E1)

The Scituate Water Department was authorized (MAG640042) to discharge from their water treatment plant, however no discharge has been occurring (wastewater is collected and taken off-site to wastewater treatment plant) and EPA terminated the permit in 2003. The area is currently being sewered so the lagoons will soon be abandoned and replaced with tanks with flow equalization, which will be tied into the WWTP (Keohane 2005a).

The Town of Scituate is authorized (MA0102695 issued in November 2004 but currently under appeal) to discharge from the Scituate Wastewater Treatment Plant (WWTP) (formerly improperly permitted as a groundwater discharge) 1.6 MGD (average monthly) of treated effluent disinfected using UV light via Outfall #001 to a tidal creek tributary that flows into the Herring River. In 2000 the Town of Scituate's WWTP was upgraded. This extended aeration facility performs nitrification for ammonia-nitrogen reduction and denitrification for total nitrogen reduction. Submerged anaerobic deep bed filters with methanol addition accomplish the denitrification process (Rowland 2004). The new total nitrogen limit (monthly average) is 4.0 mg/l using a 12-month moving average. The ammonia-nitrogen concentrations in the effluent between February 2000 and August 2004 ranged from <0.10 to 3.1 mg/L (n=19)(TOXTD database). The pH (permit limits 6.5 to 8.5 SU) of the effluent between February 2000 and August 2004 ranged from 6.3 to 7.6 SU (n=20) (only one measurement was < 6.5 SU). Since August 2000 the TRC measurements were all <0.05 mg/L (n=16)(TOXTD database). The facility's whole effluent toxicity testing limits are $LC_{50} \geq 100$ and C-NOEC $\geq$100% effluent (although the prior permit required monitoring only for chronic toxicity) using *Mysidopsis bahia* (acute testing) and *Menedia beryllina* (modified acute and chronic testing) on a quarterly basis.

OTHER

According to the Water Quality Certification variance, stormwater runoff from the Greenbush Commuter Rail Restoration Project will be directed to the Herring River from the train layover facility and parking facility at the Greenbush railroad station. Street sweeping, deep-sump hooded catch basins and the Downstream Defenders treatment units are proposed for water quality treatment (MassDEP 2004b).

Water quality in the Old Stockbridge Grist Mill channel that drains into the Herring River appears to be compromised by unknown dry weather discharges as well as a lack of flow (stagnation) (Chase in preparation).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Smelt spawning habitat in the Herring River includes the area downstream from the Old Oaken Bucket Pond dam to the tidal zone upstream from the New Driftway bridge (approximately 190m). Although the primary spawning riffle has very good physical features to support high densities of smelt eggs, several stressors that affect the smelt spawning habitat were identified by DMF biologists. These included low flows, algal growth that may also be exacerbated by flow manipulation, and the disturbed riparian buffer zone adjacent to the smelt spawning habitat (Chase in preparation).

Biology

The once numerous alewife run has apparently declined to low levels (Chase in preparation).

Toxicity

Effluent

A total of 17 whole effluent toxicity tests were conducted on the Scituate WWTP effluent (Outfall #001) between February 2000 and August 2004. The LC_{50}s were all >100% effluent for both test species with the exception of one *M. bahia* test (May 2000, LC_{50} = 91.4% effluent). The C-NOEC *M. beryllina* results ranged from <6.25 to 100% (n=16 valid tests) although the C-NOEC was 100% in 12 of these test events. Prior to November 2004 the facility was only required to monitor for chronic toxicity so there were no violations of the permit. During that time period, three tests that exhibited chronic toxicity did not exhibit a good dose-response relationship. Growth was significantly different in only the 6.25% test concentration in two tests (March 2001 and May 2002) while in the August 2004 test the CNOEC was 25% because of increased growth of the test organisms. The CNOEC of the November 2002 test was 50% effluent.

No in-stream water quality data are available so the *Aquatic Life Use* is not assessed for the Herring River. This use is identified with an Alert Status, however, because of low flows, algal growth that may also be exacerbated by flow manipulation, the disturbed riparian buffer zone adjacent to the smelt spawning habitat and the apparent decline of the once numerous alewife run.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Area MB5.3 (which contains this entire segment) is prohibited (MA DFG 2000 and Appendix G, Table G3).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired because of elevated bacteria counts. The sources include the WWTP discharge although the marina and stormwater may also contribute to the bacteria problem.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

Although no quality assured data are available, it should be noted that since 1994 NSRWA volunteers have conducted bacteria sampling as part of their River Watch Monitoring Program on a weekly basis during the summer months. They sample at the James Landing Marina, Scituate along this segment of the Herring River (NSRWA 2005b).

No objectionable conditions have been observed by DWM biologists in the Herring River (DeCesare 2005).

The *Primary* and *Secondary Contact Recreational* are not assessed for the Herring River, however, the *Aesthetics Use* is assessed as support based on the lack of aesthetically objectionable conditions.

Herring River (MA94-07) Use Summary Table

Designated Uses		Status
Aquatic Life		NOT ASSESSED*
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Municipal point source discharge (Suspected source: Discharges from municipal separate storm sewer systems, and marina)
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		SUPPORT

*Alert Status issues identified, see details in use assessment

RECOMMENDATIONS

Implement recommendations in the DMF shellfish management plan for Area MB5.3.

Develop a monitoring plan and conduct bacteria sampling to evaluate effectiveness of point (Phase II stormwater permits) and non-point source pollution control activities and other actions and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Continue to monitor and review whole effluent toxicity data for the Town of Scituate WWTP (MA0102695).

Work with NSRWA to implement a quality assurance component for their water quality monitoring program.

RECOMMENDATIONS CONTINUED

Support the following actions identified by DMF to study/protect/remediate smelt spawning habitat (Chase in preparation).

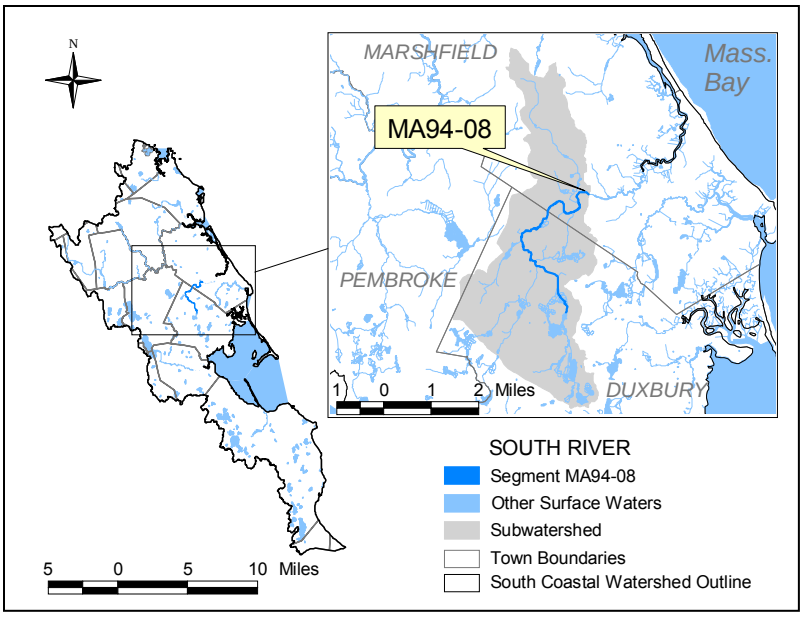
Work with the town of Scituate (DPW) to develop water supply management practices that would provide sufficient flows to protect anadromous fish spawning habitat in the Herring River.

Restoration of the riparian buffer zones along both banks of the Herring River adjacent to the smelt spawning habitat should be undertaken. This would include removing an area infested with the non-native Japanese bamboo. Improvements would result in bank stabilization and shading of smelt spawning habitat.

Water quality in the Old Stockbridge Grist Mill channel that drains into the Herring River directly into the smelt spawning habitat area appears to be compromised by unknown discharges and lack of flow. These conditions need to be investigated and corrected if necessary.

SOUTH RIVER (SEGMENT MA94-08)

Location: Headwaters from the outlet of unnamed pond north of Congress Street, Duxbury to dam at Main Street (Route 3A), Marshfield.
Segment Length: 4.9 miles
Classification: Class B (It should be noted that the South River is currently listed in the SWQS as a Class SA/SFO/ORW for the entire length (which would make this a 0.007 square mile segment) but the corrected classification in the proposed revisions of the SWQS identifies this as a Class B, Warm Water Fishery, ORW.)



Land-use estimates (top 3, excluding water) for the 11.4 mi^2 subwatershed (map inset, gray shaded area):

Forest..... 55%
Residential..... 27%
Open Land..... 8%

South River is listed on the 2002 Integrated List of Waters in Category 3. This segment had insufficient information to make assessments for any of the designated uses (MassDEP 2003a).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Sources	Authorized Withdrawal (MGD)
Marshfield Water & Sewer**	9P42117101	42117105	4171000-01G Mt Skirgo 4171000-04G Furnace Br #1 4171000-05G Furnace Br #2 4171000-06G Furnace Br #3 4171000-07G Furnace Br #4 4171000-09G School St	3.07 registered 0.23 permitted 3.30 total*

*System-wide withdrawal, all sources are not necessarily within this segment.
** A wellhead protection project is underway (Appendix F, Project 01-11/WHP).

Additionally, there are 288 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 2.6 MGD.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

The impassable weir-pool fishway at the Veterans Memorial Park dam just upstream from the Route 3A bridge, Marshfield is being modified to allow anadromous fish (herring) access to the habitat in this segment of the South River (Reback *et al.* 2004).

Chemistry – water

DWM conducted water quality monitoring (DO and % saturation, temperature, pH, conductivity, alkalinity, hardness, chlorides, nitrate-nitrite nitrogen, ammonia-nitrogen and/or total phosphorus) at two locations in this segment of the South River between June and October 2001 (Appendix A, Tables A6 and A7). From upstream to downstream these locations are at Temple Street crossing, Duxbury (Station SR103) and upstream from the Route 3A bridge, Marshfield (Station SR102), upstream side of Veterans Memorial Park Dam fishway. These data are summarized below.

Dissolved oxygen and percent saturation
The DO in the South River at the Temple Street crossing (Station SR103) ranged from 1.9 to 6.0 mg/L with saturations between 23 and 57%. Further downstream, near the Route 3A bridge (Station SR102), DOs were much higher ranging from 5.7 to 7.5 mg/L with saturations between 66 and 80%. The data represent both pre-dawn and daytime measurements.

Temperature
The maximum temperature measured in this segment of the South River (26.4°C) was taken at the Route 3A bridge (Station SR102).

pH, hardness, and alkalinity
The pH of the South River was lowest at the most upstream sampling location (Station SR103) ranging from 5.9 to 6.2 SU and slightly higher (6.3 to 6.4 SU) at the downstream sampling location (SR102). Hardness and alkalinity were low at both sampling location (21 to 25 mg/L and 9 to 11mg/L, respectively).

Conductivity
Specific conductance in this segment of the South River ranged from 189 to 212 μS/cm.

Ammonia-nitrogen
No detectable concentrations of ammonia-nitrogen were found in this segment of the South River (exclusive of qualified data).

Total phosphorus
The total phosphorus concentrations measured in samples collected from this segment of the South River ranged from 0.058 to 0.080 mg/L (n=3) at the upstream sampling location and between 0.032 and 0.13 mg/L (average concentration = 0.07 mg/L) in the river near the Route 3A bridge.

The *Aquatic Life Use* for this segment of the South River is assessed as support based primarily on the *in-situ* water quality data and best professional judgment. Although DO, DO saturation and pH measurements were low, these conditions are considered to be naturally occurring. This use is identified with an Alert Status, however, because of the somewhat elevated total phosphorus measurement. Moderate growth of aquatic plants, which may be in response to the elevated phosphorus, was recorded in the field sampling notes for sites along this segment of the South River, particularly in the impounded and slow-moving areas along the river.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) at two locations in this segment of the South River - Temple Street crossing, Duxbury (Station SR103) and at the Route 3A bridge, Marshfield (Station SR102) between June and October 2001 (Appendix A, Table A7). None of the fecal coliform bacteria counts exceeded 140 cfu/100 ml at either of the two sampling locations.

Field observations were made by DWM personnel during the surveys conducted in the South River between June and October 2001. Some foam and algae were noted in the river near the Temple Street crossing (Station SR103). No objectionable conditions (odors, oils, trash/debris) were noted during any of the surveys in the river near Route 3A (Station SR102; MassDEP 2001a).

The *Primary* and *Secondary Contact Recreational* and *Aesthetic* uses for this segment of the South River are assessed as support based on the fecal coliform bacteria data and the lack of aesthetically objectionable conditions.

South River (MA94-08) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT*
Fish Consumption		NOT ASSESSED
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

* Alert Status issues identified, see details in use assessment section

RECOMMENDATIONS

Develop a monitoring plan and conduct bacteria sampling to evaluate effectiveness of point (Phase II stormwater permits) and non-point source pollution control activities and other actions and to assess the status of the *Recreational* uses.

Support efforts to improve/maintain anadromous fish passage at the Veterans Memorial Park dam as well as provide passage at the Chandlers Pond dam (Reback *et al.* 2004).

Continue to conduct water quality monitoring in this segment of the South River to better evaluate nutrient inputs and identify sources (e.g., cranberry bogs, developments, etc.) into the system.

SOUTH RIVER (SEGMENT MA94-09)

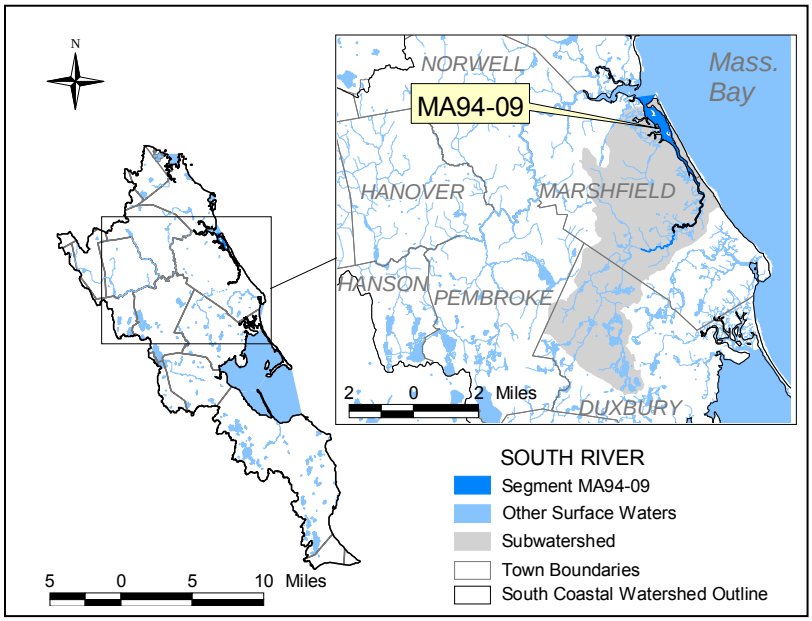
Location: From dam at Main Street, Marshfield to confluence with North River/MA Bay, Marshfield/Scituate.
Size: 0.63 square miles
Classification: Class SA, Outstanding Resource Water

Land-use estimates (top 3, excluding water) for the 21.3 mi^2 subwatershed (map inset, gray shaded area):

Forest..... 44%
Residential..... 31%
Wetlands..... 12%

South River is listed on the 2002 Integrated List of Waters in Category 5. This segment is impaired due to pathogens and a TMDL is required (MassDEP 2003a).

There is a pump-out facility at White's Ferry Marina on Ferry Street, Scituate, that was funded by the Clean Vessel Act to provide free pump-outs (MA DMF 2003 and Burtner 2003).



WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Source	Authorized Withdrawal (MGD)
Marshfield Water & Sewer**	9P42117101	42117105	4171000-02G Parsonage #1 4171000-08G South River St 4171000-11G Ferry St 4171000-13G Church St	3.07 registered 0.23 permitted 3.30 total*

*System-wide withdrawal, all sources are not necessarily within this segment.
** The wellhead protection project is completed (Appendix F, Project 01-11/WHP).

Additionally, there are 323 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 2.9 MGD.

US Coast Guard Communication Station NPDES permit MA0090450 was terminated by EPA as of April 1999. With the exception of a bunker and antenna, the area was deeded to the Town of Marshfield and the Recreation Department plans to use it as a park. There are currently no sanitary facilities although a septic system has been designed (Keohane 2005b).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Smelt spawning habitat in the South River was found between the dam and the Willow Street Bridge (approximately 229 m) although spawning habitat was not continuous. The discharges were sufficient to provide adequate coverage of spawning habitat during most of the spawning season ,although there were indications that habitat coverage may be a limiting factor for blueback herring spawning in some years at the end of May. A dramatic growth of filamentous green algae in the river in the spawning reach was also noted as a concern by DMF biologists (Chase in preparation).

Biology
Rainbow smelt, blueback herring and alewife eggs were all found during the spring spawning seasons in 1994 and 1995 (Chase in preparation).

Toxicity
Sediment
A 10-day static toxicity test was performed with *Ampelisca abdita (*amphipod) exposed to sediment collected on 6 September 2000 from the South River near Ferry Street, Marshfield (Station MA00-0067-A) as part of the National Coastal Assessment Project (EPA 2003a). A second 10-day static *Ampelisca abdita* test was conducted on sediment collected on 9 July 2001 from the confluence of the North and South Rivers (Station MA01-0070-A). No significant toxicity was detected in either test (EPA 2003a).

Chemistry – water
DWM conducted water quality monitoring (DO and % saturation, temperature, pH, conductivity, alkalinity, hardness, and chlorides) in this segment of the South River near the Julian Street/Bayberry Road bridge, Scituate/Marshfield (Station SR101), between June and October 2001 (Appendix A, Tables A6 and A7).

One site on the river near Ferry Street, Marshfield (Station MA00-0067-A), and a second site at the confluence of the South and North Rivers (Station MA01-0070-A) were sampled as part of the National Coastal Assessment Project on 6 September 2000 and on 9 July 2001, respectively (EPA 2003b).

These data are summarized below.

Dissolved oxygen and percent saturation
The DO ranged from 6.1 to 10.3 mg/L with saturations between 78 and 127%. These data represent both daytime and pre-dawn measurements. Similar to the North River near the Route 3A bridge, the highest DO/saturation readings represented the pre-dawn sampling event. These conditions are considered to be likely associated with strong turbulent flows related to tidal action. The remaining data represent daytime measurements.

Surface and bottom DOs in the river near Ferry Street, Marshfield (Station MA00-0067-A), in September 2000 were 9.27 and 9.3 mg/L, respectively (EPA 2003b). On 9 July 2001 surface and bottom DOs at the confluence of the South and North Rivers (Station MA01-0070-A) were 6.2 and 6.8 mg/L, respectively (EPA 2003b).

Temperature
The maximum temperature in this segment of the South River was 21.9°C.

pH, hardness, and alkalinity
The pH ranged from 7.3 to 7.9 SU (n=6). Hardness and alkalinity ranged from 4,500 to 5,000 mg/L and 96 to 100 mg/L, respectively.

Conductivity
Specific conductance ranged from 42,040 to 49,040 μS/cm (n=6).

Ammonia-nitrogen
The ammonium-nitrogen concentration in the surface sample of the river near Ferry Street, Marshfield (Station MA00-0067-A), on 6 September 2000 was 0.111 mgN/L and the concentration in the mid-water sample at the confluence of the South and North Rivers (Station MA01-0070-A) on 9 July 2001 was 0.091 mgN/L (EPA 2003b). No comparisons to in-stream chronic criterion for ammonia-nitrogen can be made because of the lack of pH measurements at the time when the sampling was conducted.

The *Aquatic Life Use* for this segment of the South River is assessed as support based primarily on the *in-situ* water quality data and best professional judgment.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Area MB6.0 (which contains this entire segment) is prohibited (MA DFG 2000 and Appendix G, Table G3).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired. Elevated fecal coliform bacteria levels in stormwater outfalls have been documented near Marshfield center. On-site septic systems and marina/boating discharges may also be problematic.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DMF biologists observed filamentous green algae (*Spirogyra* sp.) at the upper end of this segment of the South River during the smelt spawning season (late April/early May) (Chase in preparation).

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) just upstream from this segment of the South River near the Route 3A bridge and at the Julian Street/Baybery Road bridge, Scituate/Marshfield (Station SR101), between July and October 2001 (Appendix A, Table A7). None of the fecal coliform bacteria counts exceeded 170 cfu/100 ml at either of these sampling locations.

Sampling was recently conducted as part of a stormwater management watershed assessment for a tributary to the South River in the town of Marshfield (Appendix F, CPR Grants – Marshfield). Stormwater sampling was conducted of selected outfalls in Marshfield Center in the Willow Street drainage area on 1 June 2004. Elevated fecal coliform bacteria counts (as high as 2,500 cfu/100 ml) were found in three of the four locations sampled (Horsley Witten Group 2004). Although no quality-assured data are available, it should be noted that since 1994 NSRWA volunteers have conducted bacteria sampling as part of their River Watch Monitoring Program on a weekly basis during the summer months. They sample at two locations in this segment of the South River – near the Willow Street Bridge and also near the Julian Street Bridge (NSRWA 2005b). Higher counts were documented at the Willow Street Bridge sampling location.

Field observations were made by DWM personnel during the surveys conducted in the South River between June and October 2001. No objectionable conditions (odors, oils, trash/debris) were noted during any of the surveys in the river near the Julian Street/Baybery Road bridge (Station SR101) (MassDEP 2001a). The Secchi disk depth reported for the river near Ferry Street, Marshfield (Station MA00-0067-A), on 6 September 2000 was 1.8 m and at the confluence of the South and North Rivers (Station MA01-0070-A) on 9 July 2001 was 2 m (EPA 2003b). These measurements both met the recommended Secchi disk depth of 1.2 m.

The *Primary Contact Recreational Use* is assessed as support for this segment of the South River based primarily on the limited data collected by DWM in the summer of 2001. This use is identified with an Alert Status, however, because of elevated fecal coliform bacteria levels in stormwater outfalls documented near Marshfield center and the occasionally elevated fecal coliform bacteria counts reported by NSRWA. Both the *Secondary Contact Recreational* and *Aesthetic* uses are assessed as support for this segment of the South River. The dramatic growth of filamentous green algae noted during the smelt spawning seasons at the upper end of this segment is also of concern (therefore the recreational and aesthetic uses are all identified with an Alert Status).

South River (MA94-09) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Discharges from municipal separate storm sewer systems (Suspected sources: On-site septic systems, municipal high density area, and marina/boating discharges)
Primary Contact		SUPPORT*
Secondary Contact		SUPPORT*
Aesthetics		SUPPORT*

*Alert Status issues identified, see details in use assessment

RECOMMENDATIONS

Implement recommendations in the DMF shellfish management plan for Area MB6.0.

Develop a monitoring plan and conduct bacteria sampling to evaluate effectiveness of point (Phase II stormwater permits), sewering and non-point source pollution control activities and other actions and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Additional bacteria sampling near the Willow Street Bridge reach of the river to identify potential sources of fecal coliform bacteria contamination.

Encourage use of boat pump-out facilities.

Work with NSRWA to implement a quality assurance component for their water quality monitoring program.

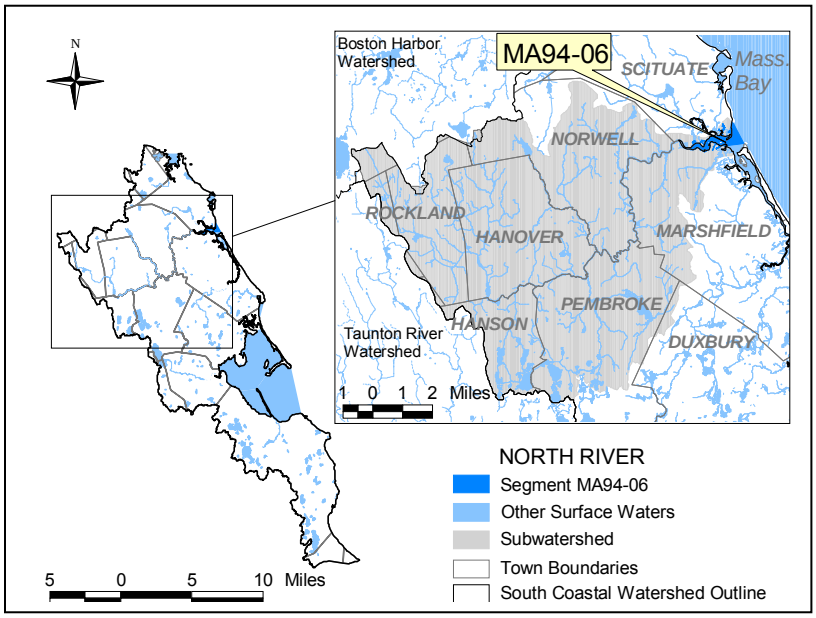
Support the following actions identified by DMF to study/protect/remediate smelt spawning habitat (Chase in preparation).

The riparian buffer along the South River particularly where spawning takes place should be protected.

During spring spawning seasons of smelt and blueback herring, wading should be prohibited in the South River spawning area.

NORTH RIVER (SEGMENT MA94-06)

Location: Route 3A (Main Street), Marshfield/Scituate to confluence South River/MA Bay, Scituate.
Size: 0.56 square miles
Classification: Class SA



Land-use estimates (top 3, excluding water) for the 76.0 mi^2 subwatershed (map inset, gray shaded area):

- Forest..... 48%
- Residential..... 31%
- Open Land..... 6%

North River is listed on the 2002 Integrated List of Waters in Category 5. This segment is impaired due to pathogens and a TMDL is required (MassDEP 2003a).

The Town of Scituate was required by an Administrative Consent Order (ACO) issued by the Commonwealth of Massachusetts to meet several conditions centered on improving water quality in the North River and estuary (CEI 1998).

The Massachusetts Audubon Society owns a 184-acre North River Wildlife Sanctuary on Route 3A, which borders the south bank of the North River. The sanctuary includes a half-mile boardwalk leading through a red maple swamp and small cattail marsh to a salt marsh overlooking the North River, as well a Woodland Loop. Harbor seals are visible in the river as they occasionally swim past the platform at the end of the boardwalk (Mass Audubon 2002). A pump-out boat is located at North River Marine on the north bank downstream from the Route 3A bridge (MA DMF 2003 and Burtner 2003).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

There are no WMA water withdrawals or NPDES wastewater discharges in this segment.

However, there are 443 acres of cranberry bog open space in this subwatershed (including 436 acres from the subwatershed for North River Segment MA94-05), inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 4.0 MGD.

USE ASSESSMENT

AQUATIC LIFE

Toxicity

Ambient

The Scituate WWTP staff collects water from the North River near fourth cliff beach (Rowland 2004). These samples are used as dilution water in the facility's whole effluent toxicity tests. Survival of *Mysidopsis bahia* (exposed 48 hours) ranged from 85 to 100% in the 16 tests conducted between February 2000 and August 2004. Survival of *Menidia beryllina* exposed (7-day) to the river water ranged from 88 to 100% with the exception of one test (survival = 63% in February 2001 test event) in the 16 tests conducted between February 2000 and August 2004.

Chemistry-water

The Scituate WWTP staff collects water from the North River near fourth cliff beach (Rowland 2004).

Data from the facility's whole effluent toxicity test reports were entered into the DWM's TOXTD database and the results between March 2001 and August 2004 are summarized below.

pH
The pH measurements ranged from 7.4 to 7.8 SU (n=5)(TOXTD database).

Suspended solids
The suspended solids concentrations ranged from 48 to 66 mg/l (n=3)(TOXTD database).

Ammonia-nitrogen
The ammonia-nitrogen concentrations ranged from <0.1 to 0.6 mg/L (n=3)(TOXTD database).

Total residual chlorine (TRC)
The total residual chlorine measurements were all <0.05 mg/L (n=5)(TOXTD database).

The *Aquatic Life Use* is assessed as support based primarily on the good survival of test organisms exposed to water collected from this segment of the North River.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Areas MB5.2 and MB5.4 (which contain 0.09 mi^2 of this segment) are prohibited and Area MB5.1, which contains 0.47 mi^2 of this segment, is conditionally approved (MA DFG 2000 and Appendix G, Table G3). It should be noted, however, that opening for Area MB5.1 has recently been extended for an additional month (Churchill 2005b).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired presumably due to elevated fecal coliform bacteria. Although the sources of bacteria are currently unknown, discharges from municipal separate storm sewers and boats are suspected.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

Although no quality-assured data are available, it should be noted that since 1994 NSRWA volunteers have conducted bacteria sampling as part of their River Watch Monitoring Program on a weekly basis during the summer months. They sample at two locations in this segment of the North River - off Damon's Point and near the mouth of the North River near Circle End Terrace (NSRWA 2005b).

No objectionable conditions have been observed by DWM biologists in this segment of the North River (DeCesare 2005).

The *Primary* and *Secondary Contact Recreational* are not assessed for this segment of the North River, but the *Aesthetics Use* is assessed as support based on the lack of aesthetically objectionable conditions.

North River (MA94-06) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Unknown (Suspected sources: Marina/boating sanitary on-vessel discharges, discharges from municipal separate storm sewer systems)
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		SUPPORT

RECOMMENDATIONS

Implement recommendations in the DMF shellfish management plans for Areas MB5.2, MB5.4, and MB5.1.

Develop a monitoring plan and conduct bacteria sampling to evaluate effectiveness of point (Phase II stormwater permits) and non-point source pollution control activities and other actions and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

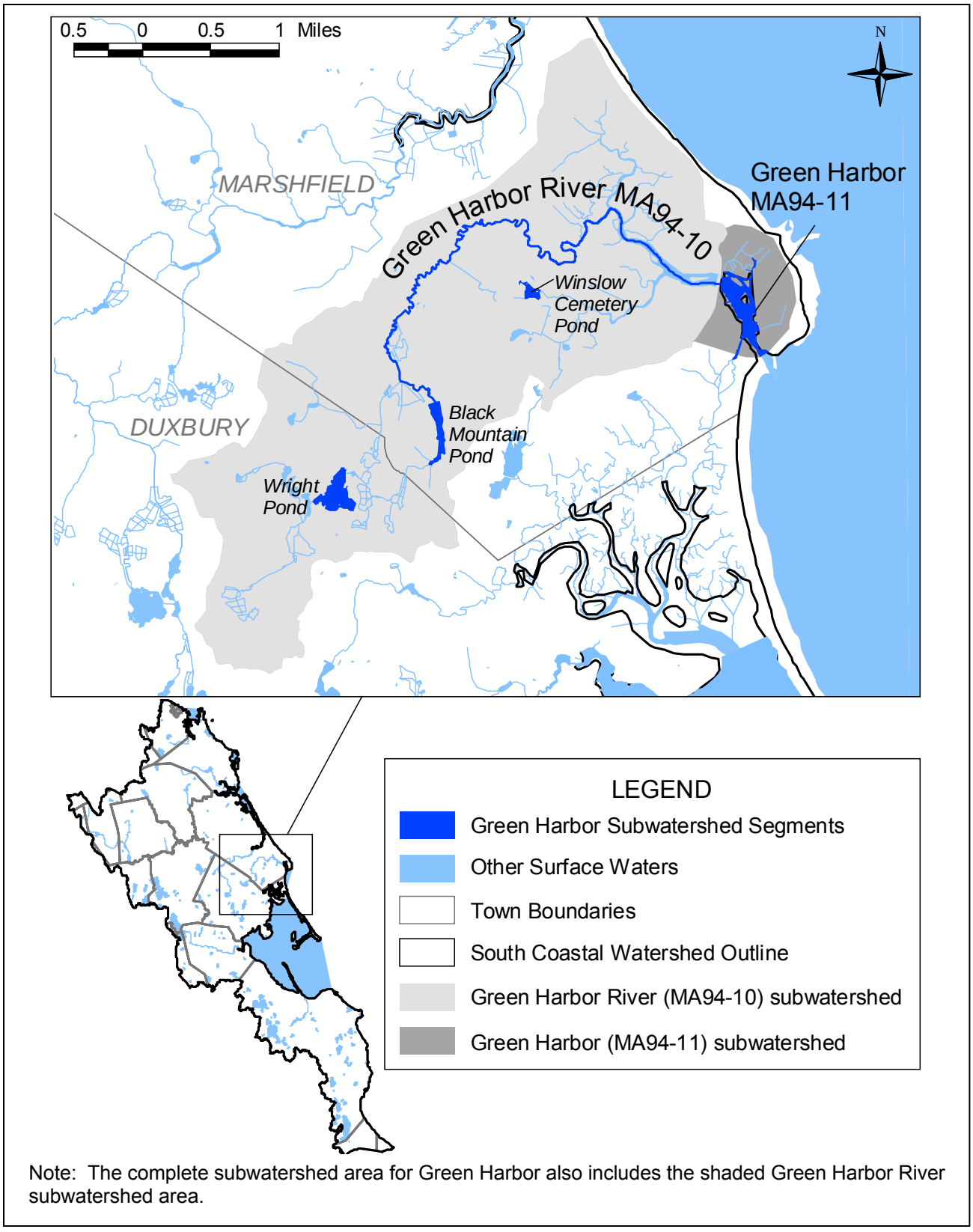
Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Work with NSRWA to implement a quality assurance component for their water quality monitoring program.

Collect and analyze estuarine and diadromous fishes from this segment of the North River to determine if mercury related to the Fireworks Site and the Indian Head River is impacting resident and migratory fishes if deemed necessary.

GREEN HARBOR SUBWATERSHED

The Green Harbor Subwatershed includes the Green Harbor River (MA94-10) and Green Harbor (MA94-11).



Note: The complete subwatershed area for Green Harbor also includes the shaded Green Harbor River subwatershed area.

Figure 11. Locations of segments in the Green Harbor Subwatershed.

GREEN HARBOR RIVER (SEGMENT MA94-10)

Location: Outlet Black Mountain Pond, Marshfield to the tide gate at Route 139, Marshfield.
Segment Length: 5.6 miles
Classification: Class B

Land-use estimates (top 3, excluding water) for the 7.3 mi^2 subwatershed:

Forest..... 38%
Residential..... 33%
Open Land..... 11%

Green Harbor River is listed on the 2002 Integrated List of Waters in Category 3. This segment had insufficient information to make assessments for any of the designated uses (MassDEP 2003a).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Sources	Authorized Withdrawal (MGD)
Marshfield Water & Sewer	9P42117101	42117105	4171000-03G Parsonage #2 4171000-10G Webster #1	3.07 registered 0.23 permitted 3.30 total*
Marshfield Country Club	N/A	42117102	Well #1 Well #2 Well #3	0.1

*System-wide withdrawal, all sources are not necessarily within this segment.

However, there are 178 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 1.6 MGD.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

The tide gates at the Route 139 dike restrict the natural flow/tidal flushing of this segment of the Green Harbor River. Although there is no evidence of tidal fluctuations or flow reversal, the lower portion of this segment is subject to saltwater intrusion at the dike. Marine macroalgae were also observed upstream from the dike (DeCesare 2005). The upstream extent of the salt water influence of this segment of the Green Harbor River is unknown at this time. The upstream passage of anadromous fish is almost completely inhibited because of the tide gates (Reback et al 2004). The tide gates have been at the Dike Street location since industrial revolution times. They consist of four separate gates that will only allow flow out. Currently the local conservation agent is working with CDM to develop a plan for partial opening in one of the gates. During a previous 4-year period one of the gates was in disrepair and would not fully close. In that 4-year period a herring run re-established itself into the upper portion of Green Harbor River (Wennemer 2005).

Chemistry – water

DWM conducted water quality monitoring (DO and % saturation, temperature, pH, conductivity, alkalinity, hardness, chlorides, nitrate-nitrite nitrogen, ammonia-nitrogen and/or total phosphorus) in the Green Harbor River just upstream from the Route 139 dike, Marshfield (Station GH01), between June and October 2001 (Appendix A, Tables A6 and A7). *In-situ* measurements were also collected at this sampling location during the summer of 1996 (Appendix B, Table B2). The 2001 data are summarized below.

Dissolved oxygen and percent saturation

The DO ranged from 5.0 to 7.0 mg/L with saturations between 56 and 87% (n=5). These data represent both daytime and pre-dawn measurements.

Temperature

The maximum temperature was 34.4°C. One of the five measurements was >28.3°C.

pH, hardness, and alkalinity
The pH of the Green Harbor River ranged from 6.9 to 9.3 SU (n=6). Hardness ranged from 340 to 770 mg/L and alkalinity ranged from 25 to 52 mg/L (n=5).

Conductivity
Specific conductance was high ranging from 1,663 to 47,764 μS/cm (n=4).

The *Aquatic Life Use* for this segment of the Green Harbor River is assessed as impaired based on the flow regime alterations from the tide gate structure. These gates also prevent most of the anadromous fish migration.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) in this segment of the Green Harbor River just upstream from the Route 139 dike, Marshfield (Station GH01), between July and October 2001 (Appendix A, Table A7). Samples were also collected at this location during the summer of 1996 (Appendix B, Table B3). None of the fecal coliform bacteria counts exceeded 200 cfu/100 ml in either of the 2001 or 1996 surveys.

Field observations were made by DWM personnel during the surveys conducted in the Green Harbor River between June and October 2001. Some foam and excessive algae growth and scums were noted in the river upstream from the Route 139 dike Sstation GH01; MassDEP 2001a). Recent observations made at various points along this segment (July 2005) indicate the water column was very turbid and brown in color and excessive growth of algae and duckweed were also present (DeCesare 2005).

The *Primary* and *Secondary Contact Recreational* and *Aesthetic* uses for the Green Harbor River are assessed as impaired based on the aesthetically objectionable conditions including turbidity and excessive algal growth.

Green Harbor River (MA94-10) Use Summary Table

Designated Uses		Status
Aquatic Life		IMPAIRED Causes: Flow regime alteration and fish passage barrier Sources: Changes in tidal circulation/flushing, impacts from hydrostructure flow regulation/modification, and hydrostructure impacts on fish passage
Fish Consumption		NOT ASSESSED
Primary Contact		IMPAIRED Cause: Turbidity and excess algal growth (Suspected causes: Elevated total phosphorus and flow regime alterations) Source: Unknown (Suspected sources: Golf course, cranberry bog operations, changes in tidal circulation/flushing, impacts from hydrostructure flow regulation/modification, and farmland both crop and livestock)
Secondary Contact		
Aesthetics		

RECOMMENDATIONS

The operation and maintenance of the tide gates at Route 139 should be investigated. To the extent possible, a natural flow regime should be restored in the Green Harbor River to improve water quality conditions and allow for fish passage.

Develop a monitoring plan and conduct bacteria sampling to evaluate effectiveness of point (Phase II stormwater permits) and non-point source pollution control activities and other actions and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Continue to conduct water quality monitoring (including nutrient sampling with appropriate methodologies for brackish water where necessary) in the Green Harbor River to evaluate potential non-point sources of pollution (e.g., cranberry bogs, golf courses, developments, etc.) into the system. Develop and implement BMPs to reduce nutrient inputs as deemed necessary to improve water quality.

Since *Myriophyllum heterophyllum* (a non-native freshwater aquatic plant species) was found to be abundant in Black Mountain Pond (at the headwaters of this segment) (see Black Mountain Pond in Table 3 of this report), determine the extent, if any, of the infestation of this non-native aquatic plant in the Green Harbor River.

GREEN HARBOR (SEGMENT MA94-11)

Location: From the tide gates at Route 139, Marshfield to the mouth of the harbor at MA Bay/Cape Cod Bay, Marshfield.
Segment Length: 0.08 square miles
Classification: Class SA

Land-use estimates (top 3, excluding water) for the 7.7 mi^2 subwatershed (including the subwatershed for MA94-10):

Forest..... 36%
Residential..... 33%
Open Land..... 11%

Green Harbor is listed on the 2002 Integrated List of Waters in Category 5. This segment is impaired due to pathogens and a TMDL is required (MassDEP 2003a).

The Town of Marshfield manages a concrete boat ramp with three launching lanes at Town Pier Road for general access with parking for 74 trailers (MA DFWELE 2003). There is a pump-out facility at Municipal Pier off of Town Pier Road, (Brant Rock) Marshfield. The pump-out was funded by the Clean Vessel Act to provide free pump-outs (MA DMF 2003 and Burtner 2003).

The ACOE performed annual maintenance dredging of the Green Harbor entrance channel in May 2003. About 35,000 cubic yards were removed to maintain the authorized 6 to 8 foot depth (ACOE 2003).

WMA WATER WITHDRAWAL AND NPDES DISCHARGE SUMMARY

There are no WMA water withdrawals or NPDES wastewater discharges in this segment.

USE ASSESSMENT

AQUATIC LIFE

The tide gates at the Route 139 dike restrict the natural flow/tidal flushing of Green Harbor. Fish passage is almost completely inhibited because of the tide gates (Reback et al 2004). The tide gates have been at the Dike Street location since industrial revolution times. They consist of four separate gates that will only allow flow out. Currently the local conservation agent is working with CDM to develop a plan for partial opening in one of the gates. During a previous 4-year period one of the gates was in disrepair and would not fully close. In that 4-year period a herring run reestablished itself into the upper portion of Green Harbor River (Wennemer 2005).

The *Aquatic Life Use* is not assessed but is identified with an Alert Status because of the barrier to fish passage at the dike and the limited tidal flushing.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Area MB3.0 (which contains this entire segment) is prohibited (MA DFG 2000 and Appendix G, Table G3).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired. This closure is related to elevated bacteria counts as well as the lack of a current sanitary survey (Churchill 2005c). Although the sources of bacteria are currently unknown, discharges from municipal separate storm sewers are suspected.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

With the exception of occasional turbidity primarily associated with the annual dredging operations, no other objectionable conditions (trash/debris, odors, oils, deposits) have been observed in Green Harbor (DeCesare 2005).

The *Primary* and *Secondary Contact Recreational* are not assessed for Green Harbor but the *Aesthetics Use* is assessed as support based on the lack of aesthetically objectionable conditions.

Green Harbor (MA94-11) Use Summary Table

Designated Uses		Status
Aquatic Life		NOT ASSESSED*
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Unknown (Suspected source: Discharges from municipal separate storm sewer systems)
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		SUPPORT

* Alert Status issues identified, see details in use assessment

RECOMMENDATIONS

The operation and maintenance of the tide gates at Route 139 should be investigated. To the extent possible, a natural flow regime should be restored in Green Harbor to improve water quality conditions and allow for fish passage.

Implement recommendations in the DMF shellfish management plans for Area MB3.0.

Develop a monitoring plan and conduct bacteria sampling to evaluate effectiveness of point (Phase II stormwater permits) and non-point source pollution control activities and other actions and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

PLYMOUTH BAY SUBWATERSHED

The Plymouth Bay subwatershed (also known as the Plymouth/Kingston/Duxbury Bay system) includes the following segments:

Bluefish River (MA94-30) flows into Duxbury Bay
Jones River subwatershed (Segments MA94-12, MA94-13, and MA94-14)
Duxbury Bay (MA94-15)
Eel River (MA94-23) flows into Plymouth Harbor
Unnamed Tributary to Eel River (MA94-35)
Plymouth Harbor (MA94-16)
Plymouth Bay (MA94-17)

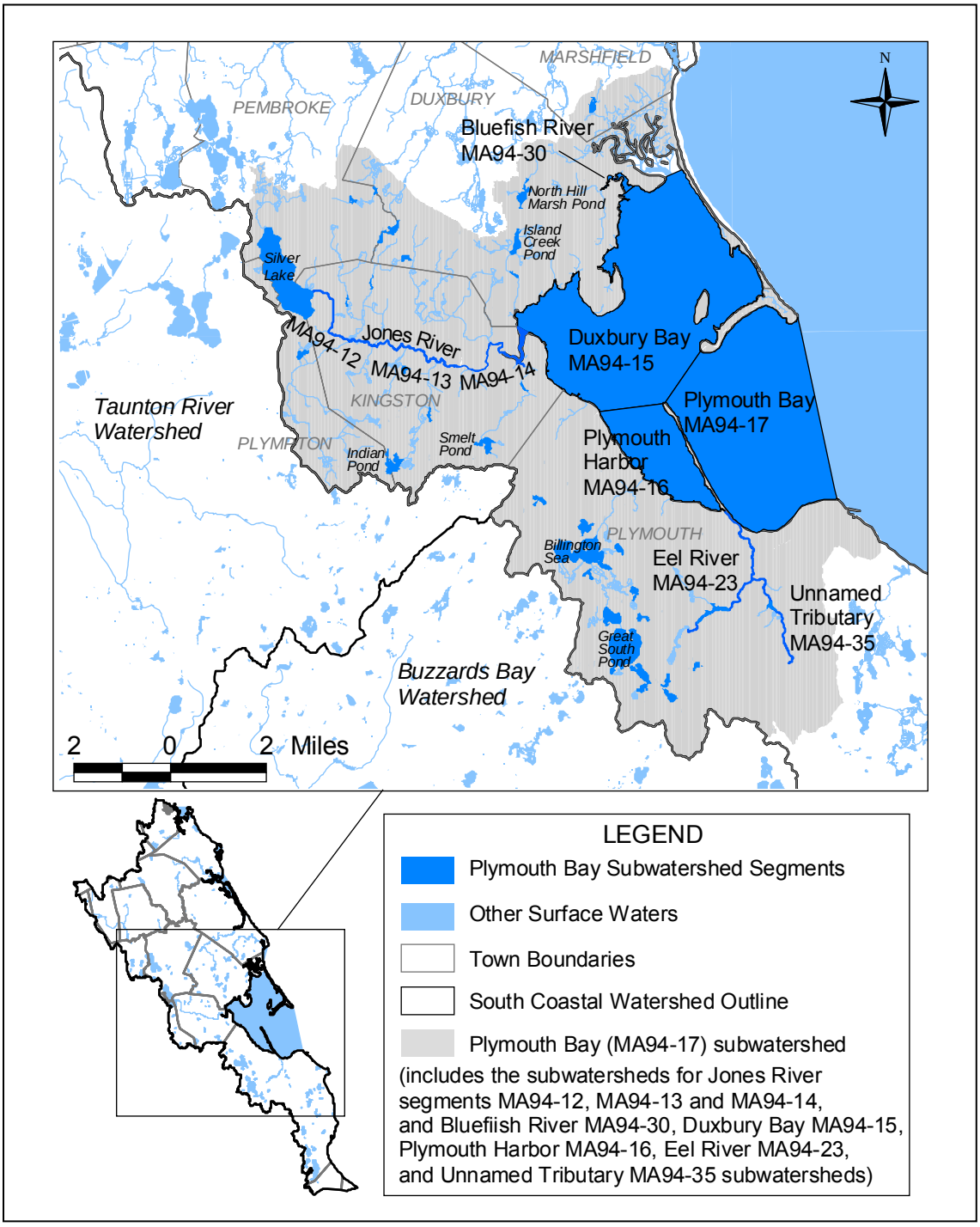


Figure 12. Locations of segments in the Plymouth Bay Subwatershed.

Plymouth Bay Subwatershed Information

In the Town Brook subwatershed, there are currently two of six obstructions to fish passage along Town Brook between Plymouth Harbor and Billington Sea that should be replaced or lined with aluminum steeppass sections to improve fish passage efficiency. These two obstructions are the Jenny Grist Mill and the dam off Billington Street (Reback *et al.* 2004). A seventh dam was removed in September 2002 (see Appendix F, MWI Project *Town Brook Dam Removal and Alewife Habitat Restoration*). Reducing the weir height at Water Street should provide an opportunity to improve the degraded status of the smelt spawning habitat in Town Brook and may improve passage by allowing fish to pass over a greater range of the tide (Chase in preparation). Sedimentation control in downtown Plymouth should be supported and continued in order to correct the significant sedimentation of smelt spawning riffles between Water Street and Pleasant Street (Chase in preparation).

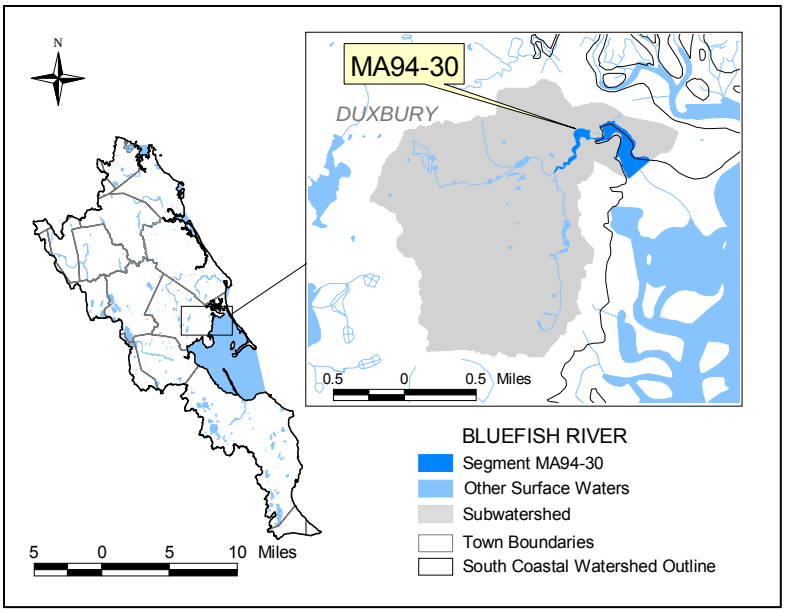
CZM has been working with the Towns of Plymouth, Kingston, and Duxbury on a federally approved boat sewage ***No Discharge Area (NDA)*** for the entire Plymouth/Kingston/Duxbury Bay. The Bay has approximately 1,600 boats, 10,000 acres of shellfish beds, and numerous recreational bathing beaches. The designation is seen as one more step in the municipalities' continuing clean water initiatives for the Bay. The ultimate goal is to designate the Bay as an NDA by the 2006 boating season.

BLUEFISH RIVER (SEGMENT MA94-30)

Location: Saltmarsh north of Harrison Street, Duxbury to mouth at Duxbury Bay, Duxbury.
Size: 0.06 square miles
Classification: Class SA

Land-use estimates (top 3, excluding water) for the 2.3 mi^2 subwatershed (map inset, gray shaded area):

Residential 41%
Forest..... 31%
Open Land 18%



WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Sources	Authorized Withdrawal (MGD)
Duxbury Water Department	9P42108201	42108205	4082000-02G Partridge Road 4082000-03G Depot Street 4082000-05G Tremont I 4082000-06G Tremont II	1.23 registered 0.62 permitted 1.85 total*
Duxbury Yacht Club	N/A	42108212	1 ground 1 surface	0.1

*System-wide withdrawal, all sources are not necessarily within this segment.

Additionally, there are 11 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 0.10 MGD.

NPDES WASTEWATER DISCHARGE SUMMARY

There are no NPDES wastewater discharges into this segment.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

There are no barriers to fish migration along this segment of the Bluefish River. There is a wooden notched weir-pool fishway in the unnamed tributary (locally known as the Bluefish River) at the Armory Dam south of the Harrison Street Bridge in Duxbury (Reback *et al.* 2004).

Biology

According to DMF the Bluefish River is an important shellfish area, supporting both recreational and commercial soft shelled clam (*Mya arenaria*), razor clam (*Enis directus*) and blue mussel (*Mytilus edulis*) fisheries along the inter-tidal and immediate sub-tidal areas as well as quahogs (*Mercenaria mercenaria*) in lesser abundance on the hard bottom near the mouth of the river (Churchill 2003c).

Chemistry – water

DWM conducted water quality monitoring (DO and % saturation, temperature, pH, conductivity, alkalinity, hardness, and chlorides) in the Bluefish River at the Washington Street Bridge, Duxbury (Station BR101), between June and October 2001 (Appendix A, Tables A6 and A7). Water quality samples were also collected from the tributary to the river (locally known as the part of the Bluefish River) at the Harrison Street Bridge, Duxbury (Station BR102).

Dissolved oxygen and percent saturation

The DO in the Bluefish River near the Washington Street Bridge ranged from 5.4 to 7.1 mg/L with saturations between 73 and 87% (n=6). These data represent both daytime and pre-dawn measurements. Only one of the six *in-situ* measurements was less than 6.0 mg/L and 75% saturation.

Temperature

The maximum temperature was 21.5°C.

pH, hardness, and alkalinity

The pH of the river ranged from 7.6 to 7.8 SU (n=6). Hardness ranged from 4700 to 5200 mg/L and alkalinity ranged from 92 to 100 mg/L (n=4).

Conductivity

Specific conductance ranged from 41,585 to 47,638 µS/cm (n=6).

The *Aquatic Life Use* is assessed as support for the Bluefish River based primarily on the *in-situ* water quality data.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Area CCB46.5 (which contains 0.02mi^2 of this segment) is prohibited and Area CCB46.2 (which contains 0.04 mi^2 of this segment) is conditionally approved (MA DFG 2000 and Appendix G, Table G3).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired due to elevated fecal coliform bacteria counts. It should be noted that three septic system pollution sources were eliminated since they have connected to the town sewer system (MA BAYS undated and Churchill 2003c). This project received an innovation award from the Massachusetts Municipal Association (MMA) in 1996 (Duxbury 1996). Although the current sources are unknown, discharges from municipal separate storm sewers are still suspected sources of bacteria.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) in the Bluefish River between July and October 2001 (Appendix A, Table A7) at the Washington Street Bridge, Duxbury (Station BR101). None of the fecal coliform bacteria samples exceeded 45 cfu/100 ml. Fecal coliform bacteria samples collected from the tributary to the river (locally known as the part of the Bluefish River) at the Harrison Street Bridge, Duxbury (Station BR102), were higher (ranging from 120 to an estimated 1000 cfu/100 ml).

Field observations were made by DWM personnel during the surveys conducted in the Bluefish River between June and October 2001. No objectionable conditions other than a slight oily/dusty sheen on one sampling occasion were noted (Station BR101; MassDEP 2001a).

The *Primary* and *Secondary Contact Recreational* and *Aesthetic* uses for the Bluefish River are assessed as support based on the fecal coliform bacteria data and the lack of aesthetically objectionable conditions.

Bluefish River (MA94-30) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Unknown (Suspected source: Discharges from municipal separate storm sewer systems)
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

RECOMMENDATIONS

Implement recommendations in the DMF shellfish management plans for Areas CCB46.2 and CCB46.5.

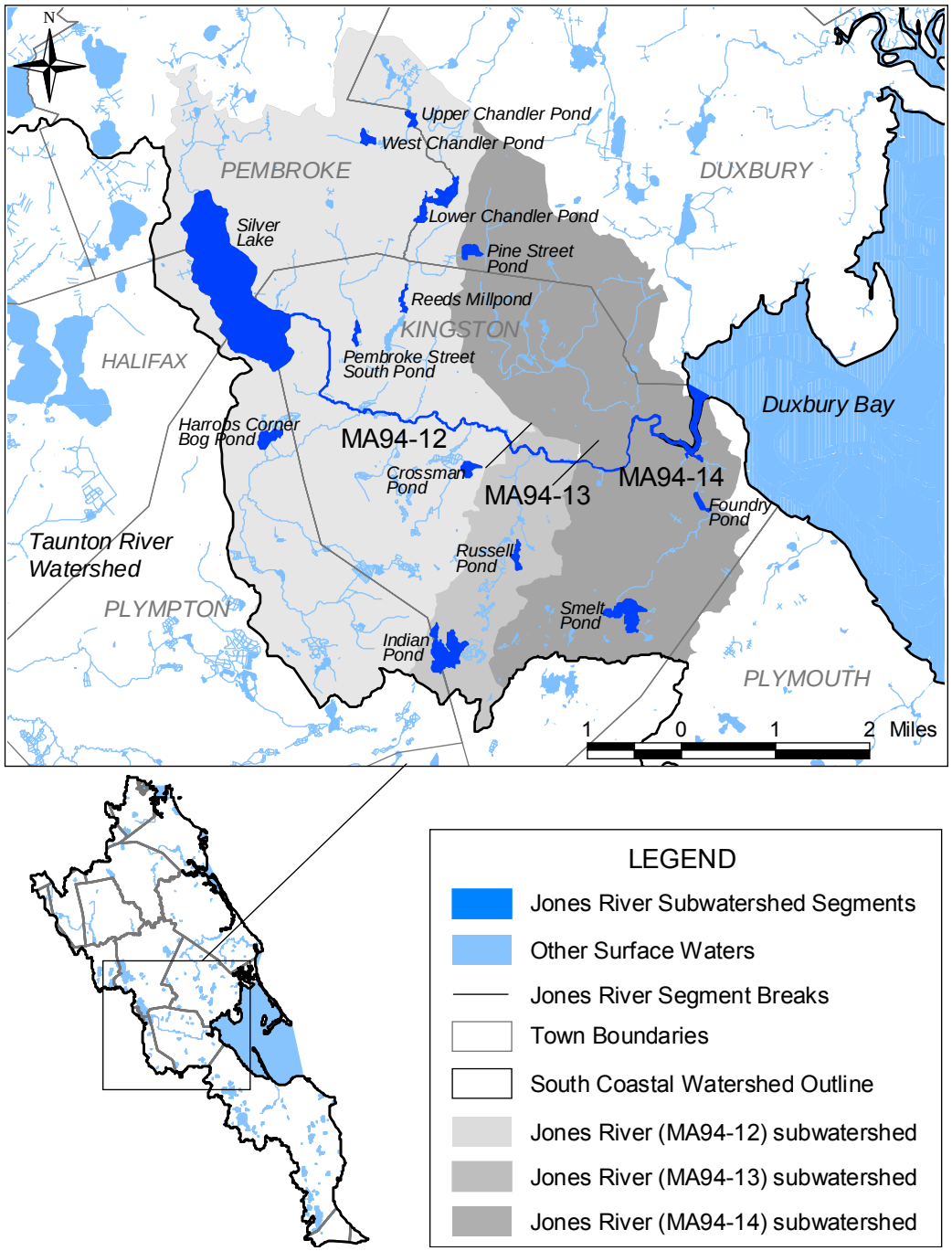
Develop a monitoring plan and conduct bacteria sampling to evaluate effectiveness of point (Phase II stormwater permits) and non-point source pollution control activities and other actions and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Support passage of the federally approved boat sewage ***No Discharge Area (NDA)*** for the entire Plymouth/Kingston/Duxbury Bay so the Bay is designated as an NDA by the 2006 boating season.

JONES RIVER SUBWATERSHED

The Jones River is a major tributary to Duxbury Bay and is divided into three segments: MA94-12, MA94-13, and MA94-14. Stage height data for several tributaries to the Jones River including Tubbs Meadow, Jones River, and Pine brooks as well as one unnamed tributary locally known as Howard Brook are available as part of the Massachusetts Riverways Programs pilot River Instream Flow Stewards (RIFLS) project (MA DFG 2005). Some biological monitoring data (benthos, fish, and habitat) are also available for several tributaries (Teal Ltd. 2000).



Note: Jones River subwatershed area for MA94-13 includes area shaded for MA94-12 and Jones River area for MA94-14 includes the areas shaded for MA94-12 and MA94-13.

Figure 13. Locations of segments in the Jones River Subwatershed.

JONES RIVER (SEGMENT MA94-12)

Location: Headwaters, outlet Silver Lake, Kingston to dam near Wapping Road, Kingston.
Segment Length: 4.1 miles
Classification: Class B, Warm Water Fishery.

Land-use estimates (top 3, excluding water) for the 17.5 mi^2 subwatershed (Figure 13):

Forest..... 51%
Residential..... 25%
Open Land..... 12%

This segment of Jones River is listed on the 2002 Integrated List of Waters in Category 3 due to insufficient information to make assessments for any of the designated uses (MassDEP 2003a).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Sources	Authorized Withdrawal (MGD)
Brockton DPW	N/A	42104401	4044000-01S Silver Lake**	11.11*
Duxbury Water Department	9P42108201	42108205	4082000-04G Lake Shore Dr	1.23 registered 0.62 permitted 1.85 total*

*System-wide withdrawal, all sources are not necessarily within this segment.
**Water from Silver Lake supplies cities and towns in the Taunton River Watershed. Because of periodic water shortages, the Massachusetts Legislature authorized diversions into Silver Lake from Monponsett Pond in the Taunton River Basin and from Furnace Pond in the North River subwatershed in 1964 (Teal Ltd. 2000).

There are also 874 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 7.8 MGD.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX E, TABLE E2)

There are no permitted direct discharges to this segment of the Jones River. The Brockton Water Filtration Plant (MAG640029) currently discharges to a lagoon near to Silver Lake, however, this discharge is tentatively scheduled to be eliminated by June 2006.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Little if any water flows from the outlet of Silver Lake to this segment of the Jones River (Reback *et al.* 2004). Flow discontinuity is typical from July through December (Teal Ltd. 2000). Additionally, neither the dam at Silver Lake nor at Wapping Road are equipped with any upstream passage for anadromous fish (Reback *et al.* 2004). During the water quality surveys conducted by DWM during the summer of 2001, there was very little if any flow near the outlet structure near Lake Street, Kingston (Station JR104) (this reach was described as being a stagnant pool) and further downstream (Station JR103) the river was also very slow moving. GeoEnvironmental, Inc. recently completed an inflow/outflow analysis for the Jones River Watershed (GZA 2003). The report concluded "*The majority of the Jones River watershed currently contains flow rates to support aquatic habitat under the current level of permitted and registered water withdrawals… Although the watershed as a whole experiences streamflows which meet flow targets, there are nevertheless specific reaches of the Jones River and its tributaries that are flow-impaired. The flow-impaired portion included the "Upper" Jones River (i.e., freshwater portion of the river above the Elm Street Dam) downstream of the Forge Pond Dam*".

Stage height data for the Jones River near Lake Street crossing are available as part of the Massachusetts Riverways Programs pilot River Instream Flow Stewards (RIFLS) project (MA DFG 2005).

Biology

Benthic macroinvertebrate samples were collected at two locations in this segment of the Jones River in late September/early October 1998 – near Grove Street (Station 7) and near Foxwood Lane (Station 6), Kingston (Teal Ltd. 2000). Sampling was also conducted near Grove Street in 1999 and again in May 2000. Although RPB III analyses are not available, family level taxanomic data were reported (Teal Ltd. 2000). Electrofishing in the river near Grove Street in October 1998 resulted in the capture of tesselated darter, redfin pickerel and a chain pickerel (Teal Ltd. 2000). The species collected are typically found in coastal streams with impoundments.

Chemistry – water

DWM conducted water quality monitoring (DO and % saturation, temperature, pH, conductivity, alkalinity, hardness, chlorides, nitrate-nitrite nitrogen, ammonia-nitrogen and/or total phosphorus) at two locations in this segment of the Jones River between June and October 2001 (Appendix A, Tables A6 and A7). From upstream to downstream these locations are just upstream from the outlet structure near Lake Street, Kingston (Station JR104), and near the Route 106 (Wapping Road) crossing, Kingston (Station JR103). These data are summarized below.

Dissolved oxygen and percent saturation

With the exception of one DO measurement in the river near Route 106 in October 2001, none of the measurements at either sampling location was greater than 3.7 mg/L nor were saturations any higher than 53%. The data represent both pre-dawn and daytime measurements.

Temperature

The highest temperature measured in this segment of the Jones River (24.0°C) was near Lake Street (Station JR104).

pH, hardness, and alkalinity

The pH of the Jones River was low ranging from 5.8 to 6.4 SU. Hardness and alkalinity were also fairly low at both sampling locations (21 to 26 mg/L and 6 to 25mg/L, respectively).

Conductivity

Specific conductance in this segment of the Jones River ranged from 129 to 201μS/cm.

Ammonia-nitrogen

No detectable concentrations of ammonia-nitrogen were found in this segment of the Jones River.

Total phosphorus

The total phosphorus concentrations were moderate to high (0.039 to 0.18 mg/L) in this segment of the Jones River and were consistently higher at the upstream sampling location.

The *Aquatic Life Use* is assessed as impaired based primarily on the lack of streamflow, which is a chronic problem for this segment of the Jones River as well as the extremely low DO/saturation conditions. These problems result from flow regulation/modification associated with water withdrawals in this segment (including but not necessarily limited to the out of basin transfer of water from Silver Lake to the City of Brockton for public water supply). Barriers to fish migration are also present at the Silver Lake and Wapping Road dams. Although pH, hardness and alkalinities were also low, these conditions are considered to be naturally occurring. The elevated total phosphorus concentrations are also of concern. Evidence of enrichment along this segment of the Jones River included abundant macrophyte growth particularly in the impounded and slow moving areas along the river.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) at two locations in this segment of the Jones River between June and October 2001 ((Appendix A, Table A7). From upstream to downstream these locations are just upstream from the outlet structure near Lake Street, Kingston (Station JR104), and near the Route 106 (Wapping Road) crossing, Kingston (Station JR103). None of the fecal coliform bacteria counts exceeded 30 cfu/100 ml at the upstream sampling location. The counts ranged from 75 to 290 in the river near Route 106 during the primary contact recreational season (geometric mean = 141 cfu/100 ml) although the highest count was in late October (410 cfu/100 ml).

Field observations were made by DWM personnel during the surveys conducted in this segment of the Jones River between June and October 2001. Objectionable conditions (odors, trash/debris, algal scums, dense macrophyte cover, turbidity) were noted near the outlet structure near Lake Street, Kingston (Station JR104). Moderate/dense amounts of macrophytes/algae and turbidity were also present in the impounded reach of the river near the Route 106 (Wapping Road) crossing, Kingston (Station JR103; MassDEP 2001a).

The bacteria counts were generally low in this segment of the Jones River, but the *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses are assessed as impaired because of the aesthetically objectionable amounts of algae and macrophyte growth as well as turbidity. These conditions appear to be exacerbated by the lack of flow in the river resulting from flow regulation/modification associated with water withdrawals in this segment (including but not necessarily limited to the out of basin transfer of water from Silver Lake to the City of Brockton for public water supply). Odor and trash and debris were also problematic in the upper reach of the river.

Jones River (MA94-12) Use Summary Table

Designated Uses		Status
Aquatic Life		IMPAIRED Causes: Low flow alteration, low dissolved oxygen, dissolved oxygen saturation, and fish passage barrier Sources: Flow alterations from water diversions, impacts from hydrostructure flow regulation/modification, and hydrostructure impacts on fish passage
Fish Consumption		NOT ASSESSED
Primary Contact		IMPAIRED Causes: Excess algal and aquatic plant growth, and turbidity Source: Flow alterations from water diversions
Secondary Contact		
Aesthetics		

RECOMMENDATIONS

To the extent possible, a natural flow regime should be restored to this segment of the Jones River to improve water quality conditions. Some specific recommendations can be found in the Jones River Watershed Study Final Report (GZA 2003).

Restoration of the anadromous fishery in this segment of the Jones River would require fish passage at both the Silver Lake and Wapping Road dams.

Future biological monitoring should be conducted utilizing an appropriate regional reference station and RBP III analysis (multihabitat sampling and genus/species level taxonomy) to better evaluate the status of the *Aquatic Life Use*. Candidate reference streams in the Jones River Subwatershed might include Pine and Furnace brooks based on benthos data that suggests relatively healthy biological communities in these waterbodies (Teal Ltd. 2000).

JONES RIVER (SEGMENT MA94-13)

Location: From dam near Wapping Road, Kingston to dam at Elm Street, Kingston.
Segment Length: 0.9 miles
Classification: Class B, Warm Water Fishery.

Land-use estimates (top 3, excluding water) for the 20.0 mi^2 subwatershed (including the subwatershed for MA94-12) (Figure 13):

Forest..... 51%
Residential..... 25%
Open Land..... 11%

This segment of Jones River is listed on the 2002 Integrated List of Waters in Category 3 due to insufficient information to make assessments for any of the designated uses (MassDEP 2003a).

The fishway below Sylvia Place Road on Furnace Brook should be repaired (Reback *et al.* 2004).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Sources	Authorized Withdrawal (MGD)
Kingston Water Department	9P42114501	42114508	4145000-02G Soules Pond 4145000-03G South Street 4145000-05G Millgate 4145000-07G Trackle Pond	0.99 registered 0.57 permitted 1.56 total*

*System-wide withdrawal, all sources are not necessarily within this segment.
See also MA94-12 for additional withdrawals that may apply to this segment.

Additionally, there are 953 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 8.5 MGD. However, the majority of this cranberry acreage (874 acres) is located in the upper subwatershed area (in Segment MA94-12).

NPDES WASTEWATER DISCHARGE SUMMARY

There are no permitted direct discharges to this segment of the Jones River.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Furnace Brook contributes to the improved streamflow in this segment of the Jones River, but the freshwater portion of the Jones River (i.e., above the Elm Street Dam) is flow-impaired (GZA 2003). In 2001 the fishway at the Elm Street Dam in Kingston was fitted with an aluminum steeppass insert at the recommendation of DMF and now river herring can now efficiently move beyond the dam (Reback *et al.* 2004).

Biology

Benthic macroinvertebrate samples were collected from the Jones River in late September/early October 1998 and again in 1999 near Wapping Road (Station 2). Although RPB III analyses are not available, family level taxanomic data were reported (Teal Ltd. 2000).

Chemistry – water

DWM conducted water quality monitoring (DO and % saturation, temperature, pH, conductivity, alkalinity, hardness, chlorides, nitrate-nitrite-nitrogen, ammonia-nitrogen and/or total phosphorus) in this segment of the Jones River just upstream from Elm Street bridge, Kingston (Station JR102), between June and October 2001 (Appendix A, Tables A6 and A7).

Dissolved oxygen and percent saturation
The DO ranged from 2.8 to 6.1 mg/L with saturations between 33 and 72% (n=7). These data represent both daytime and pre-dawn measurements. More than half of the measurements taken did not exceed 5.0 mg/L or 60% saturation.

Temperature
The maximum temperature was 23.9°C.

pH, hardness, and alkalinity
The pH of the Jones River was low ranging from 6.1 to 6.6 SU (n=7). Hardness ranged from 23 to 25 mg/L and alkalinity ranged from 8 to 13 mg/L (n=4).

Conductivity
Specific conductance ranged from 135 to 153 µS/cm (n=7).

Ammonia-nitrogen
No detectable concentrations of ammonia-nitrogen were found in this segment of the Jones River.

Total phosphorus
The total phosphorus concentrations were slightly elevated (0.029 to 0.085 mg/L) with an average concentration of 0.052 mg/L (n=5).

The *Aquatic Life Use* is assessed as impaired based primarily on the lack of streamflow, which is a chronic problem for this segment of the Jones River, as well as the extremely low DO/saturation conditions. These problems result from flow regulation/modification associated with water withdrawals in this segment (including but not necessarily limited to the out of basin transfer of water from Silver Lake to the City of Brockton for public water supply). Although pH, hardness and alkalinities were also low, these conditions are considered to be naturally occurring. The elevated total phosphorus concentrations are also of concern. Evidence of enrichment along this segment of the Jones River included abundant macrophyte growth particularly in the impounded and slow moving areas along the river.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) in this segment of the Jones River between June and October 2001 ((Appendix A, Table A7) just upstream from the Elm Street Bridge, Kingston (Station JR102). None of the fecal coliform bacteria counts exceeded 180 cfu/100 ml.

Field observations were made by DWM personnel during the surveys conducted in this segment of the Jones River between June and October 2001. Objectionable conditions (algal scums, dense macrophyte cover, turbidity) were noted (Station JR102; MassDEP 2001a).

The bacteria counts were generally low in this segment of the Jones River, however the *Primary* and *Secondary Contact Recreational* and *Aesthetic* uses are assessed as impaired because of the aesthetically objectionable amounts of algae and macrophyte growth as well as turbidity. These conditions appear to be exacerbated by the lack of flow in the river resulting from flow regulation/modification associated with water withdrawals in this segment (including but not necessarily limited to the out of basin transfer of water from Silver Lake to the City of Brockton for public water supply).

Jones River (MA94-13) Use Summary Table

Designated Uses		Status
Aquatic Life		IMPAIRED: Causes: Low flow alteration, low dissolved oxygen, and dissolved oxygen saturation Source: Flow alterations from water diversions and impacts from hydrostructure flow regulation/modification
Fish Consumption		NOT ASSESSED
Primary Contact		IMPAIRED Causes: Excess algal and aquatic plant growth, and turbidity Source: Flow alterations from water diversions
Secondary Contact		
Aesthetics		

RECOMMENDATIONS

To the extent possible, a natural flow regime should be restored to this segment of the Jones River to improve water quality conditions. Some specific recommendations can be found in the Jones River Watershed Study Final Report (GZA 2003).

The fishway below Sylvia Place Road on Furnace Brook should be repaired (Reback *et al.* 2004).

Future biological monitoring should be conducted utilizing an appropriate regional reference station and RBP III analysis (multihabitat sampling and genus/species level taxonomy) to better evaluate the status of the *Aquatic Life Use*. Candidate reference streams in the Jones River Subwatershed might include Pine and Furnace brooks based on benthos data that suggests relatively healthy biological communities in these waterbodies (Teal Ltd. 2000).

JONES RIVER (SEGMENT MA94-14)

Location: From dam at Elm Street, Kingston to mouth at Duxbury Bay, Kingston.
Size: 0.09 square miles
Classification: Class SA

Land-use estimates (top 3, excluding water) for the 29.8 mi^2 subwatershed (including the subwatersheds for MA94-12 and MA94-13) (Figure 13):

Forest..... 47%
Residential..... 27%
Open Land..... 11%

This segment of the Jones River is listed on the 2002 Integrated List of Waters in Category 5 due to pathogens and therefore a TMDL is required (MassDEP 2003a).

Kingston Town Pier, also known as Ah-De-Nah, is located off of River Road. A pump-out boat, funded by the Clean Vessel Act, is moored here to provide free pump-outs (MA DMF 2003 and Burtner 2003).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Sources	Authorized Withdrawal (MGD)
Kingston Water Department	9P42114501	42114508	4145000-04G Winthrop Street 4145000-06G Grassy Hole	0.99 registered 0.57 permitted 1.56 total*
Country Club at Indian Pond Estates	9P342114502	N/A		

*System-wide withdrawal, all sources are not necessarily within this segment.
See also MA94-12 and MA94-13 for additional withdrawals that may apply to this segment.

Additionally, there are 1115 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 10 MGD. However, most of this cranberry acreage (953 acres) is located in the upper subwatershed area (Segments MA94-12 and MA94-13).

NPDES WASTEWATER DISCHARGE SUMMARY

There are no permitted direct discharges to this segment of the Jones River.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

One of the two active USGS stream gages in the South Shore Coastal Watersheds is located on the Jones River; specifically, on the left bank downstream from Elm Street Bridge in Kingston. The period of record for this gage (01105870) is August 1966 to the present. The average discharge for the thirty-six year period of record is 32.5 cfs. The maximum discharge occurred on 19 March 1968 (575 cfs) and the minimum discharge occurred on 11 August 1966 (0.59 cfs). The 7Q10 for the Jones River gage is 0.67cfs (USGS 2002). The USGS remarks that flow is regulated by a pond upstream and is affected at times by wastage from Silver Lake. Additionally, the surface flow may be affected by ground water that enters from or moves into adjacent basins. There is also occasional backwater from tidal surge at the gage (Socolow *et al.* 2002). A water level gauge was also installed in the Jones River near the Route 3A bridge in July 2003 and was removed in February 2005 for use in determining nitrogen loading to the bay from the Jones River as part of the *South Coastal Basin Estuaries Monitoring Project* (Howes and Samimy 2005).

Smelt spawning habitat in the Jones River includes the area below Elm Street Dam to slightly downstream from Route 3A (approximately 1111 m). Chronic sedimentation, likely from road sand contributions and riparian erosion, as well as water level manipulations, and the presence of filamentous green algae, were noted concerns expressed by DMF biologists (Chase in preparation).

Biology

The streambed below Elm Street Dam downstream to Route 3A has supported a large smelt run in past years (historically one of the largest smelt runs in Massachusetts) and although it continues to do so the numbers have diminished. (Chase in preparation). This has also been the location of a number of smelt research projects conducted by DMF (Reback *et al.* 2004). Lawton et al. (1990) investigations included the effects of smelt impingement events at the Plymouth Nuclear Power Station and found low proportions of impinged smelt in relation to the large smelt runs occurring in the 1970s and early 1980s. Impingement events could have a larger impact on the smelt run in the Jones River given the current poor status of the population (Chase 2005). Based on a recent interview with DMF personnel, there have been no recent quantitative estimates of the adult rainbow smelt population in the Jones River and therefore the degree of impact of particular impingement events to the current population cannot be quantitatively assessed. However, concerns were expressed by DMF (Appendix H) that there has been a sharp decline in the rainbow smelt population in the Jones River since the time when the Lawton, et al. (1990), studies were conducted. Observations since 1995 have found peak season egg deposition far lower than that seen in 1995 (Chase in preparation). Electrofishing in the Jones River downstream from Elm Street in October 1998 resulted in the capture of American eel, bluegill, and an individual each of largemouth bass, tessellated darter, and yellow perch (Teal Ltd. 2000). The species collected are typically found in coastal streams with impoundments.

Chemistry – water

DWM conducted water quality monitoring (DO and % saturation, temperature, pH, conductivity, alkalinity, hardness, and chlorides) in this segment of the Jones River at the Route 3A crossing, Kingston (Station JR101) between June and October 2001 (Appendix A, Tables A6 and A7). Water quality samples have also been collected near Route 3A on a weekly basis since July 2003 (sampling is still being conducted) for use in determining nitrogen loading to the bay from the Jones River as part of the *South Coastal Basin Estuaries Monitoring Project* (Howes and Samimy 2005). Between July 2003 and February 2005, samples (n=82) were analyzed for nutrients (total nitrogen and phosphorus). Although the actual quality assurance data have not been released to MassDEP, data validation is required as part of this Estuaries Monitoring Project and was conducted prior to the release of the data which are summarized below.

DO and % saturation

The DO ranged from 7.8 to 9.4 mg/L with saturations between 91 and 106% (n=6). These data represent both daytime and pre-dawn measurements.

Temperature

The maximum temperature was 24.6°C.

pH, hardness, and alkalinity

The pH of the river ranged from 6.6 to 7.0 SU (n=6). Hardness ranged from 24 to 29 mg/L and alkalinity ranged from 7 to 16 mg/L (n=4).

Conductivity

Specific conductance ranged from 156 to 214 μS/cm (n=6).

Total nitrogen

The concentration of total nitrogen ranged from 0.501 to 1.498 mg/L with an average concentration of 0.955 mg/L (n=82).

Total phosphorus

The concentration of total phosphorus ranged from 0.0064 to 0.128 mg/L with an average concentration of 0.032 mg/L (n=82).

The *Aquatic Life Use* is assessed as support based primarily on the *in-situ* water quality data. This use is identified with an Alert Status, however, because of the sharp decline in the rainbow smelt population in the Jones River noted by DMF biologists. Habitat degradation, water level manipulations, and filamentous green algae were all expressed concerns.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Area CCB44.0 (which contains this entire segment) is prohibited (MA DFG 2000 and Appendix G, Table G3). According to the DMF, the Jones River and in particular its "Halls Brook" tributary continue to be the single largest source of pollution to Kingston Bay (Germano 2002). However, as a result of the recent and ongoing sewering project, dry weather fecal coliform levels at the mouth of the Jones River are generally less than 50 cfu/100 ml, although wet weather samples continue to be elevated. Despite improvements in the Jones River, "Halls Brook" (also known as "Stony Creek") continues to be problematic. Suspected sources of pollution include septic systems in the center of town abutting the brook and/or waterfowl in the surrounding wetlands (Germano 2002).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired. The closure is due to elevated fecal coliform bacteria counts particularly during wet weather. In addition to stormwater runoff, potential pollution sources include waterfowl, and the "Halls Brook" tributary, where either septic systems in the center of town near the brook and/or waterfowl in the wetlands contribute to elevated fecal coliform bacteria counts.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

DMF biologists observed filamentous green algae (*Spirogyra* sp.) at the upper end of this segment of the Jones River in the smelt spawning habitat. No algal growth had been reported in earlier studies (Chase in preparation).

DWM conducted bacteria sampling (fecal coliform, *E coli*. and *Enterococci*) in this segment of the Jones River between June and October 2001 (Appendix A, Table A7) at the Route 3A crossing, Kingston (Station JR101). The fecal coliform bacteria counts ranged from 80 to 250 cfu/100 ml (geometric mean was 169 cfu/100 ml during the primary contact recreation season). Two of the three counts exceeded 200 cfu/100 ml.

According to the sampling and analysis plan for the *South Coastal Basin Estuaries Monitoring Project* one station in the Jones River near the Route 3A bridge (Station PDH-16) was proposed for sampling (Appendix F, Project 03-04/604 and Howes and Samimy 2004). Fecal coliform bacteria sampling and Secchi disk transparency measurements at these locations were to be taken weekly between June 2003 and September 2004. Three fecal coliform bacteria samples were collected and analyzed from this sampling location in July/August 2004 and the counts ranged from 90 to 1380 cfu/100 ml (Howes and Samimy 2005). Only one of the samples exceeded 400 cfu/100 ml.

Field observations were made by DWM personnel during the surveys conducted in this segment of the Jones River between June and October 2001. No objectionable conditions were noted (Station JR101; MassDEP 2001a).

The *Primary* and *Secondary Contact Recreational* and *Aesthetic* uses for this segment of the Jones River are assessed as support based on the fecal coliform bacteria data and the general lack of aesthetically objectionable conditions. Although the highest fecal coliform bacteria count is certainly a concern, a use impairment decision cannot be made on a single data point. Furthermore, the fecal coliform bacteria datasets for this river from both sampling years were small. Because of the occasionally elevated bacteria counts and the presence of filamentous green algae near the smelt spawning area the *Recreational* and *Aesthetics* uses are identified with an Alert Status for this segment of the Jones River.

Jones River (MA94-14) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT*
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Discharges from municipal separate storm sewer systems (Suspected sources: Septic systems and waterfowl)
Primary Contact		SUPPORT*
Secondary Contact		SUPPORT*
Aesthetics		SUPPORT*

* Alert Status issues identified, see details in use assessment

RECOMMENDATIONS

Implement recommendations in the DMF shellfish management plans for Area CCB44.0.

Develop a monitoring plan and conduct bacteria sampling to evaluate effectiveness of point (Phase II stormwater permits, sewering) and non-point source pollution control activities and other actions and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Support the following actions identified by DMF to study/protect/remediate smelt spawning habitat (Chase in preparation).

- Local authorities should develop a management plan for addressing sediment containment along roadways adjacent to the Jones River. This management plan can set priorities for seeking funding to correct stormwater conduits to the river with poor sediment containment/removal. The plan can also discuss advanced strategies for sediment removal such as installation of an in-river sump to collect sediments near the spawning habitat.

- Additional water quality sampling that includes pH and nutrient sampling should be conducted.

- Additional information is needed to evaluate streamflow conditions in the Jones River as they relate to municipal water withdrawals, climate and the discharge requirements of anadromous fish in the Jones River (i.e., depths in riffles, egg crowding at low discharge which can result in high egg mortality).

- A smelt population investigation similar to that conducted between 1979 and 1981 (including key population variables such as sex, size, age structure and spawning run estimates) should be conducted to better evaluate the status of the smelt population in the Jones River.

- Stabilization/shading adjacent to smelt spawning habitat in the Halls Brook tributary to the Jones River.

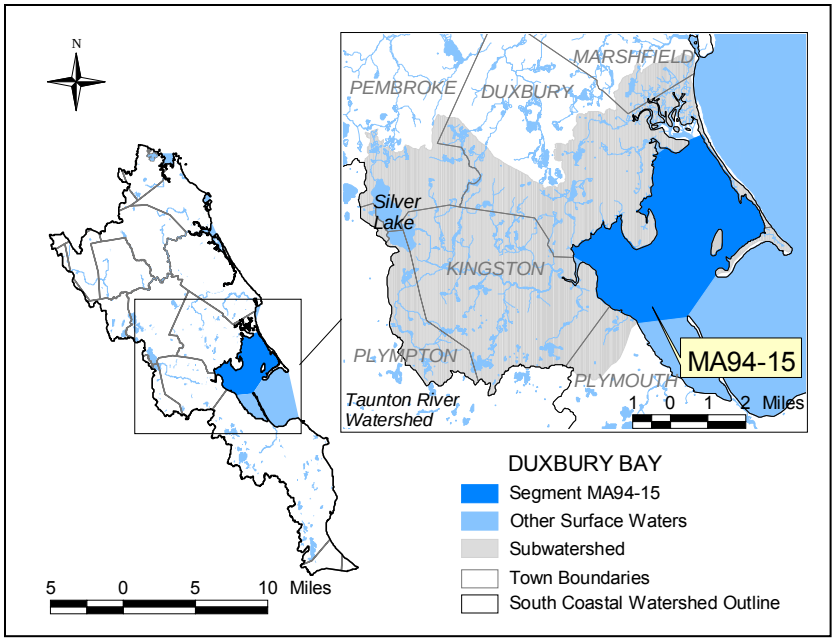
Support passage of the federally approved boat sewage ***No Discharge Area (NDA)*** for the entire Plymouth/Kingston/Duxbury Bay so the Bay is designated as an NDA by the 2006 boating season.

DUXBURY BAY (SEGMENT MA94-15)

Location: The waters north and west of a line from Saquish Head to the tip of Plymouth Beach and from there to High Cliff, Plymouth excluding Back River and Bluefish River, Duxbury and Jones River, Kingston.
Size: 12.7 square miles
Classification: Class SA

Land-use estimates (top 3, excluding water) for the 44.2 mi^2 subwatershed (map inset, gray shaded area):

- Forest..... 40%
- Residential..... 30%
- Open Land..... 10%



Duxbury Bay is listed on the 2002 Integrated List of Waters in Category 5. This segment is impaired due to pathogens and a TMDL is required (MassDEP 2003a).

Duxbury Bay is separated from Cape Cod Bay on the east by one of the longest barrier beaches in Massachusetts. Known as Duxbury Beach, it is a local and regional attraction having a 1400 car parking lot, bathhouse and other public beach facilities. The only houses on Duxbury Beach are located at the southernmost tip facing Plymouth Harbor. Clarks Island is located within the southern section of the bay and includes about a dozen residences on large lots (Churchill 2003d).

The primary residential areas are located along the northern and western shores in Duxbury, Kingston, and Plymouth. The focus of Duxbury's village and boating activity is Snug Harbor, located in the northern portion of the bay (Churchill 2003d). There is a shared community septic system that was built to service the Snug Harbor Business District that is owned and operated by the Town of Duxbury (Duxbury 1996). There is a pump-out boat and a shore-side facility at Duxbury Town Pier. The pump-out facilities were funded by the Clean Vessel Act to provide free pump-outs (MA DMF 2003). Adjacent to Duxbury Town Pier is the town boat ramp, Duxbury Yacht Club and the Duxbury Bay Maritime School, the latter offering sailing, boat building and ecology classes to the public (Churchill 2003d). The Kingston town boat ramp and Harbormaster Office are located in Kingston Bay at the mouth of the Jones River (Germano 2002).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Source	Authorized Withdrawal (MGD)
Marshfield Water & Sewer Department**	9P42117101	42117105	4171000-12G Webster #2	3.07 registered 0.23 permitted 3.30 total*
Duxbury Water Department	9P42108201	42108205	4082000-01G Millbrook #2 4082000-07G Evergreen I 4082000-08G Evergreen II 4082000-09G Mayflower/East 4082000-10G Mayflower #2 4082000-11G Damon #1 4082000-12G Damon #2	1.23 registered 0.62 permitted 1.85 total*
Mayflower Sand & Gravel	N/A	42112201	Well #1	1.0 registered

*System-wide withdrawal, all sources are not necessarily within this segment.
** A wellhead protection project is underway (Appendix F, Project 01-11/WHP).

There are 1195 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 11 MGD.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX E, TABLE E1)

Battelle Duxbury Operations Wastewater Treatment Plant (WWTP) located in Duxbury, MA, is authorized (NPDES permit MA0025852 issued in August 1999 and modified in February 2000) to discharge 0.29 MGD (average monthly) of culture water used for culturing and testing marine organisms, non-toxic wastewater from laboratory sinks, and sea water return via Outfall #001 to Duxbury Bay. The permit requires effluent limits for pH and fecal coliform bacteria and requires monitoring and reporting of copper and zinc concentrations. The ammonia-nitrogen concentration of the effluent reported in the facility's February 2001 whole effluent toxicity test was <0.10 mg/L (TOXTD database). The pH of the effluent between February 2000 and February 2001 ranged from 7.9 to 8.1 SU while TRC measurements were all <0.05 mg/L (n=4)(TOXTD database). The facility's whole effluent toxicity limits were $LC_{50} \geq 50\%$ effluent using *Mysidopsis bahia* and *Menidia beryllina* two times per year. However, EPA no longer requires toxicity testing from this facility (Pitt 2001). This facility is also permitted to discharge non-contact cooling water via Outfall #003 at an average monthly rate of 0.000597 MGD.

USE ASSESSMENT

AQUATIC LIFE

Eelgrass Bed Habitat

MassDEP's Wetlands Conservancy Program (WCP) identified the presence of eelgrass in Duxbury Bay from historic 1951 black and white aerial photography (Costello 2003). In 1998 MassDEP WCP performed field verification of 1995 aerial photography and mapped the extent of eelgrass bed habitat in Duxbury Bay. Total areal coverage of the bay from the 1998 survey was approximately 23% of the bay. In 2001 MassDEP WCP performed field verification of 2001 aerial photography and mapped the extent of eelgrass bed habitat in Duxbury Bay. There was a slight decline (approximately 4%) in the size of eelgrass beds between 1998 and 2001. There were no major changes in the eelgrass beds since 1951.

Biology

Soft shell clams (*Mya arenaria*) and razor clams (*Enis directus*) can now be found in commercial quantities on the large inter-tidal flats along the Duxbury side of the bay. Quahogs (*Mercenaria mercenaria*) are also found in the deeper waters and on many of the numerous tidal flats throughout the bay. Interestingly, bay scallops (*Argopecten irradians*) have also been found on these flats. By January 2003 there were 21 shellfish aquaculture lease sites in operation in the Duxbury portion of the bay raising american oysters (*Crassostrea virginica*) on a total of 39 acres (Churchill 2003d).

Toxicity

Ambient

Water from Duxbury Bay was used as dilution water in the Battelle WWTP whole effluent toxicity tests. Survival of *M. bahia* and *M. beryllina* exposed (48 hours) to the bay water between February 2000 and February 2001 was not less than 95 and 75%, respectively, in the four tests conducted between February 2000 and February 2001.

Effluent

No acute toxicity (LC_{50} >100% effluent) was detected in the Battelle WWTP discharge by either *M. bahia* (n=4) or *M. beryllina* (n=3 valid tests) during the testing period between February 2000 and February 2001.

Sediment

Ten-day static toxicity tests were performed with *Ampelisca abdita (*amphipod) exposed to sediment collected from three sites in Duxbury Bay as part of the National Coastal Assessment Project (EPA 2003a). On 6 September 2000 sediment was collected from Duxbury just north of the tip of Plymouth Beach (station MA00-0025-B). Significant toxicity was detected in this test (EPA 2003a). Two additional samples were collected from the bay on 10 July 2001 – one south of Powder Point (Station MA01-0030-A) and one just south of Goose Point (Station MA01-0024-A). No significant toxicity was detected in either test (EPA 2003a).

Chemistry-water

According to the sampling and analysis plan for the *South Coastal Basin Estuaries Monitoring Project* ten stations within Duxbury Bay were proposed for sampling: northeast of Clarks Island (Station PDH-12), inner central Duxbury Bay (Station PDH-13), south of Long Point (Station PDH-14), main channel east of Clark Island (Station PDH-11), main channel near Goose Point (Station PDH-8), near mouth of Jones River (Station PDH-9), off Rocky Nook (Station PDH-7), channel east of Rocky Nook (Station PDH-6), entrance to Goose Point Channel (Station PDH-5), and mouth of Bay off Duxbury Pier Lighthouse (Station PDH-10) (Appendix F, Project 03-04/604 and Howes and Samimy 2004). *In-situ* measurements of DO, temperature, and Secchi disk depth as well as nutrient (organic and inorganic nitrogen) samples, were to be taken at these locations six times between June and September 2003 and 2004. Samples were to be collected at approximately two-week intervals during the falling tide (2 hours before and after mid-ebb tide) during the morning hours (0600 to 0900 hours). Water quality samples and *in-situ* measurement were taken from the ten sites on six occasions between July and September 2003 and again in 2004. Although the actual quality assurance data has not been released to MassDEP, data validation is required as part of this *Estuaries Monitoring Project* and was conducted prior to the release of the data which are summarized below (Howes and Samimy 2005).

Water quality sampling was conducted at a total of three stations on one occasion each within Duxbury Bay as part of the National Coastal Assessment Project (EPA 2003b). These stations were located south of Powder Point (MA01-0031-A), south of Goose Point (MA01-0024-A), and near the tip of Plymouth Beach (MA00-0025-B).

The Battelle Duxbury Operations WWTP staff collected water from Duxbury Bay for use as dilution water in the facility's whole effluent toxicity tests. Results from the facility's whole effluent toxicity test reports between February 2000 and February 2001 were entered into DWM's TOXTD database and the results are summarized below.

Dissolved oxygen

The surface and bottom DO ranged from 5.5 to 13.1 mg/L (n=232) at the ten *Estuaries Monitoring Project* sampling locations (Howes and Samimy 2005). Surface and bottom DO measurements (n=6) taken as part of the National Coastal Assessment Project ranged from 5.8 to 10.03 mg/L (EPA 2003b). Only three measurements were <6.0 mg/L.

Temperature

The maximum temperature was 23.1ºC (Howes and Samimy 2005 and EPA 2003b).

pH

The pH measurements ranged from 7.9 to 8.2 SU (n=4) (TOXTD database).

Total residual chlorine (TRC)

The total residual chlorine measurements were all <0.05 mg/L (n=4) (TOXTD database).

Total nitrogen

The concentrations of total nitrogen ranged from 0.085 to 0.506 mg/L at the ten sampling locations. The average concentration in 2003 was 0.303 mg/L and in 2004 was 0.224 mg/L (Howes and Samimy 2005).

Ammonia-nitrogen

The ammonium concentration in the surface sample water samples collected south of Powder Point (MA01-0031-A) and near Goose Point (MA01-0024-A) on 10 July 2001 was 0.05 and 0.041 mgN/L, respectively while the concentration in the mid-water sample collected near the tip of Plymouth Beach (station MA00-0025-B) on 6 September 2000 was 0.133 mgN/L (EPA 2003b). No comparisons to in-stream chronic criterion for ammonia-nitrogen can be made however because of the lack of pH measurements at the time of sampling.

The *Aquatic Life Use* is assessed as support for Duxbury Bay based primarily on the apparent stability of the eelgrass bed habitat, the presence of productive shellfish beds, the good survival of test organisms exposed to water from Duxbury Bay, and best professional judgment.

SHELLFISH HARVESTING

The Division of Marine Fisheries classifies the shellfish growing areas within Duxbury Bay in the following manner. Areas classified as approved are CCB42.0, CCB43.1, CCB45.0, CCB45.20, CCB45.21, and CCB46.1 (comprising 8.4 mi^2 of this segment). Areas classified as conditionally approved are CCB43.3, CCB45.2 and CCB46.2. Areas where shellfish harvesting is prohibited are CCB42.1, CCB42.3, CCB43.2, CCB43.4, CCB45.3 and CCB46.3. The cumulative size of the conditionally approved and prohibited areas is 4.3 mi^2 of this segment (MA DFG 2000; Appendix G, Table G3; and MA DMF 2002b).

The most recent DMF surveys of potential pollution sources in Duxbury Bay is described in the January 2003 Triennial Report (for Duxbury Bay Area CCB45) and in the Kingston Bay section as described in the 2002 Sanitary Survey. The 2002 Sanitary Survey of Kingston Bay identified potential pollution sources from: individual septic systems; stormwater runoff directly from storm drains and as carried into the bay through Jones River and major creeks; large flocks of waterfowl present during the winter months, and pipes. As in the Duxbury section, the pipes primarily represent yard drains and seawall weep holes draining the high groundwater table (Germano 2002). In the section of Duxbury Bay bordered by Duxbury Beach, thirteen pipes were identified along residential seawalls or at roadway storm drains; eight of which were tested for dry weather flow rate, salinity and fecal coliform concentration. DMF concluded the flow was from fresh water springs in the area and did not represent a problem for shellfish. (All but one had a concentration < 10 cfu. A storm drain 100 yards from the beach had a concentration of 20 cfu. Salinity was zero and flow ranged from 0 to 3 gallons per minute.) The Battelle Labs discharge pipe also was tested. This pipe had a flow of 5 gallons per minute, a fecal coliform result of 10 cfu and salinity of 32 ppm (Churchill 2003d).

Large acreage of shellfish beds in Kingston Bay that were prohibited are now conditionally available for harvesting due to the actions the Towns of Kingston and Duxbury have taken over the last few years to address impacts from individual septic systems and stormwater runoff. Duxbury has required twenty-nine dwellings on the south side of Bay Road to connect to an upland community septic system. Kingston has required more than four hundred houses in the Rocky Nook and Jones River areas to connect to a recently constructed wastewater treatment plant in Kingston utilizing SRF funds awarded by MassDEP (Project CW SRF-411; MA DMF 2002a). This discharge is permitted as a ground water discharge (# 659-1) (Gould 2005a). Both towns have also installed stormwater BMPs at a number of locations to correct stormwater runoff problems. In 2002 the Town of Kingston installed deep sump catch basins, a drainage conduit, and a pre-treatment and infiltration system at Cole Street (Rocky Nook) utilizing CPR grant funds (see CPR Grants, Kingston in Appendix F). Construction of stormwater improvements at Gray's Beach on the shores of Kingston Bay was completed included swales, sand filters, curbing and deep sump catch basins with funds awarded from MassDEP (Appendix F, Project 01-08/319). (See Appendix F for a full description of grants awarded by MassDEP and other state agencies in the South Shore Coastal Watershed.) Most recently the Town of Duxbury was awarded a CPR grant for the Snug Harbor Stormwater Mitigation Demonstration Project (FY2005). This project was completed in June 2005. This project should remediate stormwater pollution from Washington Street and Beaverbrook Lane that was identified by DMF as the primary source of pollution to Snug Harbor (MA CZM 2005). Sampling by DMF will be done as part of the Triennial Sanitary Survey (Station CCB45.3).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as support for 8.4 mi^2 and impaired for 4.3 mi^2 of this segment because of elevated fecal coliform bacteria. Pollution sources include waterfowl, stormwater runoff, and the Jones River (particularly its "Halls Brook" tributary) where either septic systems in the center of town near the brook or waterfowl in the wetlands contribute to elevated fecal coliform bacteria counts.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

Weekly testing for *Enterococci* bacteria during the swimming season has been conducted at three public and two semi-public beaches within the Duxbury Bay segment. These beaches include:

West End Beach, Duxbury – this public beach was tested weekly during the summers of 2002, 2003, and 2004. No postings were reported in either 2002 or 2003, but there were three reported elevated *Enterococci* bacteria counts in 2002 and two elevated counts in 2003.

Shipyard Lane Beach, Duxbury - this semi-public beach was tested weekly during the summers of 2002 and 2003. No postings were reported in 2002, but there was one reported posting in 2003 because of elevated *Enterococci* bacteria counts.

Landing Road Beach, Duxbury - this public beach was tested weekly during the summers of 2002 and 2003. No postings were reported in either 2002 or 2003. There were a few reported elevated *Enterococci* bacteria counts in 2003.

Rocky Nook Beach, Kingston - this semi-public beach was tested weekly during the summers of 2002 and 2003. No postings were reported in either year, but there was one reported elevated *Enterococci* bacteria counts in 2003.

Grays Beach, Kingston - this public beach was tested weekly during the summers of 2002 and 2003. No postings were reported in either year, but there were two reported elevated *Enterococci* bacteria counts in 2003.

According to the sampling and analysis plan for the *South Coastal Basin Estuaries Monitoring Project* ten stations within Plymouth Harbor were proposed for sampling: northeast of Clarks Island (Station PDH-12), inner central Duxbury Bay (Station PDH-13), south of Long Point (Station PDH-14), main channel east of Clark Island (Station PDH-11), main channel near Goose Point (Station PDH-8), near mouth of Jones River (Station PDH-9), off Rocky Nook (Station PDH-7), channel east of Rocky Nook (Station PDH-6), entrance to Goose Point Channel (Station PDH-5), and mouth of Bay off Duxbury Pier Lighthouse (Station PDH-10) (Appendix F, Project 03-04/604 and Howes and Samimy 2004).. Secchi disk depth at these locations was to be taken six times between June and September 2003 and 2004. Samples were collected at approximately two-week intervals during the falling tide (2 hours before and after mid-ebb tide) during the morning hours (0600 to 0900 hours). Secchi disk depth measurements were also made at a total of three stations on one occasion each within Duxbury Bay as part of the National Coastal Assessment Project (EPA 2003b). These stations were located south of Powder Point (MA01-0031-A), south of Goose Point (MA01-0024-A), and near the tip of Plymouth Beach (MA00-0025-B).

Fecal coliform bacteria samples were collected from the ten sites on six occasions between July and September 2003, five occasions between July and Septemer 2004 and again in June 2005. The fecal coliform bacteria counts ranged from <2 to 384 cfu/100 ml, although only two counts exceeded 200 cfu/100 ml (n=119) (Howes and Samimy 2005). The samples collected near the mouth of the Jones River (Station PDH9) had somewhat higher counts than the other sampling locations.

The Secchi depth data were all reported as being >1.2 m (recommended transparency) with the exception of one measurement (0.88m at Station PDH12) and the 1m measurement taken south of Powder Point (Station MA01-0030-A) on 10 July 2001 (Howes and Samimy 2005 and EPA 2003b). The highest chlorophyll *a* measurements at most stations were found during the September surveys. The sampling station near the mouth of the Jones River (Station PHD9) was found to have the highest (10.90 µg/L) and highest average concentration of chlorophyll *a* (6.65µg/L) of the ten sites sampled in Duxbury Bay. The median concentration in the samples analyzed, however, (n=98) was only 3.19 µg/L (Howes and Samimy 2005). Secchi disk depth measurements were also made at a total of three stations on one occasion each within Duxbury Bay as part of the National Coastal Assessment Project (EPA 2003b). There have been no visual observations of aesthetically objectionable conditions (e.g., oils, odors, deposits, etc.) in Duxbury Bay (DeCesare 2005).

The *Primary* and *Secondary Contact Recreation* and *Aesthetics* uses are assessed as support for Duxbury Bay based on the low fecal coliform bacteria counts. The vast majority of Duxbury Bay is approved for shellfishing (indicative of low bacteria levels) and the beaches have been open for the majority of the 2002 and 2003 bathing seasons (only one of the five beaches was posted once in 2002/2003). Additionally no aesthetically objectionable conditions were noted.

Duxbury Bay (MA94-15) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		SUPPORT 8.4 mi^2 IMPAIRED 4.3 mi^2 Cause: Elevated fecal coliform bacteria Source: Discharges from municipal separate storm sewer systems (Suspected sources: Septic systems and waterfowl)
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

RECOMMENDATIONS

Implement recommendations in the DMF shellfish management plans for Areas CCB42.0, CCB42.1, CCB42.3, CCB43.1, CCB43.2, CCB43.3, CCB43.4, CCB45.0, CCB45.2, CCB45.20, CCB45.21, CCB45.3, CCB46.1, CCB46.2, and CCB46.3.

Remediate fecal coliform bacteria sources in the Jones River (particularly its “Halls Brook” tributary) where either septic systems in the center of town near the brook and/or waterfowl in the wetlands contribute to elevated fecal coliform bacteria counts.

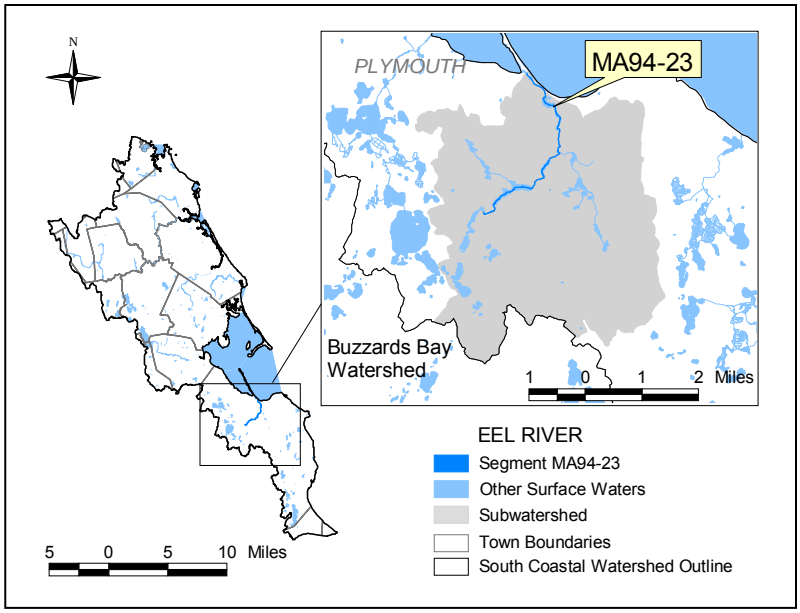
Develop a monitoring plan and conduct bacteria sampling to evaluate effectiveness of point (sewering and Phase II stormwater permits) and non-point source pollution control activities and other actions and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Support passage of the federally approved boat sewage ***No Discharge Area (NDA)*** for the entire Plymouth/Kingston/Duxbury Bay so the Bay is designated as an NDA by the 2006 boating season.

EEL RIVER (SEGMENT MA94-23)

Location: Outlet cranberry bog east of Long Pond Road, Plymouth through Russell Millpond to mouth at Plymouth Harbor, Plymouth.
Segment Length: 3.9 miles
Classification: Class B



Land-use estimates (top 3, excluding water) for the 15.1 mi^2 subwatershed (map inset, gray shaded area):

- Forest..... 70%
- Open Land..... 11%
- Residential..... 8%

Eel River is listed on the 2002 Integrated List of Waters in Category 3. This segment had insufficient information to make assessments for any of the designated uses (MassDEP 2003a).

WMA WATER WITHDRAWAL SUMMARY

For information on water users, see WMA water withdrawal summary in the unnamed tributary to Eel River (Segment MA94-35).

Additionally, there are approximately 103 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 0.92 MGD.

NPDES WASTEWATER DISCHARGE SUMMARY

There are no NPDES permits in this segment. However, there is one groundwater discharge permit of note, issued for the Town of Plymouth wastewater treatment plant. Because of concerns regarding nutrient enrichment, a technical advisory committee was established (Appendix F, Project 99-07/MWI).

The Town of Plymouth recently constructed an upgraded WWTP on Camelot Drive to discharge treated effluent through the existing outfall into Plymouth Harbor (NPDES permit 0100587) and into the groundwater of the Eel River sub-watershed. Groundwater Discharge Permit SE0-677, effective June 25, 2000, allows an average annual flow of 0.75 MGD whose characteristics shall not exceed the following values: maximum daily flow of 3.45 MGD; TSS of 30 mg/L; BOD of 30 mg/L; total nitrogen of 10 mg/L; fecal coliform bacteria of 200 cfu/100 ml and chlorine residual of 1 mg/L. The Town is further directed to maximize discharge through the ocean outfall to the limits of the NPDES permit (average monthly flow of 1.75 MGD). The permittee is required to monitor the influent waste stream and the treated effluent for nitrogen & phosphorous compounds, total suspended solids, and VOC among other parameters. Monitoring is to be performed generally twice monthly with the exception of the VOC monitoring that is required on a quarterly basis. Groundwater from nine wells is monitored for the same parameters generally on a quarterly basis. The wells are located adjacent to, and at the site boundary down gradient of, the infiltration beds. To address concerns of nutrient enrichment, pre-discharge groundwater was monitored to determine ambient phosphorous concentrations. Plant operations could be modified if phosphorous concentrations in any one of the wells increase 100% above background or exceed 0.2 mg/L for either three consecutive months or four out of six consecutive monthly sampling periods (CDM 1998, ERWNTAC 2000). Additionally, the Town of Plymouth was required as a permit requirement to develop a Nutrient Management Plan that was approved by MassDEP in August 2001 (Delorenzo 2001). It should be noted that the new WWTP became operational in May 2002.

OTHER

A FERC exempt hydropower project, the Russell Mill Pond Project No. 6429-MA is located at the dam at Russell Millpond that impounds the Eel River in Plymouth. The project consists of a 25' high, 400' long earthfill dam, a 30-acre reservoir, and 8' wide intake structure with an adjacent overflow spillway in the flume wall, a 24" diameter, 18' long steel penstock, a powerhouse containing an 18kW turbine generator, a fish ladder and appurtenant facilities. The project is supposed to operate as a run-of-river unit. The

project exemption to operate was issued on 9 May 1983 (Enrico 2003). The instantaneous minimum flow required at the project is 1 cfs or inflow, whichever is less, to protect downstream aquatic habitat (Beckett 1982). An application to surrender the exemption was filed with FERC and noticed in January 2004 (FERC 2004) and the project does not appear on the current list of FERC-exempt projects (FERC 2006).

The Gilbert Trout Hatchery, located on a tributary (locally known as Warren Wells Brook) to Russell Mill Pond, raises eastern brook and rainbow trout. There is a man-made earthen dam across Warren Wells Brook, and this reservoir and brook supply the hatchery with water. The trout are spawned on site in the spring of each year and are sold as two or three year olds (CDM 1998). This facility does not have an NPDES permit (hatchery raises approximately 12,000 to 14,000 brook trout per year) (CDM 2001) because they are below the permitting threshold of 20,000 lbs/year (314 CMR 3.16).

The Brewster Trout Hatchery is located near the Eel River downstream from the Russell Mill Pond dam. The source of water for the hatchery is groundwater seepage into a collection trench. Eastern brook trout are spawned on site in the spring of each year and are sold as two or three year olds (CDM 1998). This facility does not have an NPDES permit. The hatchery raises approximately 5,000 lbs of brook trout and rainbow trout per year (CDM 2001), below the permitting threshold of 20,000 lbs/year (314 CMR 3.16).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Several currently inactive cranberry bogs upstream from the inlet to Russell Mill Pond have been purchased by the Town of Plymouth with Community Preservation Act funds and are planned on being recovered back to original stream conditions with the assistance of the United States Department of Agriculture (USDA) and the Natural Resources Conservation Service (NRCS) funding (Maloney 2005). Since approximately March 2004 the bogs have been flooded to preserve them until the restoration plan is put into effect.

Habitat for one sampling reach in the Eel River upstream from Russell Millpond (Station BM-4) was documented by CDM biologists as part of the two year baseline monitoring program for the Plymouth WWTP upgrade/groundwater discharge permit (CDM 1998). The substrates in this narrow (5 to 10') channel were comprised of sand and cobble with a mix of riffle/run/pool habitats. Submerged macrophyte beds were also observed. The mature forest riparian zone provided almost full cover to the stream reach sampled. The streambanks, though well vegetated, were steep (Monnelly 1999).

Anadromous fish passage was required at the Russell Mill Pond FERC exempt project to protect the existing run of anadromous alewives into Russell Millpond. The exemption also requested that safe downstream migration of anadromous fish be provided at the project (Beckett 1982). The fish ladder (a weir-pool fishway) at the Russell Millpond dam has not operated since 1995 because of deterioration and dam safety issues (Neidermyer 2003). Since the fishway has not operated, the Eel River herring run was estimated to be "only a fraction of what it was (as the majority of the spawning habitat exists upstream from the dam)" (Neidermyer 2003). It should also be noted that safe downstream migration does not exist.

Habitat for two additional sampling reaches along the Eel River was also documented by CDM biologists as part of the two year baseline monitoring program for the Plymouth WWTP upgrade/groundwater discharge permit (CDM 1998). These stream reaches can be described as follows (Monnelly 1999):

- Downstream from Russell Millpond (Station BM-1) – The sampling reach was adjacent to the Brewster Fish Hatchery and was several hundred feet downstream from Russell Millpond. In-stream substrates were comprised primarily of sand and gravel with pockets of silt in deeper areas. The stream reach was almost completely shaded by a mature forest canopy and little to no macrophyte growth was observed. Both banks were well vegetated.

- Upstream Sandwich Road bridge (Station BM-2) – This sampling reach was slightly upstream from the confluence with an unnamed tributary. Although some gravel and deeper silty depositional areas were found, the substrates were comprised primarily of sand. There were also extensive submerged macrophyte beds along this primarily open canopied reach. Both banks were stable and well-vegetated.

Stage height data for the Eel River near the Sandwich Road crossing are available as part of the Massachusetts Riverways Programs pilot River Instream Flow Stewards (RIFLS) project (Riverways, 2005). Locals who live near the river have expressed concern that it has been lower in the last few summers than ever before (Kearns 2005).

The average annual flow for the Eel River at Route 3A (Warren Avenue) bridge (USGS gage 01105876) was approximately 26 cfs (period of record 1970 -1971) and was most recently reported as being 32 cfs (period of record 1998-1999) (ERWNTAC 2000). The Eel River was described as being a low gradient, cool-to-cold water coastal plain watershed with stream flow dominated by groundwater inputs and river flows relatively stable throughout the year. A water level gauge was installed in the Eel River near the Route 3A bridge in July 2003 and was removed in February 2005 for use in determining nitrogen loading to the bay from the Eel River as part of the *South Coastal Basin Estuaries Monitoring Project* (Howes and Samimy 2005).

Smelt spawning habitat was documented in the Eel River between the Route 3A bridge downstream for approximately 255 m as the river flowed along the backside of Plymouth Beach. Several stretches of clean gravel and cobble were found along this reach, but, there were also areas of sediment deposition (eroded beach sand), noted as a concern by DMF biologists (Chase in preparation).

Biology

Biomonitoring in the Eel River was required as part of the two year baseline monitoring program for the Plymouth WWTP upgrade/groundwater discharge permit at three stations (CDM 1998). From upstream to downstream these stations are as follows: Eel River near the inlet to Russell Mill Pond (Station BM-4), Eel River downstream Russell Mill Pond dam (Station BM-1), and Eel River upstream from Sandwich Road (Station BM-2). Organisms tolerant of organic pollution dominated all of the stations sampled (CDM 2005 and Fiorentino 2005). There was a preponderance of filter feeders (i.e., hydropsychid caddisflies and fingernail clams) downstream from Russell Mill Pond corroborating the productive nature of the impoundment. Unfortunately, no RPB III analysis was provided including the use of a reference station nor were the data normalized to a standardized subsample unit (e.g., approximately 100 organism subset), so no evaluation of biological condition (i.e., impairment designation) can be made from these data (Fiorentino 2005).

MDFW surveyed the fish community just downstream (north) from Sandwich Road (Station 554) on the Eel River in September 2001 (Richards 2003). Sampling yielded nine species of fish. In order of abundance, these species were: American eel (*Anguilla rostrata*); chain pickerel (*Esox niger*); largemouth bass (*Micropterus salmoides*); sea lamprey (*Petromyzon marinus*); pumpkinseed (*Lepomis gibbosus*); white sucker (*Catostomus commersoni*); and an individual each of brown bullhead (*Ameiurus nebulosus*); bridle shiner (*Notropis bifrenatus*) and yellow perch (*Perca flavescens*). With the exception of American eel, the overall number of fish was low (n=21). This could be the result of a lack of quality fish habitat (available fish cover noted by MDFW biologists as being poor). All of the species collected are macrohabitat generalists except white sucker (n=2). The bridle shiner is listed as a state species of special concern and is in sharp decline in Massachusetts, "found…at only 23% of its former sites in eastern Massachusetts" (Hartel *et al*. 2002). Bridle shiner are classified as being intolerant to pollution, but no specific reason is given for their present decline. It should be noted that a substantial number of bridle shiner were found in the lower Eel River between Hayden Pond and the Eel River Pond impoundments during a survey conducted in 1999 (ERWNTAC 2000). The remaining fish collected are all considered to be tolerant or moderately tolerant of pollution. The preponderance of macrohabitat generalists and the relative absence of fluvial specialist/dependant species in the Eel River may be due to the presence of several impoundments both upstream and downstream from the sampling station.

It should be noted that two small impoundments (i.e., Hayden Pond and Eel River Pond) along this segment of the Eel River are both heavily infested with the non-native aquatic plant *Cabomba caroliniana* (fanwort) (Mercer and Monnelly 2000).

Smelt eggs and spawning Atlantic tomcod have been reported in the Eel River in the vicinity of Route 3A in Plymouth (Reback *et al.* 2004).

Chemistry – water

Water quality monitoring in the Eel River was required as part of the monitoring program for the Plymouth WWTP upgrade/groundwater discharge permit at four stations (CDM 1998 and Carlson 2005). From upstream to downstream these stations are as follows: Eel River near the inlet to Russell Mill Pond (Station S-6), near outlet Russell Mill Pond (Station S-2), near outlet Hayden Pond (Station S-3) and Eel River at Route 3A (Warren Avenue) bridge (Station S-5). *In-situ* measurements of DO, temperature, pH and Secchi disk depth, along with samples for nutrients (nitrogen and phosphorus), chloride, boron, total dissolved solids, and chlorophyll *a*, at these locations were to be taken seven times each year during February, May through September, and November (CDM 1998). This sampling has been conducted since May 1998 and continued through at least July 2004 (Carlson 2005). Insufficient quality assurance data, however, are currently available for the *in-situ* data. It should also be noted that there are data quality issues with the laboratory reported data that need to be resolved in a data validation report such as duplicate samples with Relative Percent Difference (RPDs) >50% or data values reported below the method detection limit. (Note: as an example for field replicate samples with a method detection limit <1 mg/L, MassDEP would either censor or qualify data that had an RPD >30%.) Therefore these data, though summarized below, were not utilized for this assessment.

According to the sampling and analysis plan for the *South Coastal Basin Estuaries Monitoring Project* two stations in the Eel River were proposed for sampling: near Sandwich Road (Station PDH-19) and at Route 3A (Warren Avenue) bridge (Station PDH-18) (Appendix F, Project 03-04/604 and Howes and Samimy 2004). Water quality sampling for nutrients (inorganic and organic nitrogen and phosphorus), chlorophyll *a*, and specific conductance at these locations were to be taken weekly between June 2003 and September 2004. Water quality samples were collected near Route 3A (Station PDH-18) on a weekly basis since July 2003 for use in determining nitrogen loading to the bay from the Eel River as part of the *South Coastal Basin Estuaries Monitoring Project* (Howes and Samimy 2005). Between July 2003 and February 2005, samples were analyzed for nutrients (total nitrogen and phosphorus). Although the actual quality assurance data has not been released to MassDEP, data validation is required as part of this project and was conducted prior to the release of the data which are summarized below.

In-situ measurements of dissolved oxygen, temperature, conductivity and salinity were taken by DWM during the summer of 1996 at four stations along the Eel River as well as two stations on an unnamed tributary in order to establish "background" conditions and assess conditions prior to the new groundwater discharge. These data can be found in Appendix B, Table B2.

Dissolved oxygen

Dissolved oxygen measurements in the Eel River near the inlet to Russell Mill Pond (Station S-6) reported by CDM were almost all >6.0 mg/L although there was some evidence of productivity (supersaturation). There were two incidences where the normal pattern of DO fluctuation from early morning to afternoon were reversed (October/November 2002). These data are considered suspect with respect to the other available data. Similar conditions were documented in the river downstream from the outlet of Russell Mill Pond (station S-2). Generally higher and more stable concentrations (little variations between morning and afternoon measurements) of dissolved oxygen were reported in the Eel River downstream of Hayden Pond (station S-3) near Sandwich Road bridge and none of the saturations exceeded 108%. Although dissolved oxygen measurements at the most downstream sampling location in the Eel River at Route 3A/Warren Avenue bridge (Station S-5) were also generally high and stable, supersaturation has been common in the afternoon particularly since August 2002.

pH

The pH of the Eel River near the inlet to Russell Mill Pond (Station S-6) reported by CDM was generally low (<6.5 SU) with the exception of two very high measurements (DWM staff consider them spurious). The pH of the river downstream from the outlet of Russell Mill Pond (Station S-2), downstream of Hayden Pond (Station S-3), and near the Route 3A/Warren Avenue bridge (Station S-5) was somewhat higher (generally >6.5 SU).

Temperature
Although in-stream temperatures in the Eel River at the most upstream sampling location were generally <20ºC, higher in-stream temperatures throughout the summer months reflected the influence of the impoundments at the downstream sampling locations. The maximum temperature of the Eel River near the inlet to Russell Mill Pond (Station S-6) reported by CDM was 23ºC (August 1999), while the maximum temperature of the river downstream from the outlet of Russell Mill Pond (Station S-2) was 24.9ºC, downstream of Hayden Pond (Station S-3) was 26.2ºC, and near Route 3A/Warren Avenue bridge (Station S-5) was 27.1ºC (all documented in July 1999).

Conductivity
The specific conductivity of the Eel River near the inlet to Russell Mill Pond (Station S-6) reported by CDM (2005) was generally less than 100 µS/cm. Similar conductivities were measured downstream of Russell Mill Pond (Station S-2). Slightly higher conductivities were measured in the river downstream of Hayden Pond (Station S-3) and were, with one exception, consistently >100 µS/cm in the river near Route 3A/Warren Avenue bridge (Station S-5).

Total nitrogen
The concentration of total nitrogen reported by CDM (2005) in the Eel River near the inlet to Russell Mill Pond (Station S-6) ranged from 0.230 to 1.233 mg/L with an average concentration of 0.658 mg/L (n=20 between June 1999 and November 2003). Several currently inactive cranberry bogs upstream from this sampling location have been flooded since approximately March 2004 to preserve them until the restoration plan is put into effect. It should be noted here that flooded bogs are a known source of nutrient leaching (DeMoranville and Howes 2005). The concentration of total nitrogen in the Eel River downstream from Russell Mill Pond (Station S-2) reported by CDM (2005) ranged from 0.180 to 1.474 mg/L with an average concentration of 0.484 mg/L (n=25 between June 1999 and November 2003). The concentration of total nitrogen in the Eel River in Hayden Pond (Station S-3) ranged from 0.327 to 1.968 mg/L with an average concentration of 0.716 mg/L (n=19 between June 1999 and November 2003). The concentration of total nitrogen in the Eel River near the Route 3A/Warren Avenue bridge (Station S-5) ranged from 0.187 to 1.348 mg/L with an average concentration of 0.512 mg/L (n=19 between June 1999 and November 2003). The concentration of total nitrogen in the Eel River near the Route 3A (Warren Avenue) bridge (Station PDH-18) reported by the University of Massachusetts School of Marine Science and Technology (SMAST) ranged from 0.212 to 1.164 mg/L with an average concentration of 0.489 mg/L (n=89) (Howes and Samimy 2005).

Total phosphorus
The total phosphorus concentration in the Eel River near the inlet to Russell Mill Pond (Station S-6) reported by CDM (2005) ranged from 0.017 to 0.407 mg/L. It should be noted that the highest concentrations of total phosphorus were detected in samples collected in November each year which may be due to the cranberry bogs as noted above. Half of the samples analyzed exceeded 0.05 mg/L, although very few samples exceeded 0.06 mg/L (exclusive of the November data). The concentration of total phosphorus in the Eel River downstream from Russell Mill Pond (Station S-2) reported by CDM ranged from 0.003 to 0.062 mg/L. Almost all measurements were <0.05 mg/L. It should be noted that these data need validation. Similarly, generally low concentrations (i.e., <0.05 mg/L) of total phosphorus were measured in samples collected from the Eel River downstream from and in Hayden Pond (Station S-3) and in the river near the Route 3A/Warren Avenue bridge (Station S-5). The concentration of total phosphorus in the Eel River near Route 3A (Warren Avenue) bridge (Station PDH-18) reported by SMAST ranged from 0.0064 to 0.0864 mg/L with an average concentration of 0.0418 mg/L (n=89) (Howes and Samimy 2005).

The *Aquatic Life Use* is assessed as impaired for the Eel River because of the lack of anadromous fish passage upstream from the Russell Millpond dam and the heavy infestation of the non-native macrophyte *Cabomba caroliniana* in two small impoundments (i.e., Hayden Pond and Eel River Pond) in the lower portion of the river. It should also be noted that with the exception of American eel, the overall number of fishes was low and comprised primarily of tolerant species.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

According to the sampling and analysis plan for the *South Coastal Basin Estuaries Monitoring Project* two stations in the Eel River were proposed for sampling: near Sandwich Road (Station PDH-19) and near at Route 3A (Warren Avenue) bridge (Station PDH-18) (Appendix F, Project 03-04/604 and Howes and Samimy 2004). Fecal coliform bacteria sampling and Secchi depth measurements at these locations were to be taken weekly between June 2003 and September 2004. Three fecal coliform bacteria samples were collected and analyzed from each of the sampling locations in July/August 2004. The highest count was 100 cfu/100 ml (Howes and Samimy 2005). Fecal coliform bacteria samples were also collected by DWM during the summer of 1996 at four stations along the Eel River in order to establish "background" conditions and to assess conditions prior to the new groundwater discharge. These data can be found in Appendix B, Table B3.

The *Primary* and *Secondary Contact Recreational* uses are assessed support for the Eel River based on the low fecal coliform bacteria counts.

Eel River (MA94-23) Use Summary Table

Designated Uses		Status
Aquatic Life		IMPAIRED Causes: Fish barriers upper 1.2 mile reach and Non-native aquatic macrophyte lower 2.7 mile reach Sources: Hydrostructure impacts on fish passage upper 1.2 mile reach and Unknown lower 2.7 mile reach
Fish Consumption		NOT ASSESSED
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		NOT ASSESSED

RECOMMENDATIONS

The fishway at Russell Millpond should be redesigned and replaced to restore herring access (both upstream and downstream) to the pond (Reback *et al.* 2004).

The bank of Eel River along Plymouth Harbor Beach could be stabilized with native plants to reduce the erosion of sand that degrades the spawning riffles along this stretch (Chase in preparation).

Future benthic macroinvertebrate community assessments should include the use of an appropriate reference station, a more standardized subsampling method, and RBP III multimetric analysis to better evaluate the status of the *Aquatic Life Use*.

Continue to perform fisheries assessments to monitor the bridle shiner population and document any changes to the fish community.

Continue to review and evaluate the information developed as part of Plymouth's Groundwater Discharge Permit SE0-677 as well as the watershed monitoring plan and the nutrient management plan.

The SMAST study of Plymouth Harbor should be reviewed when completed for any insight on nutrient loading to the Eel River, Plymouth Harbor, and Ellisville Harbor. This study is currently underway, but a due date for the Technical Report submission has not been assigned.

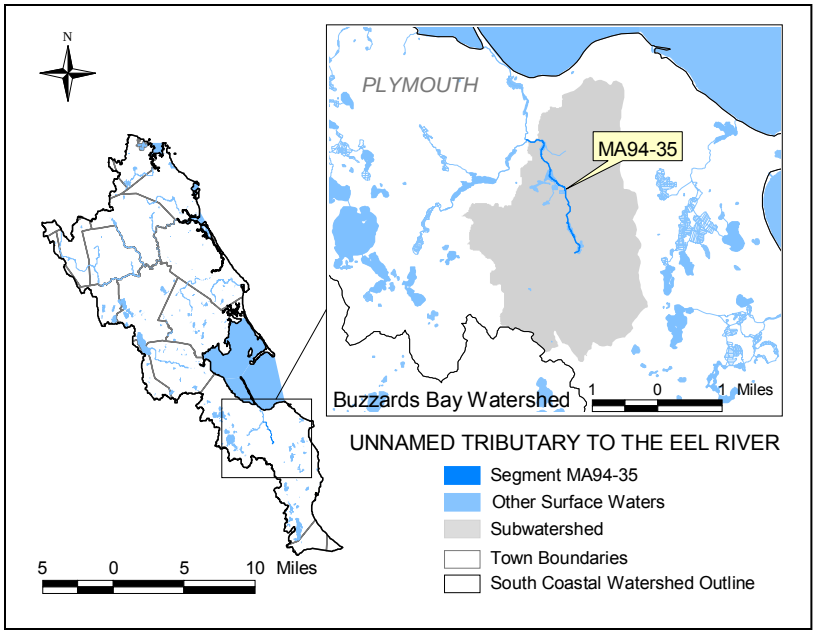
Evaluate changes associated with the restoration of abandoned cranberry bogs back to stream habitat.

UNNAMED TRIBUTARY TO EEL RIVER (SEGMENT MA94-35)

Location: Outlet cranberry bog south of Valley Road, Plymouth through Forge Pond to confluence with Eel River, Plymouth.
Segment Length: 2.4 miles
Classification: Class B

Land-use estimates (top 3, excluding water) for the 7.5 mi^2 subwatershed (map inset, gray shaded area):

Forest..... 79%
Open Land..... 12%
Agriculture..... 4%



WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Source	Authorized Withdrawal (MGD)
OS Golf Club	9P442123909	N/A	Well #1	0.27
Pinehills, LLC	9P342123903	N/A	4239055-01G Main well 4239055-02G Backup well 4239055-03G Jockey well Four irrigation wells: Forest Edge Well Stonebridge Well Summerhouse Well Winslowe's View Well	0.46
Plymouth Country Club	9P442123907	N/A	Well #1 Well #2	0.11

Note (O'Shea 2005): There are two additional applications for WMA permits currently under review in this subwatershed. The Waverly Oaks Golf Club, Inc. has applied for a WMA permit to withdraw water for irrigation of a 27-hole golf course. The withdrawal volume requested is 0.31 MGD on an average daily basis. In addition a WMA permit application has been filed for the Forges Field complex that will include the 27-hole Crosswinds Golf Course and up to 12 municipal ballfields. The withdrawal volume requested is 0.2 MGD on an average daily basis.

Additionally, there are approximately 17 acres of cranberry bog open space in this subwatershed, inclusive, but not limited to,WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 0.15 MGD.

NPDES WASTEWATER DISCHARGE SUMMARY

There are no NPDES discharges to this segment.

OTHER

The Pinehills Development is a master-planned, multi-use development located on approximately 3,084 acres of previously undeveloped land in Plymouth. When fully built out, Pinehills is expected to include 3,797 residences, 1.3 million square feet of commercial uses, a private sewer treatment facility for up to 150,000 GPD, and up to four golf courses. Approximately 70% of the property will be retained as open space. The final groundwater discharge permit (file #SE0-680) was issued to the Pinehills Development

LLC on March 2, 2000 and modified twice by July 29, 2003. For purposes of the groundwater discharge permit, the site is separated into 3 groundwater sectors; groundwater sector 1 drains into the Eel River subwatershed, the other two sectors drain into the Plymouth-Carver Sole Source Aquifer. All three sectors are considered *nutrient sensitive* and, therefore, the permit was reviewed pursuant to the MassDEP Interim Policy entitled *Nutrient Loading Approach to Wastewater Permitting and Disposal,* dated August 1999. All *phosphorus generating land uses* proposed in the Eel River Watershed (e.g. road runoff, runoff from lawns, turf and agricultural uses) are subject to a combined vertical and horizontal setback of 200 feet from surface water bodies or have BMPs installed with demonstrated equivalent protection. Golf courses and on-site septic systems within 300 feet of surface waterbodies are subject to management practices to ensure maximum phosphorus attenuation. An annual report is submitted to the MassDEP on the anniversary date of permit issuance and includes: calculations of nutrient loading as a result of the development in the previous year, results of the groundwater and surface water monitoring program, land use restrictions and drinking water protection (Horsley & Whitten 2003). The private sewer treatment facility was used as a holding facility for wastewater until the spring of 2003 (Dudley 2005). Prior to the discharge the wastewater was hauled to the Plymouth WWTP for processing.

Recent field reconnaissance by DWM biologists revealed large horse farms in the lower portion of this subwatershed area (particularly between Forge and Howland Ponds) and high densities of waterfowl around and in Howland Pond (Fiorentino 2006).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Habitat for one sampling reach along this unnamed tributary of the Eel River was documented by CDM biologists as part of the two year baseline monitoring program for the Plymouth WWTP upgrade/groundwater discharge permit (CDM 1998). In-stream habitat conditions were described for the reach (Station BM-3A) in this stream located approximately 100' upstream from the Forge Road crossing, in the reach of the river between Forge and Howland ponds (this was slightly downstream from the reach -Station ER-4 sampled by Horsley & Witten as described below). Substrates were comprised primarily of sand and gravel, although submerged macrophytes also provided habitat. The streambanks were well vegetated and gently sloped. The majority of the channel was covered with overhanging vegetation and a mature forest canopy (Monnelly 1999). In-stream habitat was limited most by the lack of pool variability and sediment deposition.

While it is a low priority for DMF, it should be noted that fish passage is lacking at all of the impoundments along this tributary to the Eel River (Reback *et al*. 2004).

Biology

Biomonitoring in this unnamed tributary of the Eel River has been required as part of the Pinehills groundwater discharge permit (0-680) since 2001 for informational purposes (Horsely & Whitten 2003). Periphyton, phytoplankton, macroinvertebrates, and/or macrophytes were sampled at nine stations including impoundments and riverine reaches. From upstream to downstream stations are as follows: upper impoundment near Valley Road (Station ERP-1), second impoundment near Valley Road (Station ERP-2), unnamed tributary upstream from Forge Pond (Station ER-2), unnamed tributary near inlet to Forge Pond (Station ER-3), Forge Pond (Station ERP-3), unnamed tributary downstream from Forge Pond (Station ER-4), unnamed tributary near the inlet to Howland Pond (Station ER-5), Howland Pond (Station ERP-4) and unnamed tributary downstream from Howland Pond (Station ER-6). Although year-to-year variability within each site was apparent, the benthic macroinvertebrate community appeared most healthy (good overall community structure and function) in the river upstream from Forge Pond (Station ER-2). Stations ER-4 and ER-6 exhibited impoundment effects (i.e., high percentage of filter feeders, low diversity) as compared to Station ER-2. That said, the community at Station ER-2 also exhibited the most notable changes -- taxa richness dropped from 20 and 22 in 2002 and 2003, respectively, to 11 in 2004 and there was a large reduction in EPT richness (12 to 4) in that same timeframe (Horsley & Witten 2003, Horsley & Witten 2004, and Horsley & Witten 2005). Unfortunately only order/family level taxonomy was provided nor were comparisons to a suitable reference station provided. The lack of an RBP III analysis precludes the evaluation of biological condition (i.e., impairment designation) (Fiorentino 2005).

Biomonitoring at one location in this unnamed tributary to the Eel River was conducted as part of the two year baseline monitoring program for the Plymouth WWTP upgrade/groundwater discharge permit (CDM 1998). The sampling station (Station BM-3A) was located approximately 100' upstream from the Forge Road crossing, in the reach of the river between Forge and Howland ponds. This was slightly downstream from the reach (Station ER-4) sampled by Horsley & Witten. Total taxa richness (including EPT taxa) of the benthic community in the unnamed tributary at 3A, while slightly better than found in the Eel River, was dominated by filter feeders including those tolerant of organic pollution (e.g., simuliid blackflies) (CDM 2005 and Fiorentino 2005). The impoundment effects here are consistent with findings of Horsley & Witten. Unfortunately no RPB III analysis was provided, including the use of a reference station, and the data were not normalized to a standardized subsample unit (e.g., approximately 100 organism subset). Therefore, no evaluation of biological condition (i.e., impairment designation) can be gleaned from these data (Fiorentino 2005).

MDFW monitored the fish population assemblage near the mouth of this stream downstream from Clifford Road (Station #550) on this unnamed tributary to the Eel River in September 2001 (Richards 2003). Sampling yielded eight species of fish. They were, in order of abundance; 72 American eel (*Anguilla rostrata*), 38 golden shiner (*Notemigonus crysoleucas*), 15 pumpkinseed (*Lepomis gibbosus*), 11 largemouth bass (*Micropterus salmoides*), chain pickerel (*Esox niger*), bridle shiner (*Notropis bifrenatus*), and an individual each of sea lamprey (*Petromyzon marinus*) and yellow perch (*Perca flavescens*). All of the species collected are macrohabitat generalists. The bridle shiner is listed as a state species of special concern, and is in sharp decline in Massachusetts, "found…at only 23% of its former sites in eastern Massachusetts" (Hartel *et al*. 2002). Bridle shiners are classified as being intolerant to pollution, although no specific reason is given for their present decline. The remaining fish collected are all considered to be tolerant or moderately tolerant of pollution. The dominance of macrohabitat generalists (and pond species) in this unnamed tributary of the Eel River may in part be due to the presence of several impoundments both upstream and downstream (Eel River) of the sampling station. It should be noted that MDFW biologists rated the overall available fish cover as poor.

Chemistry – water

Water quality monitoring in the unnamed tributary to Eel River was required as part of the Pinehills Groundwater Discharge Permit (0-680) (Horsley & Witten 2003). The purpose of the monitoring is to characterize baseline conditions and detect whether any changes occur over time as a result of development. Nine stations, including impoundments and riverine reaches, were sampled on six occasions each year and included from upstream to downstream the following: upper impoundment near Valley Road (Station ERP-1), second impoundment near Valley Road (Station ERP-2), unnamed tributary upstream from Forge Pond (Station ER-2), unnamed tributary near the inlet to Forge Pond (Station ER-3), Forge Pond (Station ERP-3), unnamed tributary downstream from Forge Pond (Station ER-4), unnamed tributary near the inlet of Howland Pond (Station ER-5), Howland Pond (Station ERP-4) and unnamed tributary downstream from Howland Pond (Station ER-6). *In-situ* measurements for DO, pH, temperature, turbidity, and specific conductivity were made using a Hydrolab™ sensor between 0600 and 0900 hours. Water quality sampling for nutrients (total nitrogen and total and dissolved phosphorus), chloride, and chlorophyll *a* was also conducted and samples were analyzed at UMass Dartmouth Campus by the School of Marine Science and Technology (SMAST). Insufficient quality assurance data, however, are currently available, so these data were not utilized for this assessment.

Water quality monitoring in the unnamed tributary to the Eel River was conducted as part of the program for the Plymouth WWTP upgrade/groundwater discharge permit near the Clifford Road Bridge (Station S-4 downstream from Howland Pond) (CDM 1998 and Carlson 2005). *In-situ* measurements of DO, temperature, pH and Secchi disk depth, along with samples for nutrients (nitrogen and phosphorus), chloride, boron, total dissolved solids, and chlorophyll *a*, at these locations were to be taken seven times each year during February, May through September, and November (CDM 1998). This sampling has been conducted since May 1998 and continued through at least July 2004 (Carlson 2005). Insufficient quality assurance data, however, are currently available for the *in-situ* data. It should also be noted that there are data quality issues with the laboratory reported data that need to be resolved in a data validation report such as duplicate samples with Relative Percent Difference (RPDs) >50% or data values reported below the method detection limit. (Note: as an example for field replicate samples with a method detection limit <1 mg/L, MassDEP would either

censor or qualify data that had an RPD >30%.) Therefore these data, though summarized below, were not utilized for this assessment.

In-situ measurements of dissolved oxygen, temperature, conductivity and salinity were taken by DWM during the summer of 1996 at two stations on this unnamed tributary to the Eel River in order to establish "background" conditions and assess conditions prior to the new groundwater discharge. These data can be found in Appendix B, Table B2.

Dissolved oxygen
Dissolved oxygen measurements in the unnamed tributary to the Eel River near the Clifford Road Bridge (Station S-4 downstream of Howland Pond) reported by CDM were almost all >6.0 mg/L although there was some evidence of productivity (supersaturation).

pH
Approximately half of the pH measurements of the unnamed tributary to the Eel River near the Clifford Road Bridge (Station S-4 downstream from Howland Pond) reported by CDM were <6.5SU.

Temperature
The maximum temperature of the unnamed tributary to the Eel River near the Clifford Road Bridge (Station S-4 downstream from Howland Pond) reported by CDM was 27.3ºC (documented in July 1999). Higher in-stream temperatures (i.e., >20ºC) throughout the summer months reflected the influence of the impoundments.

Conductivity
The specific conductivity of the unnamed tributary to the Eel River near the Clifford Road Bridge (Station S-4 downstream from Howland Pond) reported by CDM was generally less than 100 µS/cm.

Total nitrogen
The concentration of total nitrogen in the unnamed tributary to the Eel River near the Clifford Road Bridge (Station S-4 downstream from Howland Pond) reported by CDM ranged from 0.083 to 1.3 mg/L with an average concentration of 0.447mg/L (n=19).

Total phosphorus
The concentration of total phosphorus in the unnamed tributary to the Eel River near the Clifford Road Bridge (Station S-4 downstream from Howland Pond) reported by CDM ranged from 0.017 to 0.25 mg/L. Few samples (n=3) exceeded 0.05 mg/L.

The *Aquatic Life Use* is not assessed for this unnamed tributary of the Eel River due to the lack of quality assurance information and RBP III analyses that precludes the use of the in-stream water quality data generated by consultants as part of the Pinehills Development project and the Plymouth WWTP upgrade. The *Aquatic Life Use* is identified with an Alert Status because the benthic macroinvertebrate community in the river upstream from Forge Pond which exhibited good overall community structure and function in 2002 and 2003 recently (2004) exhibited a decrease in both taxa richness and EPT taxa, which is of concern considering the development in the upper subwatershed area.

PRIMARY AND SECONDARY CONTACT RECREATION

Fecal coliform bacteria samples were collected by DWM during the summer of 1996 at two stations along the unnamed tributary of the Eel River. These data can be found in Appendix B, Table B3.

No recent bacteria data are available, so the recreational uses are not assessed.

Unnamed Tributary to Eel River (MA94-35) Use Summary Table

Designated Uses		Status
Aquatic Life		NOT ASSESSED*
Fish Consumption		NOT ASSESSED
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		NOT ASSESSED

*Alert Status issues identified, see details in use assessment.

RECOMMENDATIONS

The location of sampling station ER-2 (upstream from Forge and Howland ponds and closer to the Pinehills development) appears to make this site most susceptible to anthropogenic impacts and is therefore the best choice for future benthic macroinvertebrate monitoring. Documentation of habitat quality and instream sampling conditions (i.e., habitat assessment field sheets) is also a necessary component of benthic macroinvertebrate community monitoring and should be included as a requirement of the Pinehills groundwater discharge permit (0-680).

Guidance to the consultant should be provided to improve reporting of water quality data generated as part of the Pinehills groundwater discharge permit including quality assurance/control as well as documentation of data validation process. Implementation of this guidance is necessary to meet the stated goal of the permit (document changes associated with development) and to utilize data for 305(b)/303(d) reporting purposes. Data validation for the Plymouth WWTP upgrade project data also needs to be implemented.

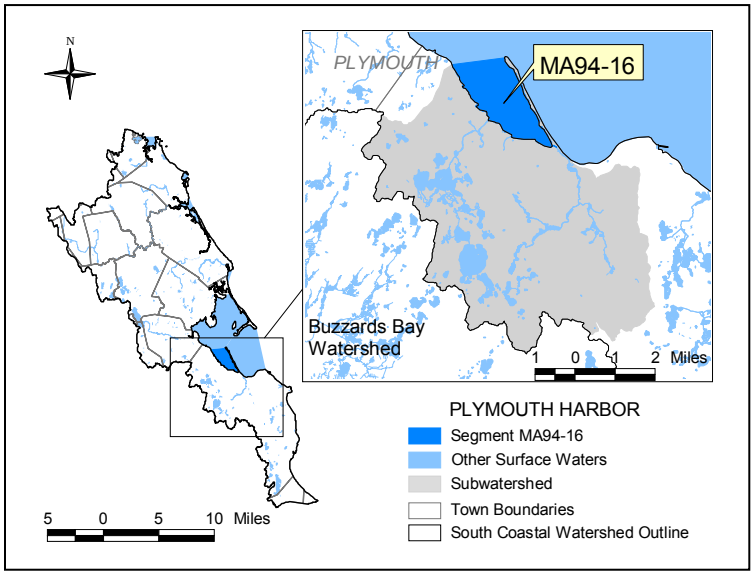
Future benthic macroinvertebrate community assessments should include the use of an appropriate reference station, a more standardized subsampling method, and RBP III multimetric analysis to better evaluate the status of the *Aquatic Life Use*.

Investigate potential nonpoint source inputs of bacteria and nutrients from horse farms and waterfowl particularly between Forge and Howland ponds. Recommend BMPs (e.g., establishing a riparian buffer zone, outreach and education) to protect instream water and habitat quality as deemed appropriate.

Continue to perform fisheries assessments to monitor the bridle shiner population and document any changes to the fish community.

PLYMOUTH HARBOR (SEGMENT MA94-16)

Location: The waters south of a line drawn from the tip of Plymouth Beach to High Cliff, Plymouth.
Segment Length: 2.53 square miles
Classification: Class SA



Land-use estimates (top 3, excluding water) for the 27.8 mi^2 subwatershed (map inset, gray shaded area):

Forest..... 57%
Residential..... 17%
Open Land..... 11%

Plymouth Harbor is listed on the 2002 Integrated List of Waters in Category 5. This segment is impaired due to pathogens and a TMDL is required (MassDEP 2003a).

The Town of Plymouth manages a concrete boat ramp for general access and a boat pump out station at Town Pier on Water Street. The boat ramp has three launching lanes and parking for 102 trailers and 15 vehicles (MA DFG 2003). The pump-out facility has two self-service pump-out stations with unrestricted hours and a pump-out boat that operates on weekends from 10 am thru 3 pm. The pump-out facility was funded by the Clean Vessel Act to provide free pump-outs for the recreational and commercial boating fleet (MA DMF 2003). Pilgrim Memorial State Park, also located in downtown Plymouth, provides shoreline pedestrian access (MA DCR 2003c).

Brewer's Plymouth Marine, located on Union Street just north of Water Street, also has a pump-out facility that was funded by the Clean Vessel Act to provide free pump-out services (MA DMF 2003, Callaghan 2003, Brewers Marine 2003).

Plymouth Harbor was included in the *Nonpoint Source Pollution Assessment of Plymouth, Kingston and Pembroke, 2001-2002,* prepared by GeoSyntec Consultants with MWI funding (Project #01-07/MWI). The consultant performed an inventory of each water body for possible sources of pollution based on field inspections and compilation of existing information. There were 34 outfall pipes identified during the April 2001 field inspection from local streets that drain directly into the harbor, including 15 that had observed flow. There was no evidence of shoreline erosion or trash along the shoreline. Potential non-point sources identified in the report include runoff from impervious surfaces, possible illicit discharges into the storm drains and boat waste (GeoSyntec 2002). The Division of Marine Fisheries performed a Sanitary Survey in October 2000 that identified 13 pipes with dry weather flows. These pipes were sampled for fecal coliform bacteria with the following results: 2 stations at Stephens Field and Howes Lane had bacterial concentrations too numerous to count (>1000 cfu/100 ml); the remaining 11 stations had results ranging from 20 – 160 cfu/100 ml (Churchill 2000b).

The Town of Plymouth has a comprehensive program to address bacterial pollution in Plymouth Harbor that utilizes funds from the MassDEP/EPA 319 and SRF Programs, the CZM Coastal Pollution Remediation Program and other sources. Early efforts addressed bacterial pollution from wastewater (upgrades of the WWTP) and boats (pump-out facilities). In 2001 a Stormwater Working Group comprised of town and state agency representatives was formed, prioritized sites from the DMF Sanitary Survey based on the water quality impact and potential for successful mitigation and has received funding to address the top four priority sites. The Town was awarded a 319 grant in 2002 (Project 02-09/319) to install infiltration stormwater treatment devices at Stephens Field, Howes Lane and Lincoln Street. A CPR grant was awarded in 2003 for the fourth priority site (Samoset Street) that will assess the drainage area and design the most appropriate stormwater BMP (Town of Plymouth 2002). A 319 Grant (04-09/319) was awarded in 2005 for the purpose of implementing the designs for the Samoset Street site (Town of Plymouth 2003). There will be water quality monitoring performed in accordance with an approved QAPP before and after installation of the 319 funded BMPs to measure project success. For more information on these grant awards see Appendix F.

WMA WATER WITHDRAWAL SUMMARY (APPENDIX E, TABLE E5)

Facility	WMA Permit Number	WMA Registration Number	Source	Authorized Withdrawal (MGD)
Plymouth DPW	9P42123901	N/A	4239000-01G Lout Pond well 4239000-05G North Plymouth well 4239000-06G Bradford well 4239000-09G South Pond well #1 4239000-10G South Pond well #2	6.0*

*System-wide withdrawal, all sources are not necessarily within this segment.

There are 337 acres of cranberry bog open space in this subwatershed, inclusive but not limited to WMA registered growers (UMass Amherst 1999). For the purpose of this report, a conservative estimate of water use for this bog area is approximately 3.0 MGD.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX E, TABLE E1)

The Town of Plymouth is authorized (MA0100587 issued in November 2004) to discharge from the Plymouth Wastewater Treatment Plant (WWTP) a flow of 1.75 MGD (average monthly) of treated effluent via Outfall #001 to Plymouth Harbor consistent with the requirements of the Ocean Sanctuaries Act and to discharge the remainder of the treated volume into the ground within the Eel River sub-watershed. The WWTP on Water Street (which went online in March 1970) was abandoned after the new 5.2 MGD facility at Camelot Industrial Park became operational in May 2002. The Plymouth WWTP's treated effluent is directed accordingly: (1) 88.2% average annual daily flow is discharged to Plymouth Harbor and (2) 11.8% average annual daily flow is discharged to the ground (Frizzell 2004). This relatively new sequencing batch reactor facility performs year-round nitrification for ammonia-nitrogen reduction and denitrification for the reduction of total nitrogen (Carvello 2004). The previous facility only nitrified ammonia-nitrogen. The facility reports ammonia-nitrogen data (June 1 to September 30). The ammonia-nitrogen concentrations in the effluent between October 2000 and January 2004 ranged from <0.10 to 23.2 mg/L (n=13)(TOXTD database). The pH (6.0 to 8.5 SU) of the effluent between October 2000 and January 2004 ranged from 6.8 to 7.7 SU (n=13)(TOXTD database). The Plymouth WWTP uses sodium hypochlorite (NaOCl) for disinfection. The TRC concentrations [permit limits of 0.075 mg/L (average monthly) and 0.130 mg/L (maximum daily)] between October 2000 and January 2004 were all <0.05 mg/L (n=13)(TOXTD database). The facility's whole effluent toxicity limits are $LC_{50} \geq 100$ and CNOEC $\geq$10% effluent using *Mysidosis bahia, Arbacia punctulata,* and *Menidia beryllina* as test species on a quarterly basis. *(See the Eel River Segment 94-23 for details of the groundwater discharge permit.)*

A NPDES General Permit (MAG250020) was issued to Harborview Place in December 2002 to discharge non-contact cooling water via two outfalls into Plymouth Harbor. DMF sampled these outfalls (P.S. #24 and #25) in September 2003 for fecal coliform bacteria. The results were <10 cfu/100 ml and 30 cfu/100 ml. There may have been some coastal water mixing in the P.S. #25 outfall since the pipe was partially submerged and had a salinity concentration of 15 ppm.

USE ASSESSMENT

AQUATIC LIFE

Eelgrass Bed Habitat

MassDEP's Wetlands Conservancy Program (WCP) identified the presence of eelgrass in Plymouth Harbor from historic 1951 black and white aerial photography (Costello 2003). In 1998 MassDEP WCP performed field verification of 1995 aerial photography and mapped the extent of eelgrass bed habitat in Plymouth Harbor. Total areal coverage of the harbor from the 1998 survey was approximately 8%. In 2001 MassDEP WCP performed field verification of 2001 aerial photography and mapped the extent of eelgrass bed habitat in Plymouth Harbor. There was almost no change in the size of eelgrass beds between 1998 and 2001. However, there has been a major loss of eelgrass since 1951.

Habitat and Flow

The tide range within Plymouth Harbor is in the range of 9'. There is a reportedly high degree of water exchange as a result of the tides (ERWNTAC 2000).

Biology
There are scattered beds of soft-shell clams (*Mya arenaria*) in low abundance along the Plymouth shoreline. Commercially viable quantities of blue mussels (*Mytilus edulis*) can be founding the two center tidal flats (Churchill 2003e).

Since May 2000 and continuing through May 2004, the Entergy Nuclear Generation Company (ENGC) has conducted efforts to support fisheries enhancement by releasing winter flounder spawned and reared in a hatchery from January to May into Plymouth Harbor near the Yacht Club (Environmental Protection Group 2005).

Toxicity
Ambient
The Plymouth WWTP staff collected water from Plymouth Harbor from the jetty approximately 100 yards away from Outfall #001 for use as dilution water in the whole effluent toxicity tests (Ernst 2004). Between October 2000 and January 2004, survival of *M. bahia* exposed (48 hours) to the harbor samples ranged from 93-100% (n=13) while survival of *M. beryllina* exposed (7-day) ranged from 85-100% (n=12).

Effluent
Between October 2000 and January 2004, whole effluent toxicity tests were conducted on the Plymouth WWTP effluent using *M. bahia* and *M. beryllina.* The LC_{50}s were $\geq$ 100% in all of the tests conducted while the *M. beryllina* C-NOEC results ranged from 50 to 100% (n=12) effluent.

Chemistry – water
Water quality monitoring was required as part of the monitoring program for the Plymouth WWTP upgrade/groundwater discharge permit at two stations in Plymouth Harbor: the head of Plymouth Harbor near the Eel River (Station S-7) and near the middle of the harbor (Station S-10) (CDM 1998). *In-situ* measurements of DO, temperature, pH and Secchi disk depth, along with samples for nutrients (nitrogen and phosphorus), chloride, boron, total dissolved solids, and chlorophyll *a*, at these locations were to be taken seven times each year during February, May through September, and November (CDM 1998). However, insufficient quality assurance data are currently available for the *in-situ* data. It should also be noted that there are data quality issues with the laboratory reported data that need to be resolved in a data validation report such as duplicate samples with Relative Percent Difference (RPDs) >50% or data values reported below the method detection limit (MDL). (Note: as an example for field replicate samples with a method detection limit <1 mg/L, MassDEP would either censor or qualify data that had an RPD >30%.) Therefore, these data collected between August 1998 and July 2004 (CDM 2005), though summarized below, were not utilized for the assessment.

According to the sampling and analysis plan for the *South Coastal Basin Estuaries Monitoring Project* four stations within Plymouth Harbor were proposed for sampling: the head of Plymouth Harbor near the Eel River (Station PDH-1), within the breakwater (PDH-2), the main channel to the breakwater (PDH-3), and between High Cliff and White Flat (PDH4) (Appendix F, Project 03-04/604 and Howes and Samimy 2004). *In-situ* measurements of DO, temperature, and Secchi disk depth as well as nutrient (organic and inorganic nitrogen) samples, were to be taken at these locations six times between June and September 2003 and 2004. Samples were collected at approximately two-week intervals during the falling tide (2 hours before and after mid-ebb tide) during the morning hours (0600 to 0900hours). Water quality samples and *in-situ* measurement were taken from the four sites on six occasions between July and September 2003 and again in 2004. Although the actual quality assurance data has not been released to MassDEP, data validation is required as part of this *Estuaries Monitoring Project* and was conducted prior to the release of the data. These data are summarized below (Howes and Samimy 2005).

[Note: CDM Station S-7 is approximately the same location as SMAST Station PDH-1 and CDM Station S-10 is approximately at SMAST Station PDH-3.]

The Plymouth (WWTP) staff collected water from Plymouth Harbor from the jetty approximately 100 yards away from Outfall #001 for use as dilution water in the whole effluent toxicity tests. Results from the facility's whole effluent toxicity test reports between October 2000 and January of 2004 were entered into DWM's TOXTD database and are summarized below.

Dissolved oxygen
The surface and bottom DOs ranged from 5.5 to 13.0 mg/L at the four Estuaries Project sampling locations (Howes and Samimy 2005). Only one measurement was <6.0 mg/L. None of the measurements reported by CDM were < 6.0 mg/L (CDM 2005).

Temperature
The maximum temperature was 19.5 ºC (Howes and Samimy 2005). The maximum temperature reported by CDM was 21.95ºC (CDM 2005).

pH
The pH measurements ranged from 7.1 to 8.3 SU (CDM 2005). The pH measurements ranged from 7.5 to 8.0 SU (n=13)(TOXTD database).

Chlorophyll a
The concentrations of chlorophyll *a* in Plymouth Harbor, with a single exception, were all very low (i.e., <5 µg/L) (Howes and Samimy 2005 and CDM 2005).

Total nitrogen
The concentrations of total nitrogen ranged from 0.096 to 0.550 mg/L at the four sampling locations. The average concentration in 2003 was 0.286 mg/L and in 2004 was 0.197 mg/L (Howes and Samimy 2005). The concentration of total nitrogen ranged from 0.199 to 0.672 mg/L at the two sampling locations with an average concentration of 0.231 mg/L (Station S-7, where n=20) and 0.417 mg/L (Station S-10, where n=14) (CDM 2005).

Ammonia-nitrogen
The concentration of ammonia-nitrogen ranged from 0.011 to 0.083 mg/L at the two sampling locations (CDM 2005). The ammonia-nitrogen concentrations were all ≤0.10 mg/L (n=13) (TOXTD database).

Total residual chlorine (TRC)
The TRC concentrations were all <0.05 mg/L (n=13)(TOXTD database).

The *Aquatic Life Use* for Plymouth Harbor is assessed as impaired because of the loss of eelgrass bed habitat since 1951. However, it should be noted that the eelgrass beds have been relatively stable more recently (1998 and 2001). Given the upgrade to the original Plymouth WWTP and other pollution abatement activities (e.g., stormwater infiltration/BMPs, boat pumpout facilities, implementation of the town's Nutrient Management Plan) and the water quality conditions, including current nitrogen and chlorophyll *a* concentrations, it is anticipated that future monitoring will show improvement in the eelgrass bed habitat in Plymouth Harbor.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Area CCB42.1 (which contains this entire segment) is prohibited due to unacceptable water quality (MA DFG 2000 and Appendix G, Table G3).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as impaired because of elevated fecal coliform bacteria counts. Although some of the Harbor is closed as a safety zone (WWTP discharge/marinas), stormwater has historically contributed to the bacteria problem.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

Weekly testing for *Enterococci* bacteria during the swimming season in 2003 was conducted at the Nelson Street semi-public beach in Plymouth. Sampling was only conducted twice during the 2002 swimming season. No postings were reported for either year. The semi-public beach at Stephens Field in Plymouth was apparently not tested in 2002 and was reportedly posted once in 2003 (MDPH 2003 and MDPH 2004b).

According to the sampling and analysis plan for the *South Coastal Basin Estuaries Monitoring Project* four stations within Plymouth Harbor were proposed for sampling: the head of Plymouth Harbor near the Eel River (Station PDH-1), within the breakwater (PDH-2), the main channel to the breakwater (PDH-3), and between High Cliff and White Flat (PDH-4) (Appendix F, Project 03-04/604 and Howes and Samimy 2004). Secchi disk depth at these locations was to be taken six times between June and September 2003 and 2004. Samples were collected at approximately two-week intervals during the falling tide (2 hours before and after mid-ebb tide) during the morning hours (0600 to 0900hours).

Fecal coliform bacteria samples were collected from the four sites on six occasions between July and September 2003, five occasions between July and Septemer 2004 and again in June 2005. The fecal coliform bacteria counts ranged from 2 to 90 cfu/100 ml (n=48) (Howes and Samimy 2005).

The Secchi disk depths were all reported as being >1.2 m (recommended transparency) (Howes and Samimy 2005 and CDM 2005). The highest chlorophyll *a* measurement reported by SMAST was only 5.58 µg/L and by CDM was 7.08 µg/L (Howes and Samimy 2005 and CDM 2005). There have been no visual observations of aesthetically objectionable conditions (e.g., oils, odors, deposits, etc.) in Plymouth Harbor (DeCesare 2005).

The *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses are assessed support for Plymouth Harbor based on the low fecal coliform bacteria counts, the lack of any observed objectionable conditions, and the high transparency data.

Plymouth Harbor (MA94-16) Use Summary Table

Designated Uses		Status
Aquatic Life		IMPAIRED Cause: Unknown (Suspected cause: Total nitrogen) Source: Unknown (Suspected sources: Municipal point source, Discharges from municipal separate storm sewer systems, and Municipal urbanized high density area)
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Municipal point source, Discharges from municipal separate storm sewer systems
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

RECOMMENDATIONS

Support passage of the federally approved boat sewage ***No Discharge Area (NDA)*** for the entire Plymouth/Kingston/Duxbury Bay so the Bay is designated as an NDA by the 2006 boating season.

Encourage boaters to use the free pump out facilities at Town Pier.

Encourage the Plymouth Stormwater Working Group to continue its efforts to remove or add treatment at stormwater facilities draining directly into the harbor.

Continue to investigate potential illicit discharges into the storm drain system as is being done for the Samoset Street drainage system.

RECOMMENDATIONS CONTINUED

Discourage waterfowl from congregating on the small pond at Steven's Field (DMF station #51).

Continue to monitor eelgrass bed habitat in Plymouth Harbor.

Water quality monitoring (e.g., dissolved oxygen, chlorophyll *a*, and total nitrogen) should be continued to evaluate the effectiveness of pollution abatement activities as they relate to nutrient associated conditions that effect eelgrass bed habitat. When the current SMAST study on Plymouth Harbor is concluded and the resulting Technical Report is available, a reevaluation of the nutrient loading in the Eel River watershed and Plymouth Harbor should be conducted.

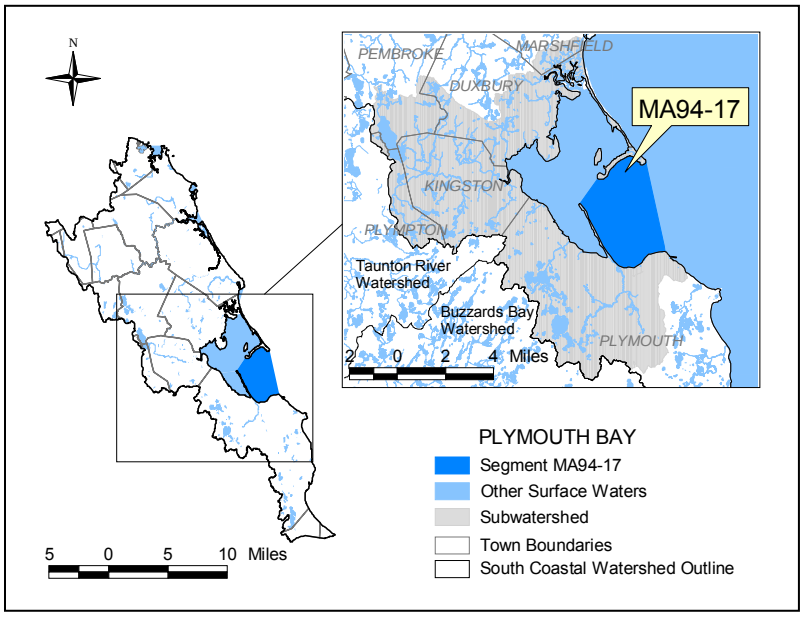
Evaluate the effectiveness of the implementation of the Town's Nutrient Management Plan.

PLYMOUTH BAY (SEGMENT MA94-17)

Location: The waters southeast of a line drawn from Saquish Head to the tip of Plymouth Beach, Plymouth and west of a line from Gurnet Point, Plymouth to Rocky Point, Plymouth.
Size: 10.3 square miles
Classification: Class SA

Land-use estimates (top 3, excluding water) for the 73.8 mi^2 subwatershed (map inset, gray shaded area):

Forest..... 47%
Residential..... 25%
Open Land..... 10%



Plymouth Bay is listed on the 2002 Integrated List of Waters in Category 5. This segment is impaired due to pathogens and a TMDL is required (MassDEP 2003a).

Plans and permitting are underway to reconstruct the Plymouth Long Beach dike. The ACOE is working with Town of Plymouth to reconstruct a 2,500-foot long section and to replenish the beach in front of the project area (ACOE 2003).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

There are no permitted direct water withdrawals or NPDES discharges to Plymouth Bay.

The Entergy Nuclear Generation Company (ENGC) - Pilgrim Nuclear Power Station is located just south of Rocky Point. ENGC operates Pilgrim Nuclear Power Plant in accordance with NPDES Permit MA0003557, issued in 29 April 1991 (modified 30 August 1994) and transferred to Entergy Nuclear from Boston Edison on 22 September 1999. This permit is still in effect since the renewal application received in March 1996 is under review. The Pilgrim Nuclear Power Station, which began operation in December 1972, is a 670 MW electric generating station. Once-through cooling water is withdrawn from an intake embayment from Cape Cod Bay via two circulating water pumps with a capacity of approximately 345 cfs (223 MGD) each. There are also five service water pumps with a combined capacity of 23 cfs (14.9 MGD). Water is drawn under a skimmer wall, through vertical bar racks, and finally through vertical traveling water screens prior to passing through the condensers. There are two traveling water screens for each water pump (Anderson 1987). Impinged organisms washed from the screens are directed into a sluiceway that directs them south (approximately 320' away) of the intake. The permit authorizes discharges from 10 outfalls as described below.

Main Discharge Canal into Cape Cod Bay:

- Outfall 001: 447 MGD average monthly (510 MGD maximum daily) condenser cooling water discharged via a 900' discharge canal. The maximum daily temperature is limited to 102ºF with a ΔT of 32ºF between intake and discharge. Total residual oxidants 0.1 mg/L when in use. Boron and sodium nitrite limited to <1.0 mg/L and 2.0 mg/L, respectively, above background levels.
- Outfall 010: 19.2 MGD average monthly discharge of chlorinated plant service cooling water; Total residual oxidant monthly average limit of 0.5 mg/L (1.0 mg/L maximum daily). Outfall 011: 0.015 MGD (0.06 MGD daily max) makeup water and demineralizer wastewater; average monthly TSS 30 mg/L (100 mg/L daily maximum).

Although subject to an annual review, the barrier net near the end of the discharge canal required to minimize entrainment of fish, primarily flounder, menhaden, and migrating rainbow smelt was removed in November 1994 (Alexander 1999). As an alternative to the physical barrier, the EPA and MassDEP can require the Permittee maintain an average dissolved nitrogen level of 115% in the canal to minimize gas bubble disease in finfish.

Intake Embayment area into Cape Cod Bay:

- Outfall 002: 255 MGD maximum daily of thermal backwash for bio-fouling control (limited to 3 hours/day twice weekly when necessary, maximum temperature 120ºF. This thermal backwash generally occurs about four to five times a year, for a period of about 1.5 to 2 hours. During a thermal backwash, heated water from the downstream end of the steam condensers is re-routed back through the system and out through the intake embayment. This is done to control macro-fouling, primarily from mussels. To accomplish this, the facility shuts down one of the two intake pumps and pushes hot water back through half the system. During this period (about 35-45 minutes) the water within the half of the system receiving the backwash is typically heated to between 105°F and 110°F, but may reach as high as 120°F. The second half of the system is then treated in the same manner. Because the facility has to reduce load during these times, which is expensive, the duration and number of backwashes per year is kept to a minimum. In summary, during a thermal backwash about 155,000 gpm of heated water (>105°F) is sent into the intake embayment for a period of about 1.5-2 hrs.
- Outfall 003: 4.1 MGD intake screen wash water (fish sluice water). This discharge can be made up of 3.2 MGD of Cape Cod Bay water and when necessary 0.9 MGD potable fresh water (Fire Station Water). The marine water will be dechlorinated before injection.
- Outfall 008: 0.73 MGD potable water for sea foam suppression (sprayed directly in front of intake structure) when necessary to reduce buildup of sea foam. Periodic testing of fire pumps is also conducted.
- Outfalls 004, 005, 006, and 007: Yard drain runoff; average monthly/daily maximum limit for total suspended solids 30/100 mg/L, respectively and oil and grease daily maximum limit 15 mg/L (sampling required twice year in April and September during first hour of significant storm).

It should be noted that the potential for re-entrainment of fish is of concern due to the nearness of the fish-return to the intake.

USE ASSESSMENT

AQUATIC LIFE

Eelgrass Bed Habitat

MassDEP's Wetlands Conservancy Program (WCP) identified the presence of eelgrass in Plymouth Bay from historic 1951 black and white aerial photography (Costello 2003). In 1998 MassDEP WCP performed field verification of 1995 aerial photography and mapped the extent of eelgrass bed habitat in Plymouth Bay. Total areal coverage in Plymouth Bay from the 1998 survey was approximately 2%. In 2001 MassDEP WCP performed field verification of 2001 aerial photography and mapped the extent of eelgrass bed habitat in Plymouth Bay. There was almost no change in the total coverage of eelgrass beds between 1998 and 2001. There are no apparent changes in eelgrass beds since 1951.

Biology

Scattered populations of blue mussels (*Mytilus edulis*) are found along the entire shoreline. The Warren Cove area has a small population of soft shelled clams (*Mya arenaria*). Surf clams (*Spisula solidissima*) are found in waters between the 10 and 30-foot contour with ocean quahogs (*Arctica islandica*) beyond the 60-foot depth (Churchill 2003f).

As part of their NPDES permit, ENGC is required to conduct environmental surveillance and monitoring programs to determine whether the operation of the Pilgrim Nuclear Power Station results in measurable effects on the marine ecology in the Western Cape Cod Bay ecosystem and in the Rocky Point area and to evaluate the significance of any observed effects (Environmental Protection Group 2005). A technical review of intake and discharge effects to finfish can be found in Appendix H. Although impingement effects to winter flounder populations appear to be fairly small, estimated entrainment effects vary from being minimal to a 20% loss to the population at large (the Plymouth/Kingston/Duxbury Bay (PKDB) and adjacent waters areas are thought to be the primary spawning ground that produced the larvae and eggs entrained by the Plymouth Nuclear Power Station). Whether or not these levels of impact are a "significant" detriment to the population, and will result in slowing the return of much higher population densities, is currently unknown.

The *Aquatic Life Use* is assessed as support for Plymouth Bay based primarily on best professional judgment, the apparent stability of the eelgrass bed habitat, and the high water quality conditions documented in the adjacent inner segment of Duxbury Bay.

SHELLFISH HARVESTING

The DMF Shellfish Status Report of July 2000 indicates that Areas CCB41.0 and CCB41.2 (which contain this entire segment) are approved (MA DFG 2000 and Appendix G, Table G3).

Based on the DMF shellfish growing area status, the *Shellfish Harvesting Use* is assessed as support.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

Weekly testing for *Enterococci* bacteria during the swimming season was conducted at five locations along the Plymouth public beach in Plymouth. No postings were reported in either of the 2002/2003 beach seasons (MDPH 2003 and MDPH 2004b).

There have been no visual observations of aesthetically objectionable conditions (e.g., oils, odors, deposits, etc.) in Plymouth Bay (DeCesare 2005).

The *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses are assessed as support in Plymouth Bay since the beach was open all of the 2002 and 2003 bathing seasons and the lack of aesthetically objectionable conditions. Furthermore, the entire area of Plymouth Bay is approved for shellfishing - indicative of low bacteria levels.

Plymouth Bay (MA94-17) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		SUPPORT
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		SUPPORT

RECOMMENDATIONS

Implement recommendations in the DMF shellfish management plans for Areas CCB41.0 and CCB41.2.

Support DMF efforts to improve availability/access (electronic or web site) to water quality and biological monitoring data collected from DMF shellfish sampling stations to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

Support passage of the federally approved boat sewage ***No Discharge Area (NDA)*** for the entire Plymouth/Kingston/Duxbury Bay so the Bay is designated as an NDA by the 2006 boating season.

Based on a review of intake and discharge effects to finfish associated with the Pilgrim Nuclear Power Station the following recommendations were suggested (Appendix H):

1. The resource agencies in concert with the permit agencies should consider further evaluation of the intake effects to winter flounder. If effects are found to be substantial, these agencies should determine what steps need to be taken to reduce the impacts of the facility on the winter flounder population.
2. Because impinged fish from the intake screens are shunted back into the intake embayment, there is a concern that these fish, weakened from impingement, will simply be re-impinged. An assessment of re-impingement rates, especially during large-scale events, should be considered by the permitting and resource agencies. These studies should also include an evaluation of the best point for locating the screen-wash discharge such that it would have the smallest negative impact on the populations of impinged species.