92-AC-1

IPSWICH RIVER WATERSHED

2000 WATER QUALITY ASSESSMENT REPORT

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
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Prepared by:

Massachusetts Department of Environmental Protection
Division of Watershed Management

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Massachusetts Department of Environmental Protection
Division of Watershed Management
Worcester, Massachusetts

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- United States Army Corps of Engineers (ACOE)
- United States Geological Survey (USGS)
  - Water Resources Division

State

- Massachusetts Executive Office of Environmental Affairs (EOEA), Ipswich River Watershed Team
- Massachusetts Department of Environmental Protection (MA DEP):
  - Bureau of Resource Protection
  - Bureau of Strategic Policy and Technology's Wall Experiment Station
  - Bureau of Waste Prevention
  - Bureau of Waste Site Cleanup
- Massachusetts Department of Public Health (MDPH)
- Massachusetts Department of Fish and Game (DFG)
  (Formerly the Department of Fisheries, Wildlife, and Environmental Law Enforcement - DFWELE)
  - Division of Fisheries and Wildlife (MassWildlife)
  - Division of Marine Fisheries (DMF)
  - Riverways Program
- Massachusetts Department of Conservation and Recreation (DCR)
  (Formerly the Department of Environmental Management - DEM)

Regional

- Ipswich River Watershed Association (IRWA)

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Cover orthophoto: MassGIS 2001 color orthophoto datalayer showing the lower Ipswich River Watershed

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7Q10	seven day, ten year low flow
ACEC	Area of Critical Environmental Concern
ACO	Administrative Consent Order
ACOE	Army Corps of Engineers (United States)
ADB	assessment database
BDL	below detection limit
BMP	best management practice
BPJ	best professional judgment
BRP	Bureau of Resource Protection
CMR	Code of Massachusetts Regulations
CNOEC	chronic no observed effect concentration
CPOM	coarse particulate organic matter
CWA	Clean Water Act
CWF	cold water fishery
DCR	Department of Conservation and Recreation (formerly DEM)
DDT	dichlorodiphenyltrichloroethane
DEM	Department of Environmental Management (now DCR)
DFG	Department of Fish and Game (formerly DFWELE)
DFWELE	Department of Fisheries, Wildlife, and Environmental Law Enforcement (now DFG)
DMF	Division of Marine Fisheries
DMTF	Drought Management Task Force
DO	dissolved oxygen
DPW	Department of Public Works
DWM	Division of Watershed Management
DWP	Drinking Water Program
EMPACT	Environmental Monitoring for Public Access and Community Tracking
EOEA	Executive Office of Environmental Affairs
EPA	United States Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FPOM	fine particulate organic matter
GIS	geographic information system
Hg	mercury
IRA	Ipswich River Watershed Association
IPSWATCH	Ipswich-Parker Suburban Watershed Channel
L-EL	low effect level
LC_{50}	lethal concentration to 50% of the test organisms
LCWD	Lynnfield Center Water District
MA DEP	Massachusetts Department of Environmental Protection
MassGIS	Massachusetts Geographic Information System
MassWildlife	Division of Fisheries and Wildlife
MDL	method detect limit
MDPH	Massachusetts Department of Public Health
MNHESP	Massachusetts Natural Heritage and Endangered Species Program
MPN	most probable number
MS4	medium and large municipal separate storm sewer systems
MWRA	Massachusetts Water Resources Authority
NAS/NAE	National Academy of Sciences/National Academy of Engineers
NAWQA	National Water-Quality Assessment
NCCW	non-contact cooling water
NECB	New England Coastal Basin
NH_3-N	ammonia-nitrogen
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source pollution
ORS	Office of Research and Standards
ORW	Outstanding Resource Water
PALIS	Pond and Lake Information System
PCB	polychlorinated biphenyls
PIE-LTER	Plum Island Ecosystem - Long Term Ecological Research Network
PWS	public water supply
QA/QC	quality assurance/quality control
RBP	rapid bioassessment protocol
RiverWatch	RiverWatch Volunteer Monitoring Program
SDWA	Safe Drinking Water Act
S-EL	severe effect level
SWAP	Source Water Assessment Program
SWPPP	stormwater pollution prevention plan
SWQS	Surface Water Quality Standards
TOC	total organic carbon
TRC	total residual chlorine
TMDL	total maximum daily load
TOXTD	MA DEP DWM Toxicity Testing Database
UMass	University of Massachusetts
UNH	University of New Hampshire
USGS	United States Geological Survey
WBID	waterbody identification code
WBS	waterbody system database
WMA	Water Management Act
WWF	warm water fishery
WWTP	waste water treatment plant

LIST OF UNITS

cfs	cubic feet per second
cfu	colony forming unit
cfsm	cubic feet per second per square mile of drainage area
MGD	million gallons per day
mg/Kg	milligram per kilogram
mg/L	milligram per liter
mg/m^3	milligram per cubic meter
MGY	million gallons per year
mi^2	square mile
mL	milliliter
µg/kg	microgram per kilogram
µg/L	microgram per liter
µS/cm	Microsiemens per centimeter
ng	nanogram
ppb	parts per billion
ppm	parts per million
SU	standard units
TEQ/kg	toxic equivalents per kilogram

EXECUTIVE SUMMARY
IPSWICH RIVER WATERSHED 2000
WATER QUALITY ASSESSMENT REPORT

The Massachusetts Surface Water Quality Standards (SWQS) designate the most sensitive uses for which surface waters in the Commonwealth shall be protected. This assessment report presents a summary of current water quality data and information used to assess the status of the designated uses as defined in the SWQS for the Ipswich River Watershed. The designated uses, where applicable, include: *Aquatic Life, Fish Consumption, Drinking Water, Shellfish Harvesting, Primary* and *Secondary Contact Recreation* and *Aesthetics*. The assessment of current water quality conditions provides a determination of whether or not each designated use of a particular water body is ***supported*** or ***impaired***. Or, when too little current data/information exists or no quality-assured data are available, the use is ***not assessed***. However, if there is some indication of water quality impairment, which is not considered to be naturally occurring, the use is identified with an "Alert Status". It is important to note that not all waters are assessed. Many small and/or unnamed rivers and lakes are currently ***unassessed***. The status of the designated uses of these waters has never been reported to the EPA in the Commonwealth's Summary of Water Quality Report (305(b) Report) nor is information on these waters maintained by the Massachusetts Department of Environmental Protection in the Water Body System (WBS) or Assessment Database (ADB). This report provides basic information that can be used to focus resource protection and remediation activities later in the watershed management planning process.

There are a total of 18 named and two unnamed freshwater rivers, streams, or brooks (the term "rivers" will hereafter be used to include all) in the Ipswich River Watershed that are included in this report. These include the Ipswich and Miles rivers; Bear Meadow, Black, Boston, Fish, Gravelly, Howlett, Idlewild, Kimball, Long Causeway, Lubbers, Maple Meadow, Martins, Mile, Nichols, Norris, and Wills brooks and account for approximately 91% (94.2 of an estimated 103.3 named river miles). The two unnamed tributaries total 2.7 river miles. The remaining rivers are small and are currently *unassessed*. This report also includes information on 0.50 out of 0.61 square miles of coastal and marine waters and on 44 of the 72 lakes, ponds or impoundments (the term "lakes" will hereafter be used to include all) that have been assigned a pond and lake identification system (PALIS) number in the Ipswich River Watershed. The 44 lakes included in this report represent 88% of the total lake acreage (1,956 of 2,226 acres) in the Ipswich River Watershed.

AQUATIC LIFE USE

The *Aquatic Life Use* is supported when suitable habitat (including water quality) is available for sustaining a native, naturally diverse, community of aquatic flora and fauna. Impairment of the *Aquatic Life Use* may result from anthropogenic stressors that include point and/or nonpoint source(s) of pollution and hydrologic modification. The status of the *Aquatic Life Use* in the Ipswich River Watershed is as follows.

Aquatic Life Use Summary – Rivers and Coastal and Marine Waters (Figure 1)

As illustrated in Figure 1, seventy-seven (77)% of the freshwater river segments in the Ipswich River Watershed included in this report is assessed as either support or impaired for the *Aquatic Life Use*. Four tributaries to the Ipswich River, totaling 23.5 river miles (Boston, Fish, Gravelly, and Lubbers brooks), are assessed as supporting the *Aquatic Life Use*. The *Aquatic Life Use* is impaired for the entire freshwater portion of the Ipswich River, as well as Howlett Brook, Maple Meadow Brook, Martins Brook, and the Miles River. When known, one of the primary causes of impairment is low-flow alterations, although impacts to the benthic macroinvertebrate and fisheries communities, other habitat quality degradation, and low dissolved oxygen, were also documented. Where known, sources of impairment include baseflow depletion from

***Aquatic Life Use* Assessment**

Rivers
(total length included in report – 96.9 miles)
- **Support – 23.5 miles (24%)**
- **Impaired – 51.6 miles (53%)**
- **Not Assessed – 21.8 miles (22%)**

Coastal and Marine Waters
(total area included in report – 0.50 square miles)
- **Not Assessed – 0.50 square miles (100%)**

Lakes
(total area included in report – 1,956 acres)
- **Impaired – 215 acres (11%)**
- **Not Assessed – 1,741 (89%)**

groundwater withdrawals and streambank modification/destabilization. Additional suspected sources include: highway/road/bridge runoff, loss of riparian habitat, sand and gravel operations, impacts from hydrostructure flow regulation/modification, flow alterations from water diversions, golf courses, and grazing in the riparian zone.

The remaining nine named and two unnamed rivers included in this report (22% of the river miles) and all of the coastal and marine water portions of the watershed included in this report (0.50 square miles) are currently not assessed for the *Aquatic Life Use*.

Aquatic Life Use Summary – Lakes (Figure 1)

Few lakes in the Ipswich River Watershed have been surveyed recently for variables used to assess the status of the *Aquatic Life Use* (i.e., DO, pH, nutrients, macrophytes and plankton/chlorophyll *a*). Because of the lack of these data, none of the lakes in the Ipswich River Watershed are assessed as supporting the *Aquatic Life Use*. The *Aquatic Life Use* is assessed as impaired for six lakes (215 lake acres): Crystal Pond, Devils Dishfull Pond, Field Pond, Lowe Pond, Martins Pond and Stevens Pond (Figure 1). Crystal Pond is impaired due to excess algal growth, chlorophyll *a* and total phosphorus. Suspected sources of nutrient inputs include stormwater runoff and waterfowl. Devils Dishfull Pond is impaired due to the presence of the non-native aquatic plant, *Myriophyllum spicatum*, and because of total phosphorus, low dissolved oxygen and low oxygen saturation. Suspected sources of nutrients include stormwater runoff. Field, Lowe, and Martins ponds are impaired due to the presence of the non-native aquatic plant, *Cabomba caroliniana*. Stevens Pond is impaired due to the presence of the non-native aquatic plant, *Marsilea quadrifolia*. The first two of these non-native aquatic plant species are particularly invasive and can spread readily since they reproduce vegetatively. The majority of the lake acreage in the Ipswich River Watershed (89%) is currently not assessed for the *Aquatic Life Use*.

FISH CONSUMPTION USE

The *Fish Consumption Use* is supported when there are no pollutants present that result in concentrations unacceptable for human consumption in edible portions (as opposed to whole fish - see *Aquatic Life Use*) of fish, other aquatic life or wildlife. The assessment of the *Fish Consumption 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 2002c). The MDPH list identifies waterbodies where elevated levels of a specified contaminant in edible portions of freshwater species poses a health risk for human consumption; hence the *Fish Consumption Use* is assessed as impaired in these waters. In July 2001, MDPH issued new consumer advisories on fish consumption and mercury contamination (MDPH 2001). Because of these statewide advisories, no waters can be assessed as support for the *Fish Consumption Use*; these waters default to "not assessed". The statewide advisories read as follows:

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

The status of the *Fish Consumption Use* in the Ipswich River Watershed is as follows:

Fish Consumption Use Summary - Rivers and Coastal and Marine Waters (Figure 2)

There are currently no site-specific MDPH-issued fish consumption advisories for any rivers or coastal and marine waters in the Ipswich River Watershed. The rivers and coastal and marine waters in the watershed default to not assessed for the *Fish Consumption Use* because of the statewide advisory.

Fish Consumption Use Summary – Lakes (Figure 2)
Because of health concerns associated with exposure to mercury, MDPH issued fish consumption advisories for Hood Pond, Lowe Pond, Martins Pond, and Mill Pond (MDPH 2002c). Therefore, the *Fish Consumption Use* is impaired for these ponds representing a total of 251 acres (13% of the freshwater pond acreage included in this report). The remaining lakes in the watershed default to not assessed for the *Fish Consumption Use* because of the statewide advisory.

***Fish Consumption Use* Assessment**

Rivers
(total length included in report – 96.9 miles)
- **Not Assessed – 96.9 miles (100%)**

Coastal and Marine Waters
(total area included in report – 0.50 square miles)
- **Not Assessed – 0.50 square miles (100%)**

Lakes
(total area included in report – 1,956 acres)
- **Impaired – 251 acres (13%)**
- **Not Assessed – 1,705 acres (87%)**

DRINKING WATER USE
The term *Drinking Water Use* has been used to indicate sources of public drinking water. While this use is not assessed in this report, the state provides general guidance on drinking water source protection of both surface water and groundwater sources (available at http://www.mass.gov/dep/brp/dws/dwshome.htm). These waters are subject to stringent regulation in accordance with the Massachusetts Drinking Water Regulations. MA DEP's Drinking Water Program (DWP) has primacy for implementing the provisions of the federal Safe Drinking Water Act. DWP has also initiated work on its Source Water Assessment Program (SWAP), which requires that the Commonwealth delineate protection areas for all public ground and surface water sources, inventory land uses that may present potential threats to drinking water quality in these areas, determine the susceptibility of water supplies to contamination from these sources, and publicize the results.

Public water suppliers monitor their finished water (tap water) for major categories of both naturally-occurring and man-made contaminants such as: microbiological, inorganic, organic, pesticides, herbicides and radioactive contaminants. Specific information on community drinking water sources including SWAP activities and drinking water quality information are updated and distributed annually by the public water system to its customers in a "Consumer Confidence Report". These reports are available from the public water system.

SHELLFISH HARVESTING USE
The *Shellfish Harvesting Use* is assessed as support when shellfish harvested from Approved (Class SA or SB) or Conditionally Approved (Class SB) Shellfish Growing Areas are suitable for consumption without depuration and when shellfish harvested from Restricted (Class SB) Shellfish Growing Areas are suitable for consumption with depuration. The Division of Marine Fisheries (DMF) classifies shellfishing areas in the Ipswich River Watershed. The *Shellfish Harvesting Use* for this report was assessed using the DMF shellfishing closure list dated 1 July 2000 and published on Massachusetts Geographic Information System (MassGIS) in October 2000 (http://www.mass.gov/mgis/dsga.htm) and updated classification information provided by DMF. All of the coastal and marine waters included in this report, are impaired for the *Shellfish Harvesting Use* because of elevated bacteria.

***Shellfish Harvesting Use* Assessment**

Coastal and Marine Waters
(total area included in report – 0.50 square miles)
- **Impaired – 0.50 square miles (100%)**

PRIMARY AND SECONDARY CONTACT RECREATIONAL USES
The *Primary Contact Recreational Use* is supported when conditions are suitable (fecal coliform bacteria densities, turbidity and aesthetics meet the SWQS) for any recreational or other water related activity during which there is prolonged and intimate contact with the water and there exists a significant risk of ingestion. Activities include, but are not limited to, wading, swimming, diving, surfing and water skiing. The *Secondary Contact Recreational Use* is supported when conditions are suitable for any recreational or other water use during which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact related to shoreline activities. For lakes, macrophyte cover and/or transparency data (Secchi disk depth) are evaluated to assess the status of the recreational uses. The status of the *Primary and Secondary Contact Recreational Uses* in the Ipswich River Watershed are as follows.

Primary and Secondary Contact Recreational Use Summary – Rivers and Coastal and Marine Waters (Figure 3)

All of the freshwater river miles and all of the coastal and marine water areas in the Ipswich River Watershed in this report are currently not assessed for the *Primary* and *Secondary Contact Recreational* uses due to the lack of current bacteria data.

Primary and Secondary Contact Recreational Use Assessments

Rivers
(total length included in report – 96.9 miles)
- **Not Assessed – 96.9 miles (100%)**

Coastal and Marine Waters
(total area included in report – 0.50 square miles)
- **Not Assessed – 0.50 square miles (100%)**

Lakes
(total area included in report – 1,956 acres)
- **Support – 160 acres (8%)**
- **Impaired – 22 acres (1%)**
- **Not Assessed – 1,774 acres (91%)**

Primary and Secondary Contact Recreational Use Summary – Lakes (Figure 3)

Four lakes (Berry Pond, Hood Pond, Silver Lake and Stiles Pond) totaling 160 acres and representing 8% of the freshwater lake acreage included in this report were assessed as supporting the *Primary* and *Secondary Contact Recreational* uses. Two lakes (Crystal Pond and Devils Dishfull Pond) totaling 22 acres (1% of the freshwater lake acreage) were assessed as impaired for both the *Primary* and *Secondary Contact Recreational uses*. Crystal Pond is impaired due to excess algal growth, poor transparency (i.e., Secchi disk depth readings below the bathing beach guidance) and total phosphorus. Suspected sources of nutrient inputs to Crystal Pond include runoff and waterfowl. Devils Dishfull Pond is impaired due to the high biovolume occupied by non-native aquatic macrophytes, particularly *Myriophyllum spicatum*.

AESTHETICS USE

The *Aesthetics Use* is supported when surface waters are 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 status of the *Aesthetics Use* in the Ipswich River Watershed is as follows:

Aesthetics Use Summary – Rivers and Coastal and Marine Waters (Figure 4)

Of the 96.9 river miles in the Ipswich River Watershed included in this report, a total of 58.3 miles (approximately 60%), representing seven tributaries to the Ipswich River (Boston Brook, Fish Brook, Gravelly Brook, Lubbers Brook, Maple Meadow Brook, Miles River, and an unnamed tributary) and the segment of the Ipswich River from the confluence of Maple Meadow Brook and Lubbers Brook, Wilmington, to Salem Beverly Waterway Canal, Topsfield are assessed as supporting the *Aesthetics Use*. The remaining 38.6 miles (40%) are not assessed for this use. Additionally, the entire 0.50 square mile coastal and marine water portion of the Ipswich River Watershed included in this report is not assessed for the *Aesthetics Use*.

Aesthetics Use Assessment

Rivers
(total length included in report – 96.9 miles)
- **Support – 58.3 miles (60%)**
- **Not Assessed – 38.6 miles (40%)**

Coastal and Marine Waters
(total area included in report – 0.50 square miles)
- **Not Assessed – 0.50 square miles (100%)**

Lakes
(total area included in report – 1,956 acres)
- **Impaired – 22 acres (1%)**
- **Not Assessed – 1,934 acres (99%)**

Aesthetics Use Summary – Lakes (Figure 4)

Due to the lack of current information, none of the freshwater lake acreage in the Ipswich River Watershed is assessed as support for the *Aesthetics Use*. Two lakes (Crystal Pond and Devils Dishfull Pond) totaling 22 acres (1% of the freshwater lake acreage) were assessed as impaired for the *Aesthetics Use*. The causes of impairment in Crystal Pond are the presence of algae and duckweed blooms, poor transparency (i.e., Secchi disk depth readings below the bathing beach guidance), and total phosphorus. Suspected sources of nutrient inputs to Crystal Pond include runoff and waterfowl. The cause of impairment in Devils Dishfull Pond is the high biovolume occupied by non-native aquatic macrophytes particularly *Myriophyllum spicatum*.

RECOMMENDATIONS

In addition to specific issues for the individual segments, the evaluation of current water quality conditions in the Ipswich River Watershed has revealed the need for the following.

- Biological and habitat quality monitoring should continue to be conducted in the Ipswich River and it's tributaries to determine the effects, if any, resulting from efforts to improve flows in the Ipswich River Watershed. These efforts include monitoring compliance with Water Management Act (WMA) registration/permit limits and other special conditions of the permits, evaluating outlet control practices at dams in the watershed, and other management strategies being developed to protect and/or restore natural flow regimes.
- Continue to periodically evaluate fish community data against the target fish community developed by the Ipswich River Fisheries Restoration Task Force http://www.ipswichriver.org/FishRestReportA.pdf as well as to continue to evaluate the status of the *Aquatic Life Use.*
- Review and implement recommendations in the DMF anadromous fish assessment report, when available. Installation of a fish ladder or breaching of the Bostik Company Dam would help to restore anadromous fisheries to the upper Ipswich River Watershed. Investigate the potential to remove the old mill dam (Curtis Pond Dam) on Boston Brook to improve river habitat and remove a barrier to anadromous fish passage.
- Review and implement recommendations from the DMF *Rainbow Smelt (Osmerus mordax) spawning habitat on the Gulf of Maine Coast of Massachusetts* report, when available.
- Monitor bacteria levels to document effectiveness of bacteria source reduction activities associated with sewer collection system improvements, Title V (septic system) improvements/upgrades, treatment of stormwater discharges, sewering, and/or the Phase II community stormwater management programs to assess the status of the *Primary* and *Secondary Contact Recreation* uses. Bacteria sampling should also bracket potential nonpoint sources including agricultural landuses.
- Review and implement recommendations in the DMF shellfish sanitary survey reports and the triennials reviews for growing areas in the Ipswich River Watershed.
- Encourage stream cleanups.
- Evaluate potential nonpoint sources of pollution that may contribute to instream turbidity in Lubbers Brook, Boston Brook, Fish Brook, and the Miles River.
- Coordinate with DCR and/or other groups conducting lake surveys to generate quality assured lakes data. Conduct more intensive lake surveys to better determine the lake trophic and use support status and identify causes and sources of impairment. As sources are identified within lake watersheds they should be eliminated or, at least, minimized through the application of appropriate point or non-point source control techniques.
- Implement recommendations identified in lake diagnostic/feasibility studies, including lake watershed surveys to identify sources of impairment.
- Continue to review data from "Beaches Bill" required water quality testing (bacteria sampling at all formal bathing beaches) to assess the status of the recreational uses.
- Prevent spreading of non-native, invasive aquatic plants. Once the extent of the problem is determined and control practices are exercised, vigilant monitoring needs to be practiced to guard against infestations in unaffected areas and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert lake-users to the problem and responsibility of spreading these species. Confirm the presence of *Myriophyllum heterophyllum*, which is suspected to occur in Pleasant Pond (Idelwood Lake), Wenham/Hamilton and *Najas minor*, which is suspected to be in Martins Pond, North Reading.
- Review the MA DEP Drinking Water Program SWAP evaluations, when they are completed, to develop and implement appropriate recommendations for the protection of Class A lakes in the Ipswich River Watershed including Emerson Brook Reservoir, Longham Reservoir, Middleton Pond, Mill Pond, Putnamville Reservoir, Suntaug Lake, Swan Pond, Wenham Lake, and Winona Pond.

Figure 1: Ipswich River Watershed
Aquatic Life Use Assessment Summary – Rivers, Estuarine Waters and Lakes

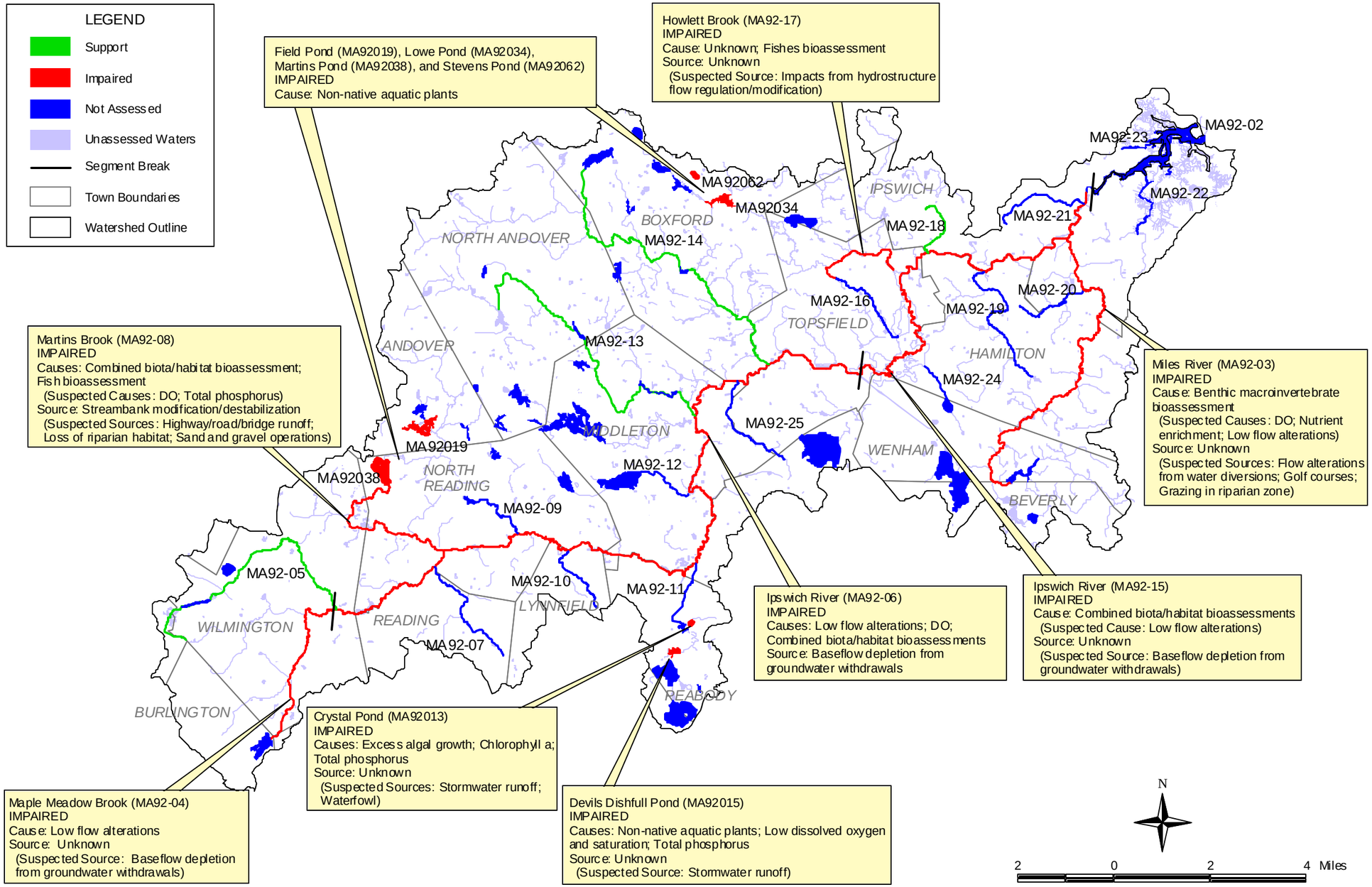

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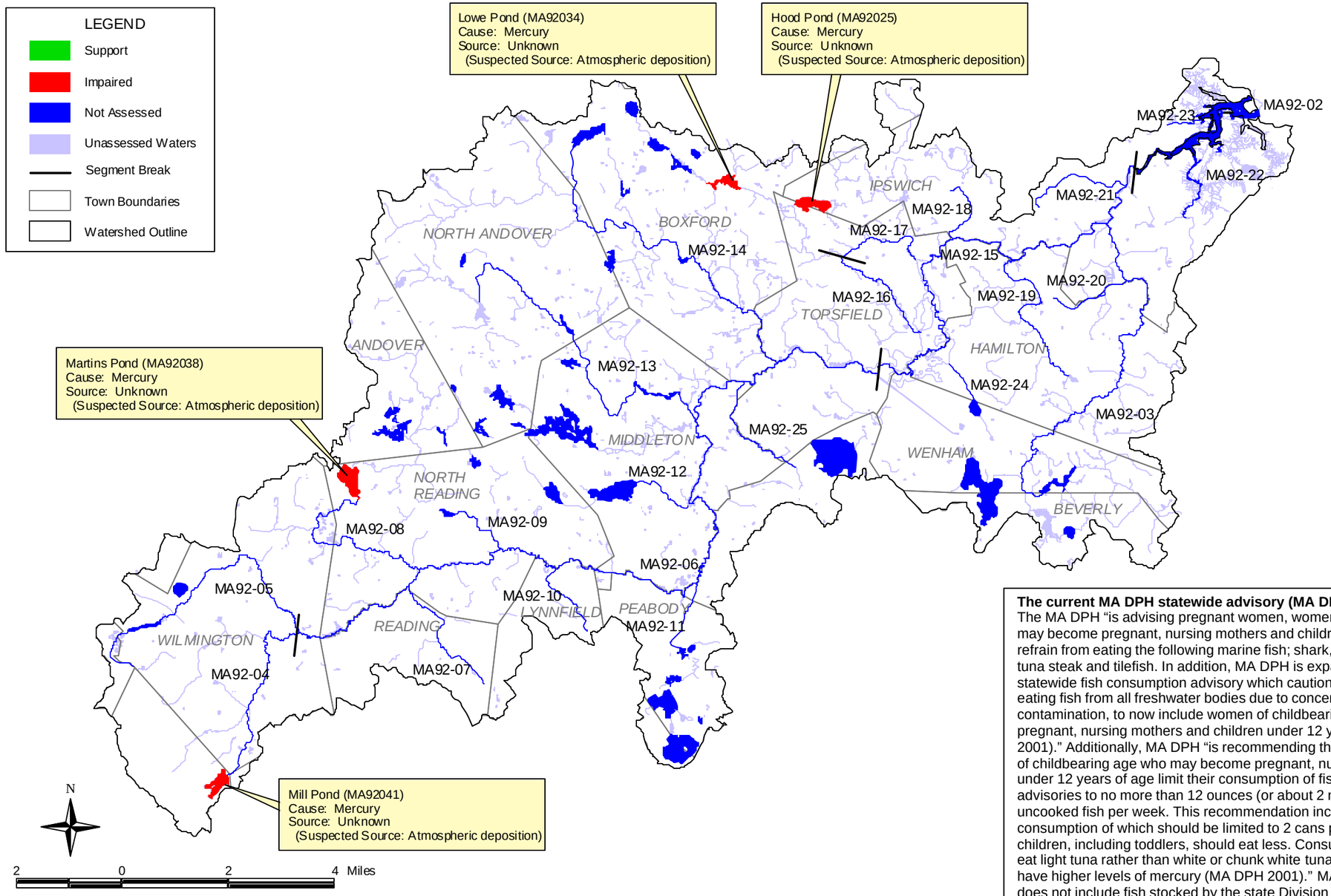
Figure 2: Ipswich River Watershed
Fish Consumption Use Assessment Summary – Rivers, Estuarine Waters and Lakes



The current MA DPH statewide advisory (MA DPH 2001):
The MA DPH "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, MA DPH 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 (MA DPH 2001)." Additionally, MA DPH "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 (MA DPH 2001)." MA DPH's statewide advisory does not include fish stocked by the state Division of Fisheries and Wildlife or farm-raised fish sold commercially.

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Figure 3: Ipswich River Watershed
*Primary and Secondary Contact Recreational Use*s Assessment Summary – Rivers, Estuarine Waters and Lakes

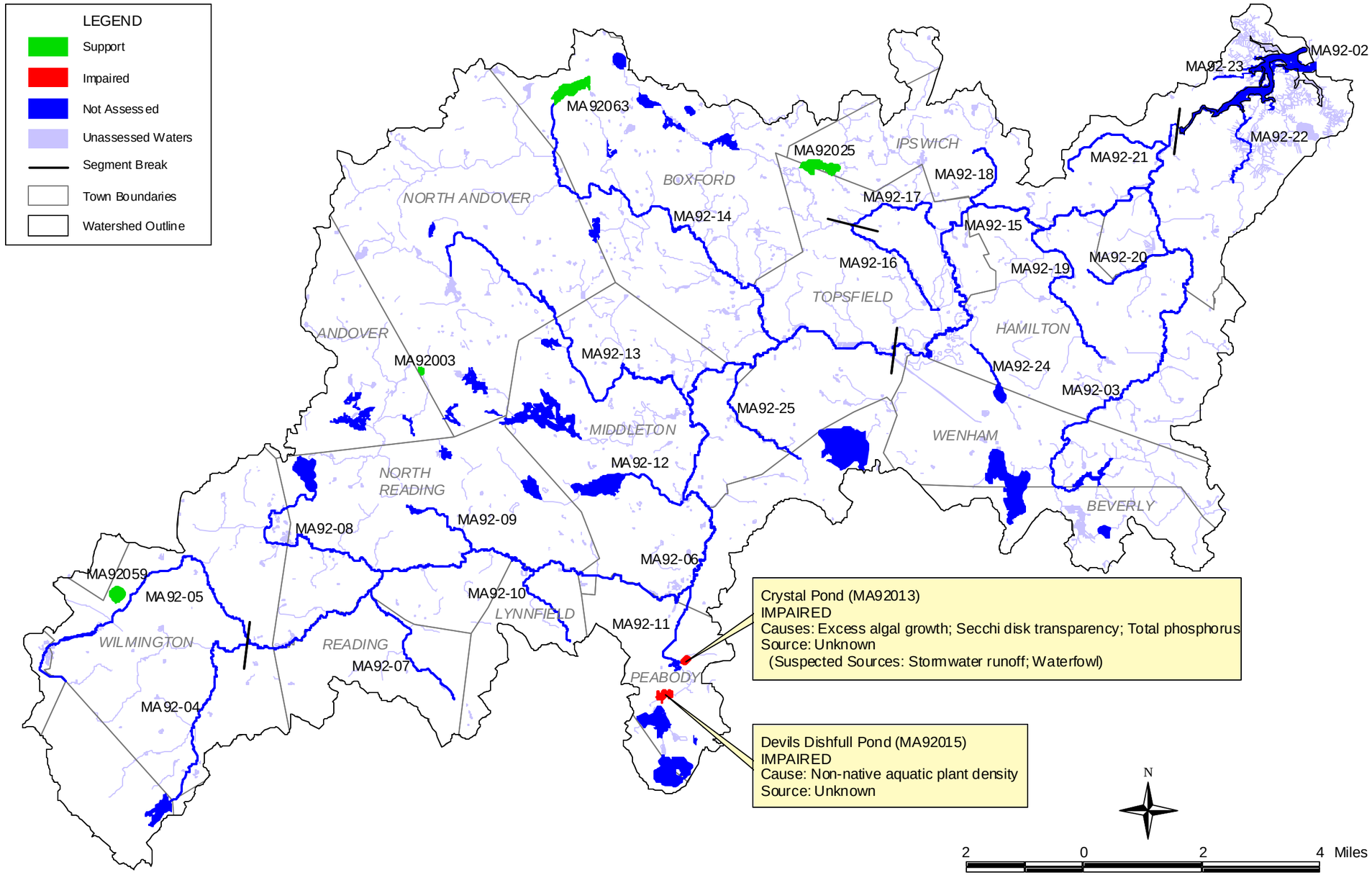

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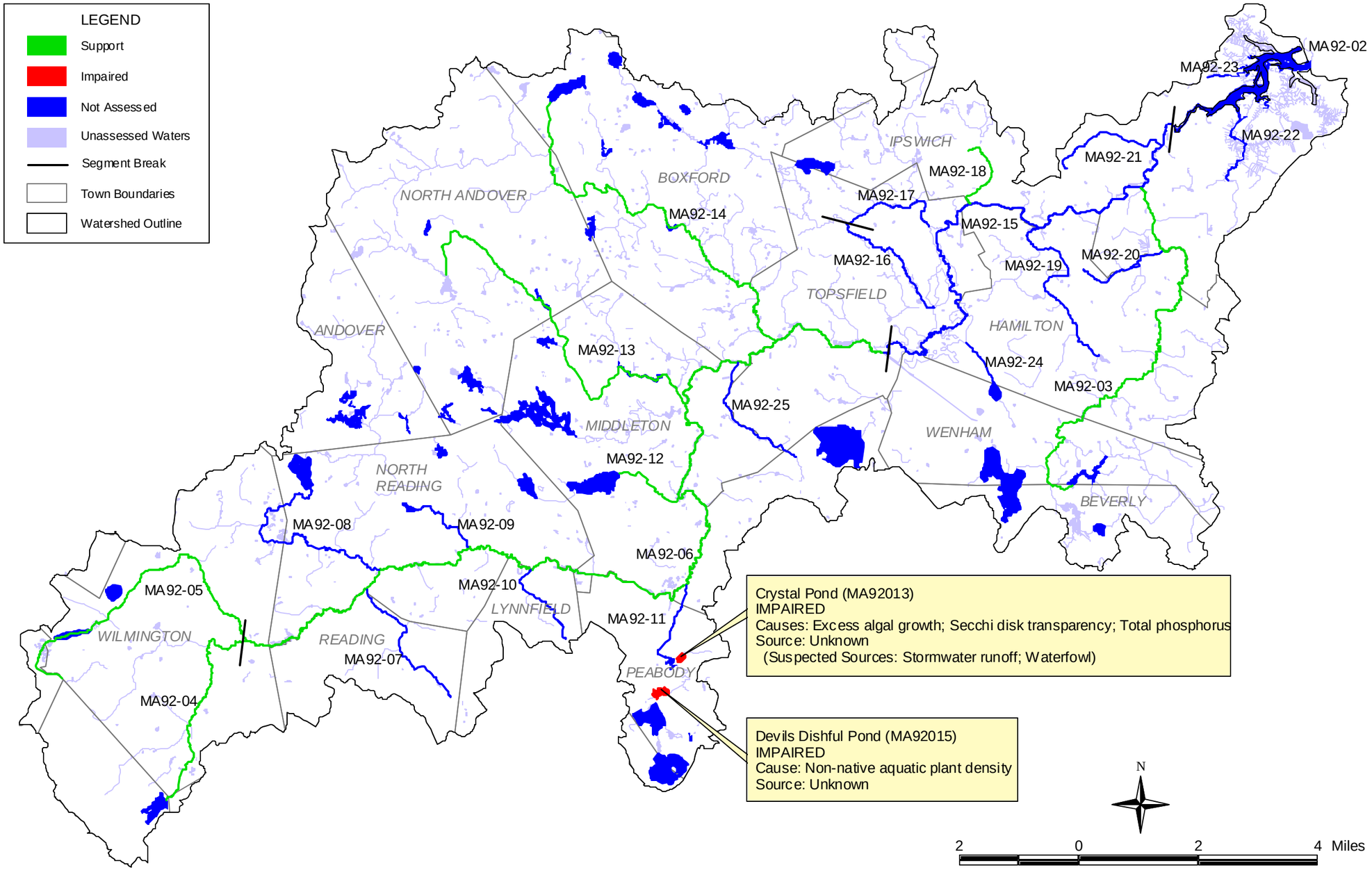
Figure 4: Ipswich River Watershed
Aesthetics Use Assessment Summary – Rivers, Estuarine Waters and Lakes



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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 5 illustrates the management structure to carry out the mission. This report presents the current assessment of water quality conditions in the Ipswich River Watershed. The assessment is based on information that has been researched and developed by the Massachusetts Department of Environmental Protection (MA DEP) through the first three years (information gathering, monitoring, and assessment) of the five-year cycle in partial fulfillment of MA DEP's federal 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).

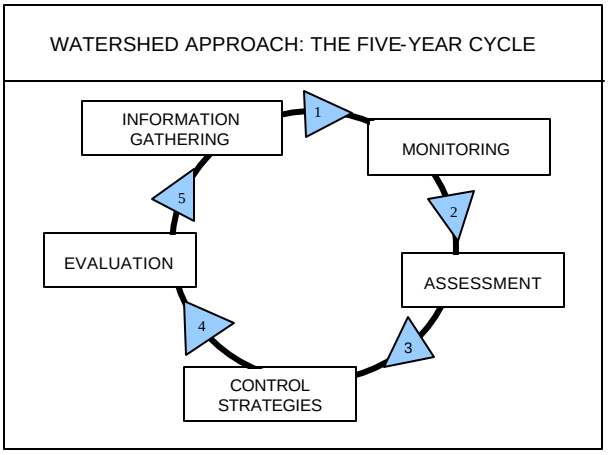


Figure 5. Five-year cycle of the watershed approach

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, MA DEP must every two years submit to EPA a statewide report that describes the status of water quality in the Commonwealth. Up until 2000, 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 waters requiring a total maximum daily load (TMDL) calculation. In 2002, however, EPA recommended that the states combine elements of the statewide 305(b) Report and the Section 303(d) List of Waters into one "Integrated List of Waters". 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 of Waters. 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 in the Assessment Methodology section of this report. Once the use assessments have been completed the segments are categorized for the Integrated List of Waters.

ASSESSMENT METHODOLOGY

WATER QUALITY 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 (MA DEP 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.

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).*
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.*

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). 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 SWQS, summarized in Table 2, prescribes minimum water quality criteria to sustain the designated uses. Furthermore, these standards describe the hydrological conditions at which water quality criteria must be applied (MA DEP 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 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 the most severe hydrological condition for which the aquatic life criteria must be applied shall be determined by MA DEP on a case-by-case basis.

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, MA DEP describes its Quality System in an EPA-approved Quality Management Plan to ensure that environmental data collected or compiled by the MA DEP are of known and documented quality and are suitable for their intended use. For external sources of information MA DEP 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 MA DEP for a particular analysis), and 3) sample data, QA/QC and other pertinent sample handling information are documented in a citable report.

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 solely to "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 exists 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 (MA DEP 1996 and MDPH 2002a).

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 Change (Δ) allowed due to a discharge	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) 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) 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 - 9.0SU and Δ1.0 outside the naturally occurring range. Class SA and Class SB: 6.5 - 8.5SU and Δ0.2 outside the normally occurring range. Class SC: 6.5 - 9.0SU 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. Summary of Massachusetts Surface Water Quality Standards (MA DEP 1996 and MDPH 2002a) - *Continued*.

Bacteria (MA DEP 1996 and MDPH 2002a) 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*.	Class A: • Fecal coliform bacteria: An arithmetic mean of <20 cfu/100mL in any representative set of samples and <10% of the samples >100 cfu/100mL. Class B: • 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* /100mL and the geometric mean of the most recent five *Enterococci* samples within same bathing season shall not exceed 33 *Enterococci* /100mL. • 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/100mL in any representative set of samples, nor shall more than 10% of the samples exceed 400 cfu/100mL. (This criterion may be applied on a seasonal basis at the discretion of the MA DEP.) Class C: • Fecal coliform bacteria: Shall not exceed a geometric mean of 1000 cfu/100ml, nor shall 10% of the samples exceed 2000 cfu/100 mL. Class SA: • 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 43 MPN/100mL. • At public bathing beaches, as defined by MDPH, where *Enterococci* are the chosen indicator: No single *Enterococci* sample shall exceed 104 *Enterococci* /100mL and the geometric mean of the five most recent *Enterococci* levels within the same bathing season shall not exceed 35 *Enterococci* /100mL. • 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/100mL in any representative set of samples, nor shall more than 10% of the samples exceed 400 cfu/100mL. (This criterion may be applied on a seasonal basis at the discretion of the MA DEP.) Class SB: • Fecal coliform bacteria: In waters approved for restricted shellfish, a fecal coliform median or geometric mean (MPN method) of <88 MPN/100mL and <10% of the samples >260 MPN/100mL. • At public bathing beaches, as defined by MDPH, where *Enterococci* are the chosen indicator: No single *Enterococci* sample shall exceed 104 *Enterococci* /100mL and the geometric mean of the most recent five *Enterococci* levels within the same bathing season shall not exceed 35 *Enterococci* /100mL. • 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/100mL in any representative set of samples, nor shall more than 10% of the samples exceed 400 cfu/100mL. (This criterion may be applied on a seasonal basis at the discretion of the MA DEP.) Class SC: • Fecal coliform bacteria: Shall not exceed a geometric mean of 1000 cfu/100mL, nor shall 10% of the samples exceed 2000 cfu/100mL.

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 (MA DEP 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; *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; 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. In lieu of any information to the contrary, both the *Agricultural* and *Industrial* uses, where applicable, are considered by the Department to be supported.

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 MA DEP'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 (Costello 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 (MA DEP 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 (MA DEP 1996, EPA 19 November 1999)	Infrequent excursion from criteria (Table 1)	Criteria exceeded >10% of measurements.
Temperature (MA DEP 1996,EPA 1997)	Infrequent excursion from criteria (Table 1)[1]	Criteria exceeded >10% of measurements.
Toxic Pollutants (MA DEP 1996, EPA 19 November 1999) Ammonia-N (MA DEP 1996, EPA 1999) Chlorine (MA DEP 1996, EPA 19 November 1999)	Infrequent excursion from criteria (Table 1) 1.98 mg/L NH_3-N [2] 0.011 mg/L 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 04 November 1999)	≤14.0 µg/kg wet weight	BPJ
PCB in aquatic tissue (Environment Canada 04 November 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] [NH_3-N] at pH = 7.4 SU and 28°C. [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 (PCBs) 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 PCBs) 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 2002c). 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 2002c)	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 in 314 CMR 4.04(3). MA DEP'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 status of the supplies is currently reported to MA DEP and EPA by the suppliers 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*** No closures or advisories (no contaminants with confirmed exceedances of maximum contaminant levels, conventional treatment is adequate to maintain the supply).	***Impaired*** 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 (DWP) 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 Ipswich River Watershed's public water suppliers.

SHELLFISH HARVESTING USE

This use is assessed using information from the Massachusetts Department of Fish and Game (DFG) 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*** SA Waters: Approved[1] SB Waters: Approved[1], Conditionally Approved[2] or Restricted[3]	***Impaired*** 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 (MA DPH 2002b) Minimum Standards for Bathing Beaches State Sanitary Code (MA DEP 1996)	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 (MA DEP 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/100mL but one of the five samples exceeds 400 cfu/100mL). 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/100mL if the result is reported as <20 cfu/100mL). 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 (MA DEP 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 (MA DEP 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.
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.
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.

IPSWICH RIVER WATERSHED DESCRIPTION AND CLASSIFICATION

The Ipswich River Watershed is located in northeastern Massachusetts where it is bordered on the north by the Parker and Merrimack River watersheds and on the south by the North Coastal and Mystic River Basins (see Figure 6). The Ipswich River originates in Burlington and follows a meandering northeasterly course to Ipswich, where it drains into the Atlantic Ocean. The watershed includes 103.3 miles of named streams and encompasses 155 square miles of drainage area. Approximately 17% of the watershed area is covered by wetland or open water.

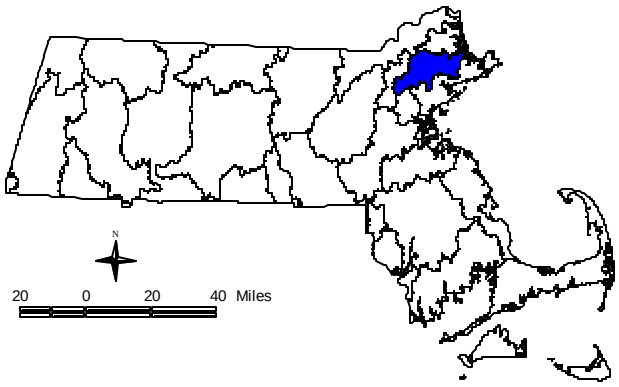


Figure 6. Location of the Ipswich River Watershed

The Ipswich River Watershed encompasses all or portions of 22 Massachusetts communities. Middleton, North Reading and Topsfield are completely within the watershed as are major portions of Boxford, Ipswich, Hamilton, North Andover, Reading, Wenham and Wilmington. Portions of Andover, Beverly, Burlington, Danvers, Lynnfield, Peabody, Billerica, Essex, Georgetown, Rowley, Tewksbury, and Woburn (the latter six having less than three percent of their land area within the basin) are also within the area drained by the Ipswich River.

An understanding of both the hydrologic and socioeconomic settings of the Ipswich River Watershed were used to establish the framework for the development of the 1976 Water Quality Management Plan (Dalton 1976). The hydrologic setting of a watershed determines the quantity and baseline quality of its surface and ground waters. The water resources of the Ipswich River Watershed have been the subject of studies by various public agencies because public water supply has been a critical question in this rapidly developing area of the Commonwealth. The bulk of the material presented herein regarding the hydrology of the Ipswich River Watershed is taken from United States Geological Survey (USGS) documents (Sammel *et al*. 1964, and Sammel *et al.* 1966) and Dalton (1976).

Precipitation in the Ipswich River basin (or watershed) averages 42.5 inches per year (more recent average rainfall is 43.5 inches per year based on gages in Ipswich, Middleton and Wilmington – Gartland 2004) and is the source of water supply in the watershed. Approximately five inches of the annual precipitation is due to the snow that falls on the basin. Actual annual precipitation may vary by as much as ten percent across the different areas within the watershed. The ultimate fate of the basin's precipitation lies in its return to the ocean. The manner and speed with which the precipitation returns to the ocean is determined by the basin's hydrologic setting.

The Ipswich River basin is located in the northern temperate zone and, as such, has a humid climate typical of its latitude. The basin's proximity to the Atlantic Ocean tends to moderate extremes in temperature fluctuations; however, there is a marked seasonal temperature variation which produces a 180-day growing season (mid-April to mid-October). The average monthly rate of precipitation ranges from 3.13 inches in February to 3.93 inches in November and is remarkably uniform. Approximately one-half of the annual precipitation is returned to the atmosphere through evapotranspiration; and during the growing season, almost all of the precipitation which falls on the basin is lost in this manner. Of the precipitation which is not lost through evapotranspiration, some runs off directly to the surface waters, but most of it is absorbed into the groundwater reservoir and then slowly released to the surface waters. In addition some of this water is transferred out of the basin as public water supply. The short-term fate of the precipitation which is not lost through evapotranspiration is determined by the basin's topography and surficial geology.

Formed during the passage of glaciers during the Pleistocene Epoch and by the formation of swamp deposits and alluvium of Recent Ages, the topography and surficial geology of the Ipswich River Basin as described by Sammel *et al*. is that of "low rounded hills surrounded by swamps." The authors further state that the relative uniformity of the basin's topography results in few variations in

temperature and precipitation. Many small lakes and ponds have formed in the basin's extensive wetlands, and much of the course of the Ipswich and its tributaries is through wetlands. The wetlands in the Ipswich River basin are critically important to the management of water quality in the basin. The hydrologic impact of the wetland areas is such that they control water supply, the location and use of on-lot subsurface disposal systems, and the baseline quality of the surface waters in the Ipswich drainage basin.

The Ipswich River basin is underlain by consolidated (bedrock) and unconsolidated rocks (Sammel *et al.* 1966). USGS authors describe the importance of the surficial geology as follows: bedrock is important only in areas where it is either exposed or near the surface and where ancient stream valleys which were cut into the bedrock have been filled in by hydrologically important glacial deposits. In these areas, there is minimal absorption of precipitation and, subsequently, maximum runoff. The USGS feels that the bedrock deposits experience a very low but uniform rate of groundwater recharge and discharge throughout the year. The ancient stream valleys are important because of the material which the which the glaciers have deposited in them and the impact this material has on the basin's groundwater reservoir. This phenomenon has been studied in the upper Ipswich Basin and Sammel *et al*. (1966) concluded that the valleys are now partly filled with stratified sediments which form a large part of the groundwater reservoir. It was further projected that valleys of the same type were also of hydrologic significance in the lower Ipswich basin. The most important unconsolidated deposits in the Ipswich drainage basin (in terms of their water bearing capacities) are till, ice-contact deposits, outwash deposits, and the swamp deposits. Till, much like bedrock, has a low permeability and low porosity. During the wetter periods of the year, the till deposits in the uplands of the basin rapidly become saturated, and subsequent precipitation runs off to the streams or lowland areas. During the drier periods of the year, precipitation is absorbed into the soil overlying the till and is lost through evapotranspiration.

Ice-contact deposits are important from a water supply standpoint because they are capable of yielding significant quantities of water. The permeability of the ice-contact deposits depends on the coarseness of the material in them; and since this will vary from deposit to deposit, there is no basin-wide uniformity in their water supply potential.

Outwash deposits store large amounts of groundwater which they slowly release to the basin's surface waters. The USGS is of the opinion that the outwash deposits are responsible for a large share of the base stream flows in the Ipswich Basin.

The swamp deposits have a very high permeability and thus have the capacity to store vast quantities of water by absorption or by ponding. Most of the Ipswich basin's swamp deposits are underlain by either ice-contact or outwash deposits. Swamp deposits have a very low vertical reservoir; however, they absorb and pond so much water and cover such a large portion of the basin (17%) that even minimal rates of vertical seepage would result in significant contributions to the basin's groundwater reservoir. During the period of the year when there is a high rate of surface runoff, the swamp deposits absorb and pond the runoff and slowly release it to the streams. This phenomenon is at its maximum during the latter part of the spring each year. During the growing season, the dense vegetation in the wetlands results in a high water loss due to evapo-transipiration. During the dry periods of late summer and early fall, surface runoff from the swamp deposits is at a minimum and, at the same time, the level of the surface waters has dropped to a point at which a hydraulic gradient is established which favors the release of the groundwaters which the ice-contact and outwash deposits have stored during the wetter parts of the year. The other unconsolidated deposits in the Ipswich River basin (marine deposits, wind deposits, and alluvium as well as beach and dune deposits) play less significant roles in the hydrology of the basin, however, they are integral parts of the overall system which determines the groundwater-surface water interrelationships in the basin.

The velocity at which a given amount of water will travel in a stream is determined by the hydraulic characteristics of the streambed. Stream velocity, or "time of travel", under various flow conditions is a good indication of the stream's hydraulic characteristics, and a knowledge of these characteristics is essential to the understanding of the stream and its behavior. Two time-of-travel studies were conducted on the Ipswich River by the Division of Water Pollution Control in support of the development of the Ipswich and Parker Rivers 1976 Water Quality Management Plan. The two studies, one conducted in

November 1972 and the second in December 1973, captured conditions of moderately high flow and intermediate flow, respectively (Dalton 1976). Contrary to the flow in a stream with a well-defined channel and hydraulic gradient where a higher flow regime would result in a higher velocity and shorter travel time, the Ipswich River time of travel was longer under the higher flow condition of 1972 than the intermediate flow condition of 1973.

The Ipswich River has a relatively low hydraulic gradient and a very poorly defined channel. In periods of low to intermediate flows, the Ipswich stays within its channel and is traveling the shortest possible distance at the optimum hydraulic gradient. Under high flow conditions, the river overflows its channel banks and the stream level equalizes with the ponded water in the surrounding swamplands. The overall hydraulic gradient decreases to a minimum, stream flow is hindered by the vegetation, and, as a result, there is a significant increase in stream travel time.

The hydrologic setting as described above determines the short-term fate of the average 42.5 inches of precipitation which fall annually on the basin. The precipitation falls at a very uniform rate; but an examination of stream flow data demonstrates that the rate at which the precipitation returns to the ocean is anything but uniform, and it is this variability in streamflow that is determined by the basin's hydrologic setting. During the course of a typical one-year hydrologic cycle for the Ipswich River Basin, the stream flow in August and September reach their lowest levels of the year as surface runoff is at a minimum. Almost all of the base flow in the basin's streams is due to groundwater discharge. Groundwater recharge is almost non-existent, with the result being that the groundwater reservoir is depleted by the discharge of groundwater to the surface waters. Most of the precipitation which falls on the basin is lost through evapotranspiration, which accounts for the lack of surface runoff and groundwater recharge.

With the end of the growing season, the rate of evapotranspiration falls off drastically because the basin's vegetation is no longer exerting a high water demand, and so precipitation is either absorbed into the ground (the predominant phenomenon in the Ipswich Basin) or runs off to surface waters. As stream levels rise, the hydraulic gradient which favored groundwater discharge to surface water becomes less favorable which increases the overall rate of recharge of the groundwater reservoir. The processes of groundwater recharge and surface runoff continue until the soil freezes for the winter.

As winter approaches, the ground freezes and groundwater recharge falls off again. Stream flows are at higher levels than those which were observed in the late fall, and there is a more direct relationship between precipitation and stream flow because the time lag due to groundwater recharge and discharge is largely absent.

Finally, in the spring as the ground thaws, the groundwater reservoir begins to be recharged from both melting snow and precipitation. Because of the soil's limited capacity to accept, transmit, and store water, most of the excess water runs off to surface water, raising the levels of streams and ponds to their highest point of the year. The groundwater reservoir, which was partially replenished during the late fall, rapidly becomes saturated, causing a further increase in surface runoff. During March and April, the swamp deposits act as a tempering factor to keep flow levels from reaching their theoretical peak as they store more water than they release. By early May, the swamp deposits are also saturated and, as the stream levels begin to drop after the passage of the snowmelt surcharge, the wetlands begin to release the water ponded in them. The release of the stored water reaches a maximum in late May early June at which time the new growth of vegetation once again places a heavy demand on the precipitation falling on the swamp deposits.

Stream levels fall as the rate of surface runoff decreases, and this trend will continue until the end of the growing season. Throughout the summer, almost all of the precipitation which falls on the basin will be lost through evapotranspiration, the highest rate occurring in the dense vegetation of the swamp deposits. The swamp deposits continue to discharge to the surface waters, but the rate of discharge drops off to a minimum as there is virtually no replenishment of their water supply. Were it not for the basin's groundwater reservoir, the streams in the Ipswich basin would soon run dry in the periods between rainstorms.

As stream levels continue to drop, a hydraulic gradient is established between the surface waters and the groundwater reservoir whereby groundwater discharges from the reservoir into the surface waters. By the end of the growing season, this discharge of groundwater accounts for practically all of the base flow in the basin's streams as surface runoff reaches a minimum.

Hypothetically, the continuation of the growing season (or the out of basin transfer of water) would result in a depletion of the groundwater reservoir, at which groundwater discharge to surface waters would cease. Streams in the Ipswich basin would then go dry in periods between rainstorms. In point of fact, the Ipswich has gone dry in periods of severe drought as occurred in the mid-1960s when the groundwater reservoir and the swamp deposits were not sufficiently replenished to supply flow to the entire river throughout the summer months. This fact, more than any other, points out the extremely fragile nature of the hydrology of the Ipswich River Basin. A delicate balance exists between the groundwater reservoir, the surface waters, and the precipitation that annually falls on the basin; and there is very little excess capacity in the hydrologic system to compensate for significant decrease in precipitation. This is the hydrologic framework within which the 1976 water quality management plan for the Ipswich River Basin was developed and which any updated management plan must also consider.

DESCRIPTION

The Ipswich River is formed at the confluence of Maple Meadow and Lubbers brooks in Wilmington. The upstream drainage area at this point is 8.6 mi^2. The Maple Meadow Brook drainage area is 5.6 mi^2 and includes Sawmill and Mill brooks, as well as several unnamed perennial and intermittent streams. The Ipswich River widens as it passes by the Reading Town Forest, where the former riverbed was excavated for sand and gravel deposits. Bear Meadow Brook, which flows out of Cedar Swamp to the south of the Ipswich River, and Martins Brook, which drains 14 mi^2 of relatively undeveloped wetlands to the north of the river are the next tributaries to flow into the Ipswich River. Below Martins Brook, the Ipswich River becomes more distinctly channelized and, as a result, there is a slight increase in stream velocity. The channel then begins to widen as the river passes through the center of North Reading. The Ipswich River flows eastward in a series of tight meanders and is joined by an unnamed tributary and by Wills Brook before it enters the impoundment created by the Bostik Company Dam (formerly the USM Chemical Dam) in South Middleton**.** The first of two flow gages maintained by the USGS on the mainstem Ipswich River is located just downstream from this dam. Station 01101500 at South Middleton, MA has a drainage area of 44.5 mi^2 and an average flow of 63.2 cubic feet per second (cfs). The river has a vertical fall of approximately 30 feet between its source and the South Middleton gage. One-third of the fall occurs at the dam.

Stream flow, which has followed an easterly course from the confluence with Martin's Brook, turns abruptly to the north approximately 1.4 river miles below the gage. As the Ipswich River meanders northward through Middleton, it is joined by Norris Brook, the outlet of Middleton Pond, and Emerson Brook. Again, much of the Ipswich River's slowly flowing course is through wetland areas. As it is joined by Boston Brook, the overall direction of flow turns to the east as the stream meanders through Topsfield. Nichols Brook and Fish Brook join the Ipswich River before it enters into the northern portion of Wenham Swamp, which is the basin's largest freshwater wetland (3 mi^2). As the Ipswich River again turns north the rate of flow is so slow and the surface of the stream so level with the surrounding wetlands that several rather large backwater ponds are formed adjacent to the main "channel".

As the Ipswich River flows northward it is joined by several tributaries including Mile, Idlewild, an unnamed tributary, Howlett and Gravelly brooks. The stream channel widens considerably and the Ipswich River begins to flow at a higher velocity in a northeasterly direction that will carry it into Ipswich Bay. The channel widens further as the river enters the impoundment created by the Willowdale "Dam". Just downstream from the Willowdale Dam the USGS monitors discharge of the Ipswich River over a small, concrete weir dam (Foote Brothers 2003). The second USGS flow gage on the mainstem Ipswich River (station 01102000 near Ipswich, MA) has a drainage area of 125 mi^2 and an average annual discharge of 187 cfs. Below the Willowdale Dam the Ipswich River is joined by Black Brook and the Miles River. The most noticeable vertical fall in the Ipswich River occurs in the stretch between the Willowdale Dam and the Miles River, where there are riffles in the stream. The river slows as it enters the impoundment created by the Ipswich Dam (formerly known as the Sylvania Dam), located in the central village of Ipswich. The Ipswich Estuary begins just downstream from the dam and the stream flows through extensive saltwater marshlands to its mouth at Ipswich Bay, delineated between Little Neck and Crane Beach. Several tidal streams, including an unnamed tributary that is known locally as Greenwood Creek (which receives the treated effluent of the Ipswich Wastewater Treatment Facility), Labor in Vain Creek, Fox Creek, Treadwell Island Creek, and Neck Creek discharge to the estuary.

From its source to its mouth the Ipswich River falls approximately 115 feet in elevation, 30 feet of which occurs over the dams. At its mouth the Ipswich River has a drainage area of 155 mi^2 and an estimated average discharge of 188 cfs at the USGS gaging station (01102000) in Ipswich (Armstrong *et al.* 2001 and Socolow *et al.* 2003).

CLASSIFICATION

Consistent with the National Goal Uses of "fishable and swimmable waters", the classification of waters in the Ipswich River Watershed according to the SWQS include the following (MA DEP 1996).

"***Class A*** – These waters are designated as a source of public water supply. To the extent compatible with its 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 ORW under 314 CMR 4.04(3)".

Class A Public Water Supplies in the Ipswich River Watershed

- Longham Reservoir, source to outlet in Wenham and those tributaries thereto
- Middleton Pond, source to outlet in Middleton and those tributaries thereto
- Mill Pond, source to outlet in Burlington and tributaries thereto
- Putnamville Reservoir, source to outlet in Danvers and those tributaries thereto
- Suntaug Lake, source to outlet in Lynn and Peabody and those tributaries thereto
- Swan Pond, source to outlet in North Reading and those tributaries thereto
- Unnamed Reservoir (Emerson Brook Reservoir), reservoir to outlet in Middleton and those tributaries thereto including Stearns and Sudden ponds
- Wenham Lake, source to outlet in Wenham and those tributaries thereto
- Winona Pond, pond to outlet in Peabody and those tributaries thereto

"***Class B*** – These waters are designated as 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."

Class B Warm Water Fisheries in the Ipswich River Watershed (other restrictions as noted)

- Ipswich River, Source to Salem Beverly Waterway Canal (Treated Water Supply)
- Ipswich River, Salem Beverly Waterway Canal to tidal portion

"**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."

Class SA Open Shellfishing Areas in the Ipswich River Watershed

- Ipswich River, tidal portion and tributaries thereto

The Massachusetts Surface Water Quality Standards contain antidegradation provisions (314 CMR 4.04) to maintain existing uses and the level of water quality necessary to protect those uses. As part of these provisions waters with exceptional socio-economic, recreational, ecological and/or aesthetic values are designed as Outstanding Resource Waters (ORWs) (Rojko *et al.* 1995). ORWs include vernal pools, certified as such by the Natural Heritage Program of the Massachusetts Division of Fisheries and Wildlife, and all designated Class A Public Water Supplies (PWS). Other waters designated as ORWs may include those found in National Parks, State Forests and Parks, and Areas of Critical Environmental Concern (ACECs) designated by the Secretary of Environmental Affairs and those protected by special legislation. Wetlands that border these ORWs are designated ORWs to the boundary of the defined area. 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. Generally, new or increased discharges of pollutants are prohibited for wastewater and stormwater. The ORWs in the Ipswich River Watershed are listed in Table 2.

Table 2. Designated Outstanding Resource Waters (ORWs) in the Ipswich River Watershed.

Waterbody	Municipality	Descriptor
Fox Creek	Ipswich	Parker River ACEC
Neck Creek	Ipswich	Parker River ACEC
Salem Beverly Waterway Canal	Topsfield/Wenham	Tributary to PWS (Wenham Lake)
Treadwell Island Creek	Ipswich	Parker River ACEC
Emerson Brook Reservoir	Middleton/North Reading	Public Water Supply
Longham Reservoir	Wenham	Public Water Supply
Middleton Pond (Forest Pond, Middleton Reservoir)	Middleton	Public Water Supply
Mill Pond	Burlington	Public Water Supply
Putnamville Reservoir	Danvers	Public Water Supply
Stearns Pond	North Andover	Tributary to PWS (Unnamed Reservoir – Emerson Brook Reservoir)
Sudden Pond	North Andover	Tributary to PWS (Unnamed Reservoir – Emerson Brook Reservoir)
Suntaug Lake	Lynnfield and Peabody	Public Water Supply
Swan Pond	North Reading	Public Water Supply
Wenham Lake	Wenham/Beverly	Public Water Supply
Winona Pond	Peabody	Public Water Supply

The Massachusetts Secretary of Environmental Affairs has formally designated a small portion of the Ipswich River Watershed as part of the Parker River/Essex Bay ACEC (Figure 7) due to its unique environmental characteristics, including the ability to support rare or endangered species (MA DEM 1993). Fox, Labor in Vain, Neck, and Treadwell Island Creeks (all in the Town of Ipswich) and the tidal portion of the Ipswich River from the mouth to approximately 1500 meters downstream of the Ipswich Dam (formerly known as the Sylvania Dam) are encompassed in this ACEC (Figure 7).

The following was excerpted from MA DEM's ACEC description of the Parker River/Essex Bay ACEC (MA DEM 2001).

> The Parker River/Essex Bay ACEC includes 25,500 acres of barrier beach, dunes, salt marsh, and waterbodies. Plum Island and Castle Neck are two of the relatively few major, undeveloped barrier beaches in the Commonwealth. They are over 10 miles in length combined, with most of the area protected under public or private management. More than 10,000 acres of salt marsh make this the largest salt marsh system north of Long Island, New York.
>
> Included within the ACEC is the 4662-acre Parker River National Wildlife Refuge, known as an important site on the Atlantic Fly-way Migration route. More than 60 bird species breed here, including the rare seaside sparrow and the least tern. Over 300 species of birds have been sighted in this area, including 75 rare species. During the spring and fall migrations concentrations of up to 25,000 ducks and 6000 Canadian Geese have been noted. Waters of the ACEC contain vast amounts of shellfish and host some of the largest anadromous fish runs of alewives and smelt on the North Shore. Other protected open space within the Parker River/Essex Bay ACEC includes the Crane Reservation, Crane Wildlife Refuge, and Plum Island State Park.

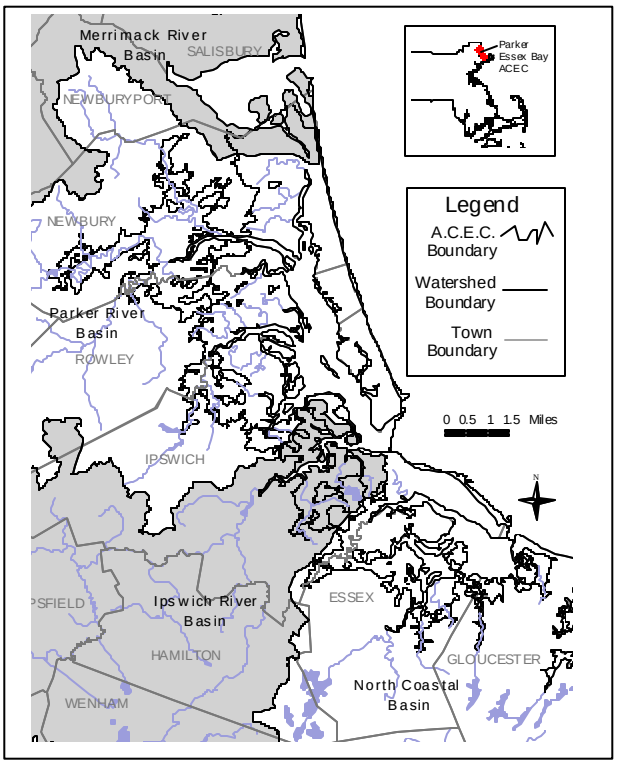


Figure 7. Parker River/Essex Bay ACEC area in the Ipswich River Watershed.

Unlisted waters in the Ipswich River Watershed and Coastal Drainage Area not otherwise designated in the SWQS are designated *Class B, High Quality Waters* for inland waters and *Class SA, High Quality Waters* for coastal and marine waters. According to the SWQS where fisheries designations are necessary they shall be made on a case-by-case basis.

Vernal pools are small, shallow ponds characterized by a lack of fish and by periods of dryness. Vernal pool habitat is extremely important to a variety of wildlife species including some amphibians that breed exclusively in vernal pools and other organisms, such as fairy shrimp, that spend their entire life cycles confined to vernal pool habitat. Many additional wildlife species utilize vernal pools for breeding, feeding and other important functions. Certified vernal pools are protected if they fall under the jurisdiction of the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00). Certified vernal pools are also afforded protection under the state Water Quality Certification regulations (401Program), the state Title 5 regulations, and the Forest Cutting Practices Act regulations. However, the certification of a pool only establishes that it functions biologically as a vernal pool. Certification does not determine that the pool is within a resource area protected by the Wetlands Protection Act (MNHESP 1999). Within the Ipswich River Watershed there are currently 277 certified vernal pools (Harding 2003). These are located in the towns of Ipswich, Beverly, Middleton, Topsfield, Danvers, Boxford, Wenham, Lynnfield, North Andover, Andover, North Reading, Reading, Wilmington, and Burlington. Species of special concern observed in these pools include the Blanding's Turtle. Other obligate vernal pool species observed include: the spotted salamander *(Ambystoma maculatum),* unidentified mole salamanders, fairy shrimp (Order Anostraca) and the wood frog *(Rana sylvatica).* Numerous facultative species of frogs, newts (a form or lifestage of a salamander), turtles, and a variety of benthic macroinvertebrates were also documented in vernal pools in the Ipswich River Watershed.

The Massachusetts Natural Heritage and Endangered Species Program (MNHESP) currently list 37 rare and endangered species within the Ipswich River Watershed (Harding 2003). These include 19 vertebrate species, seven invertebrate species and 11 vascular plant species. Ten of the 37 species listed by the MNHESP are designated as being "endangered." These include: the golden wing warbler (*Vermivora chrysoptera),* American bitten *(Botaurus lentiginosus),* least bitten (*Ixobrychus exilis),* pied-billed grebe (*Podilymbus podiceps),* copper emerald *(Somatochlora Georgiana),* Kennedy's emerald *(Somatochlora kennedyi),* small bur-reed *(Sparganium natans),* variable reed *(Carex polymorpha),* glaucous sedge *(Carex livida* var. *radicaulis)* and the Long's bulrush *(Scirpus longii)*.

In addition, seven species are designated by the MNHESP as being "threatened." These include: the marbled salamander *(Ambystoma opacum),* Blanding's turtle *(Emydoidea blandingii),* piping plover *(Charadrius melodus),* vesper sparrow *Pooecetes gramineus),* king rail *(Rallus elegans),* eastern spadefoot *(Scaphiopus holbrookii)* and the alternate-flowered water milfoil *(Myriophyllum alterniflorum).*

The MNHESP lists 16 species under the "special concern" designation. These include: the eastern box turtle *(Terrapene carolina),* Cooper's hawk *(Accipiter cooperii),* spotted turtle *(Clemmy's guttata),* blue spotted salamander *(Ambystoma laterale),* New England medicinal leech *(Marcobdella sestertia),* common moorhen *(Gallinula chloropus),* least tern *(Sterna antillarum),* common tern *(Sterna Hirundo),* Mystic Valley amphipod *(Crangonyx aberrans),* New England siltsnail *(Cincinnatia winkleyi),* Hessel's hairstreak *(*Callophrys *hesseli),* mocha emerald *(Somatochlora linearis),* seabeach needlegrass *(Aristida tuberculosa),* American sea-blite *(Suaeda calceoliformis),* New England blazing star *(Liatris scariosa)*, and the river bulrush *(Scirpus fluviatilis).*

The remaining four species are listed as "unofficial watch list" or "historic." These include: the great blue heron *(Ardea herodias),* large whorled pogonia *(Isotria verticillata),* osprey *(Pandion haliaetus),* and the reed bentgrass *(Calamagrostis pickeringii).*

SUMMARY OF HISTORICAL CONDITIONS AND PERCEIVED PROBLEMS

The development of groundwater for public supplies in the Ipswich River Watershed began in the late 1800's (Baker *et al*. 1964). According to an early 1900 legislative special commission report the water utilized in the Ipswich River Watershed for public water supply purposes included: Wenham Lake, Suntaug Lake, Middleton Pond and the supply drawn by the Town of Reading (Commonwealth of MA

1913). During 1911, a very dry year, the flow in the Ipswich River was extremely small. While the quantity of groundwater withdrawn at first was small it increased over the years. Observations of the Ipswich River in the Wilmington-Reading Area in the summer of 1956 and for a longer period in 1957 offered "convincing evidence of the hydraulic continuity between the stream and the ground-water body" when direct observations indicated a dry riverbed in the immediate vicinity of the Reading wells while there was flow in the river at points upstream and downstream (Baker *et al*. 1964).

Past water quality surveys in the Ipswich River Basin (Tennant *et al*. 1970) indicated sources of pollution on the mainstem that appeared to be from individual homes and establishments. In the tidal reach pollution was caused by the Ipswich Sewage Treatment Plant, as well as homes and establishments. The Town of Ipswich was placed on an implementation schedule to upgrade to secondary sewage treatment with chlorination by 1972. The Southern Heights Housing Project was also ordered to correct their treatment facility. Results of the water quality survey conducted in 1985 by the Division of Water Pollution Control documented low dissolved oxygen concentrations in the upper Ipswich River in the late summer and elevated coliform bacteria counts in the Ipswich River Estuary (Hanley 1988). During the summer of 1989 the Division of Water Pollution Control conducted a water quality survey of the Ipswich and Essex river estuaries. Generally, open water and mainstem river stations nearest the mouth of the Ipswich River Estuary had higher dissolved oxygen, lower coliform bacteria densities and lower nutrient concentrations than samples from the tributary and in-town river stations (Duerring 1992). The report also documented that coliform counts in Farley Brook and the easternmost storm drain pipe into Neck Cove in the Ipswich River Estuary were indicative of a raw sewage source upstream. Sampling in Greenwood Creek also indicated that problems may have been occurring at the Ipswich Waste Water Treatment Plant. The shellfish beds in the Ipswich River Estuary were "restricted" in the late 80's (shellfishing was allowed but depuration was required), were subsequently "prohibited" or closed due to contamination, and are currently conditionally approved for direct harvest (Kennedy 2003a).

The Ipswich Coastal Pollution Control Committee (ICPCC) was created and appointed by the Ipswich Board of Selectman in response to the May 1991 Ipswich Shellfish Advisory Board Report. A report prepared by the ICPCC identified high levels of bacteria as affecting the Town's recreational and commercial shellfishery. The 15- member ICPCC committee developed a plan of action to address the bacteria problem and published their recommendations in 1995. Since that time the Town has been implementing many of the recommendations (Tomczyk 2003a). Recommendations that have been implemented include, a public and school-based educational and outreach program to address sources, impact, and solutions to the handling and management of animal wastes; the posting of signs declaring a prohibition of the feeding of wild and semi-wild waterfowl and shorebirds at popular feeding locations; adoption and enforcement of a pooper scooper regulation; outreach to farms and horse owners to provide information on the proper handling and management of animal waste; implementation of conventional and innovative stormwater control measures; upgrading the wastewater treatment facility and the Town Wharf pumping station; identification of illegal connections to the wastewater collection system; removal of excessive inflow and infiltration; outreach to boat owners about proper disposal of boat waste and implementation of a boat pump out program; and outreach and education to homeowners on operation and maintenance of septic systems, with recommendations for a septic system inspection and maintenance program, including repair and upgrading of systems (Tomczyk 2003a).

The following specific issues of concern and perceived problems were identified prior to the MA DEP 1995 Ipswich River Watershed water quality monitoring program.

Impacts of water withdrawals on streamflow within the basin - The lack of adequate streamflow was identified as the major concern of stakeholders in the river basin. The importance of this basin as a drinking water source for communities located outside the basin boundaries exacerbates this problem. In some cases the water withdrawn is treated and discharged out of the basin by municipal treatment facilities. In addition, during the summer months the demand for water increases due to lawn irrigation and other outdoor uses and evapotranspiration. Concerns exist about the net impact of these water withdrawals on instream flow in the mainstem Ipswich River and some of its tributaries. The importance of maintaining adequate instream flow for aquatic habitat, recreational uses, and the assimilative capacity of the basin for discharge permitting need to be evaluated.

Nonpoint source problems - Specific concerns regarding road runoff (salt, sediment and other pollutants) along major interstate and secondary routes in the basin, agricultural runoff (specifically runoff associated with improper manure management associated with livestock), stormwater runoff from commercial/industrial parks and improperly fertilized lawns, malfunctioning wastewater pump stations (e.g., Town wharf pump station in Ipswich), improperly functioning septic systems, and other contaminated stormwater runoff in the Ipswich area were also of concern to stakeholders in the Ipswich River Watershed . The impact of these non-point sources of pollution and their contribution to the bacteria problems that resulted in shellfish bed closures were identified as problems.

Point sources of pollution - Although the number of permitted NPDES discharges (major and minor) is not large in comparison to other basins of similar drainage area the cumulative impact of these discharges may be magnified by the low flow problems characteristically experienced in the Ipswich River. Specific concerns exist about the Ipswich Waste Water Treatment Facility that has historically had problems meeting effluent limits**.**

Nutrient loading to the bay and trend monitoring - Nuisance phytoplankton are present such as *Alexandrium tamarensis* (red-tide). These algal blooms may be enhanced by increasing nutrient inputs to the bay.

Limited data - Lack of surface water quality data especially for first and second order streams and lakes and ponds in the Ipswich River Watershed.

Concerns have more recently been expressed by the Ipswich River Watershed Association including fish kills that have occurred due to low flow conditions, the impacts of low flows on biological integrity and water quality, aesthetic quality degradation and the loss of recreational values that occur during low flow conditions and occasionally due to algal blooms (Mackin 2003). Whether or not the low dissolved oxygen conditions in the river and some tributaries are naturally occurring as a result of multiple factors (e.g., seasonal low flows, wetland drainage, organic benthic deposits, limited stream reaeration under normal flow conditions, low photosynthetic activity, etc.) or are unacceptably exacerbated by anthropogenically induced factors (e.g., water withdrawals, out-of-basin transfers and interruption of groundwater recharge due to imperviousness) or result from a combination of both needs further investigation.

The Clean Water Act Section 303(d) requires states to identify those waterbodies that are not meeting the Massachusetts Surface Water Quality Standards. Table 3 identifies the waterbodies in the Ipswich River Watershed on the 1998 Massachusetts Section 303(d) List of Waters (MA DEP 1999a).

Table 3. 1998 Section 303(d) List of Waters in the Ipswich River Watershed (MA DEP 1999a).

River or Estuary (Description)	Waterbody Identification Code (WBID)	Cause of Impairment
Ipswich River (Source to Salem Beverly Waterway Canal)	MA92-06	Nutrients and flow alteration**
Ipswich River (Salem Beverly Waterway Canal to Sylvania Dam)	MA92-15	Organic enrichment/low DO and flow alteration**
Ipswich River (Sylvania Dam to mouth at Ipswich Bay)	MA92-02	Pathogens
Maple Meadow Brook (Outlet Mill Pond to confluence with Lubbers Brook)	MA92-04	Flow alteration**
Martins Brook (Outlet Martins Pond to confluence with Ipswich River)	MA92-08	Organic enrichment/low DO, other habitat alterations, pathogens
Wills Brook (Headwaters to confluence with Ipswich River)	MA92-10	Organic enrichment/low DO, pathogens
Norris Brook (Outlet Elginwood Pond to confluence with Ipswich River)	MA92-11	Organic enrichment/low DO, suspended solids, turbidity
Unnamed tributary (Outlet Middleton Pond to confluence with Ipswich River)	MA92-12	Pathogens
Howlett Brook (Headwaters to confluence with Ipswich River)	MA92-17	Pathogens
Miles River (Outlet Longham Reservoir to confluence with Ipswich River)	MA92-03	Organic enrichment/low DO, pathogens
Kimball Brook (Headwaters to confluence with Ipswich River)	MA92-21	Organic enrichment/low DO, pathogens
Labor in Vain Creek (Headwaters to confluence with Ipswich River)	MA92-22	Organic enrichment/low DO, pathogens
Unnamed tributary locally known as Greenwood Creek (Headwaters to confluence with Ipswich River)	MA92-23	Pathogens
Lake, location		
Beaver Pond, Beverly.	MA92002	Noxious aquatic plants**
Brackett Pond, Andover.	MA92004	Turbidity
Bradford Pond, North Reading.	MA92005	Noxious aquatic plants
Collins Pond, Andover.	MA92010	Noxious aquatic plants, turbidity
Crystal Pond, Peabody.	MA92013	Noxious aquatic plants
Devils Dishfull Pond, Peabody.	MA92015	Noxious aquatic plants, turbidity
Eisenhaures Pond, North Reading.	MA92016	Noxious aquatic plants
Elginwood Pond, Peabody.	MA92017	Noxious aquatic plants
Farnum Street Pond, North Andover.	MA92018	Noxious aquatic plants
Fourmile Pond, Boxford.	MA92022	Noxious aquatic plants
Frye Pond, Andover.	MA92023	Noxious aquatic plants
Hood Pond, Ipswich.	MA92025	Noxious aquatic plants
Howes Pond, Boxford.	MA92026	Noxious aquatic plants
Lower Fourmile Pond, Boxford.	MA92032	Noxious aquatic plants
Lowe Pond, Boxford.	MA92034	Noxious aquatic plants
Lubber Pond East, Wilmington.	MA92035	Siltation, noxious aquatic plants
Lubber Pond West, Wilmington.	MA92036	Siltation, noxious aquatic plants
Martins Pond, North Reading.	MA92038	Noxious aquatic plants, turbidity
Middleton Pond, Middleton.	MA92039	Noxious aquatic plants
Salem Pond, North Andover.	MA92057	Turbidity
Spofford Pond, Boxford.	MA92060	Noxious aquatic plants
Stearns Pond, North Andover.	MA92061	Noxious aquatic plants
Sudden Pond, North Andover.	MA92064	Noxious aquatic plants
Towne Pond, Boxford/North Andover.	MA92068	Siltation, noxious aquatic plants
Upper Boston Brook Pond, Middleton.	MA92070	Noxious aquatic plants

** needs confirmation

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. A primary source of mercury exposure in people is through the consumption of fish contaminated with methyl mercury (USGS 2003b). As a result of this risk the MDPH, as well as the other New England States, has issued a statewide fish consumption advisory (MDPH 2001). Additionally, there are four ponds in the Ipswich River Watershed for which MDPH has issued site-specific fish consumption advisories due to elevated levels of mercury. The most recent MDPH Fish Consumption List recommends the following for waterbodies in the Ipswich River Watershed (MDPH 2002c).

Hood Pond (Topsfield/Ipswich)

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody."
2. "The general public should not eat any largemouth bass or yellow perch from this waterbody."
3. "The general public should limit consumption of non-affected fish from this waterbody to two meals per month."

Lowe Pond (Boxford)

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody."
2. "The general public should not eat any largemouth bass from this waterbody."
3. "The general public should limit consumption of non-affected fish from this waterbody to two meals per month."

Martins Pond (North Reading)

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any largemouth bass, black crappie or yellow perch from this waterbody."
2. "The general public should limit consumption of largemouth bass, black crappie or yellow perch from this waterbody to two meals per month."

Mill Pond (Burlington)

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any largemouth bass from this waterbody."
2. "The general public should limit consumption of largemouth bass from this waterbody to two meals per month."

SOURCES OF INFORMATION

Multiple local, private, state and federal agencies provided information used in the water quality assessment of the Ipswich River Watershed. Within MA DEP 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, river and lake water quality data, biological and habitat assessments, and fish toxics monitoring were provided by MA DEP Division of Watershed Management's (DWM) Watershed Planning Program (Appendices A, B, C, D, E, F and G). Water withdrawal and wastewater discharge permit information were provided by the DWM Watershed Permitting Program (Appendix H).

The Ipswich River and several of its tributaries receive discharges of treated municipal and industrial wastewater, contact and non-contact cooling water, etc. (Appendix H, Tables H1 and H2). The following types of National Pollutant Discharge Elimination System (NPDES) discharges occur in the Ipswich River Watershed (Hogan 2002).

- Municipal wastewater treatment plants (WWTPs) - These facilities treat wastewater from domestic and industrial sources within the WWTP service area. Only one WWTP discharges within the Ipswich River basin. The Town of Ipswich wastewater treatment plant discharges to Greenwood Creek and thence to the Ipswich River. This area is tidal and flushes into Plum Island Sound and is classified SA. The treatment plant's 1.8 MGD effluent undergoes an ultraviolet method of disinfection, which

eliminates any possible toxicity effects from chlorine and chlorine compounds. Also, due to some historically high copper concentrations the Ipswich WWTP now undertakes copper controls to meet a permit limit of 2.9 µg/L maximum daily with monitoring required four times per year. The facility is also required to have whole effluent toxicity testing conducted four times a year.

Ipswich continues to make upgrades in the treatment plant by constructing a new forced main that is part of a project to eliminate the overflow of raw sewage from discharge points located at the Town Wharf and Choate Bridge.

- Water treatment plant discharges - There are five water treatment plants that are permitted to discharge filter backwash water.

- Industrial WWTPs and non-process discharges - There are two permitted discharges for contact or non-contact cooling water.

- Other sanitary discharges - There is only one facility that discharges domestic wastewater in the watershed. Turner Hill Preservation Association discharges 0.01 MGD of treated sanitary effluent into an unnamed wetland tributary to the Ipswich River (Segment MA92-15).

- 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 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. Certain 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.

All 22 communities in the Ipswich River Watershed are "Phase II" communities: Andover, Beverly, Billerica, Boxford, Burlington, Danvers, Essex, Georgetown, Hamilton, Ipswich, Lynnfield, Middleton, North Andover, North Reading, Peabody, Reading, Tewksbury, Topsfield, Wenham, Wilmington, and Woburn (Figure 8 and Appendix H, Table H3). All of these communities applied to EPA and MA DEP for coverage under the Phase II stormwater general permit, issued on 1 May 2003. 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

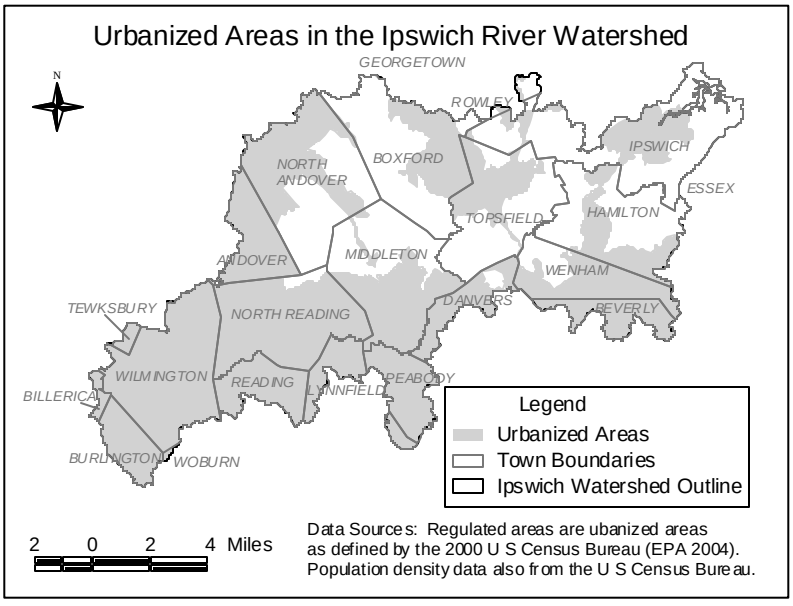


Figure 8. Phase II Regulated Area Map of the Ipswich River

only in the mapped Urbanized Areas (see http://www.epa.gov/region01/npdes/stormwater/ma.html for detailed maps for each community). Stormwater general permits will be issued jointly by EPA and DEP after administrative review by EPA. A thorough review of the communities' stormwater management program will be completed by EPA, in coordination with MA DEP, during the five year permit term. Annual reports will be submitted to EPA and MA DEP by the permittees. Phase II stormwater general permits will expire on 1 May 2008 (Domizio 2004). This report does not have information on the other municipal (i.e., non-community) MS4s that may be in the Ipswich River Watershed and are regulated under the NPDES Stormwater Phase II permit program.

NPDES Toxicity Testing Discharge Monitoring Reports (DMRs):

Five of the permittees in the Ipswich River Watershed have submitted toxicity testing reports to EPA and MA DEP 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 March 1998 to October 2002 were reviewed and summarized for use in the assessment of current water quality conditions in the Ipswich River Watershed. These include:

Bostik Findley, Inc. in Middleton (MA0001180)
Ipswich Wastewater Treatment Plant (MA0100609)
Turner Hill Preservation Associates, LLC (MA0021661)
E.H. Sargeant Water Treatment Plant (MAG640020)
Butters Row Water Treatment Facility (MAG640024)

There are no Federal Energy Regulatory Commission (FERC) licensed hydroelectric power plants in the Ipswich River Watershed nor any FERC-exempt power-generating facilities.

A list of registered and permitted Water Management Act (WMA) withdrawals (both public water suppliers and other industrial users) is provided in Appendix H, Table H4 (LeVangie 2003a).

Projects funded through various MA DEP grant and loan programs also provide valuable information that may be used in the water quality assessment report. A summary of these projects for the Ipswich River Watershed is provided in Appendix I.

Other Massachusett state agencies contributing information to this report include: the MDPH, the Department of Fish and Game's Division of Marine Fisheries (DMF), Division of Fisheries and Wildlife (MassWildlife) and Riverways programs (formerly the Department of Fisheries, Wildlife, and Environmental Law Enforcement - DFWELE), and the Department of Conservation and Recreation (DCR) (formerly the Department of Environmental Management - DEM). Contributing federal agencies include: EPA, United States Geological Survey (USGS), and the United States Army Corps of Engineers (ACOE).

In addition to state and federal agencies, regional, local and citizen monitoring groups provided valuable data/information, which may be used to indicate areas of degraded water quality, as well as causes and sources of contamination.

The USGS, as part of their National Water-Quality Assessment (NAWQA) Program in the New England Coastal Basins (Maine, Massachusetts, New Hampshire, and Rhode Island) study unit, conducted water quality sampling in the Ipswich River between 1998 and 2000 at their gaging station (01101500) at South Middleton, MA. These data are published in the Water Resources Data Massachusetts and Rhode Island Water Year 1999 and 2000 reports (Socolow *et al.* 2000 and Socolow *et al*. 2001).

A New England Coastal Basin (NECB) Mercury Study was also initiated by USGS in 1999 when the results of their National Mercury Pilot Study showed some of the highest mercury concentrations in the country were in the NECB study area (USGS 2003b). The dominant source of mercury identified in the NECB study area was atmospheric deposition. In collaboration with USGS's Toxics Substances Hydrology Program (an extension of the National Mercury Pilot Study), Urban Land Use Gradient Study (part of the NAWQA program) and the MA DEP Merrimack Valley Fish Study (described below), the USGS collected, sediment, water, and/or fish tissue for total and/or methyl mercury analysis from 22

streams north of Boston in 1999 and 30 sites in the NECB in 2000. The Ipswich River at South Middleton was sampled by USGS between September 1998 and August 2000.

The USGS, in cooperation with the Massachusetts DEM, MA DEP, and DFWELE conducted an assessment of the habitat, fish community, and streamflow requirements in the Ipswich River Basin in 1998-1999. The study concluded that the fish communities were dominated by macrohabitat generalists (tolerant of low-flow, warm water, ponded conditions) and that "minimum streamflow requirements combined with removal of dams and other barriers to fish passage, would allow fish communities to recover toward the goal of maintaining target communities consisting of more fluvial species in higher numbers" (Armstrong *et al.* 2001).

A directed study of fish in lakes in northeastern Massachusetts was performed by the MA DEP Office of Research and Standards (ORS) during 1999 in order to examine possible spatial patterns in the occurrence of higher fish mercury concentrations and to compare the fish contamination situation in this localized geographic region to statewide and regional data (MA DEP 2000b). Northeastern Massachusetts has an important history of industrialization dating back into the nineteenth century with the extensive burgeoning of mills along the Merrimack River. Most of this industry is now gone and the infrastructure for the mills is now slowly being converted to non-manufacturing uses. Many of the older, larger towns are relatively densely populated areas, yet surrounding lands are relatively undeveloped. This region was recently identified through the use of an air deposition model as having the highest predicted annual levels of recent wet and dry atmospheric deposition of mercury in the state. The area has the state's largest concentration of point sources of atmospheric mercury emissions; three municipal solid waste incinerators and a medical waste incinerator. Zones downwind from major point sources may be subject to increased deposition of a variety of contaminants. While historic records of atmospheric mercury deposition in this area do not exist, past widespread burning of coal for domestic heat and industrial boilers in the late nineteenth and first half of the twentieth centuries probably contributed to a relatively high background mercury signature in the environment of this part of the state. The objectives of the study were to: 1) sample fish from many lakes in northeastern MA where fishing takes place in order to determine if fish consumption advisories are needed for those lakes; 2) determine whether the frequency of advisories is greater in this area than across the state as a whole; 3) determine if there are any spatial patterns in fish mercury concentrations within the study area related to the locations of the major point sources of mercury emissions; 4) determine how well measured mercury concentrations match those predicted by a fish tissue mercury prediction model developed by MA DEP; and 5) compare mercury concentrations in fish from the region with those from other parts of Massachusetts.

The lakes sampled in this study were chosen on the basis of the following: size of lake (4 hectares minimum size), availability of fish species, fishing pressure, access, and proximity to other lakes. Two lakes in the Ipswich River Watershed included in this study were sampled by Normandeau and Associates under contract to MA DEP ORS in 1999: Lowe Pond, Boxford and Towne Pond, Boxford/North Andover.

Fish toxics monitoring in the Ipswich River Watershed was also conducted by MA DEP DWM at the following locations: Ipswich River in Middleton (near Bostik Company in October 1995), Ipswich River in North Reading (downstream from Central Street in August 2000), Martins Pond (September 1995) and Hood Pond (May 2000) (Maietta and Colonna-Romano 2001). Four species of fish including American eel (*Anguilla rostrata)*, bluegill (*Lepomis macrochirus*), rainbow trout (*Oncorhynchus mykiss*), and largemouth bass (*Micropterus salmoides*) were collected by the Burlington Board of Health from Mill Pond in Burlington (Rose 2002).

The only pond sampled in the Ipswich River Watershed as part of the study that does not have a site-specific advisory for mercury is Towne Pond, Boxford/North Andover.

The Plum Island Ecosystems (PIE) research site, located on the northeastern Massachusetts coast, is part of the National Science Foundation's (NSF) Long Term Ecological Research (LTER) Network. PIE-LTER research is conducted by scientists from the Ecosystems Center at the Marine Biological Laboratory, the University of South Carolina, the Massachusetts Audubon Society, the Wells National Estuarine Research Reserve, the University of New Hampshire and Clark University. Interdisciplinary research has been conducted in the Plum Island Sound estuary since the late 1980's with support from

the NSF Division of Environmental Biology. Research greatly expanded in 1992 with support from the NSF Land Margin Ecosystems Research (LMER) program. The site became part of the LTER network in 1998, as the first of four sites to focus on the effect of terrestrial and oceanic drivers on ecosystems at the land-sea interface. In the Ipswich River Watershed four stations were sampled for nutrients in 1992 and 1993. More recent data is available for one station, Ipswich River at Ipswich Dam (formerly known as the Sylvania Dam) Ipswich, (Segment MA92-02; lat 42.6777, long 70.83784).

The following is excerpted from the Massachusetts Department of Conservation and Recreation (MA DCR), Division of State Parks and Recreation's, Office of Water Resource's website (MA DCR 31 October 2003).

> Established in 2001, the Drought Management Task Force (DMTF) became the primary vehicle through which drought response is managed in Massachusetts. The purpose of the DMTF is to monitor, coordinate, and manage response to drought situations and to make recommendations to the appropriate entities to ensure impacts to public health, safety, the environment and agriculture are minimized. The DMTF is composed of liaisons from Massachusetts Emergency Management Agency, Executive Office of Environmental Affairs, Massachusetts Department of Environmental Management, Massachusetts Department of Environmental Protection, Massachusetts Department of Fish & Wildlife, Massachusetts Department of Food & Agriculture, Massachusetts Department of Public Health, Metropolitan District Commission, Massachusetts Water Resources Authority, U.S. Geological Survey, U.S. Army Corps of Engineers, National Weather Service, Massachusetts Water Works Association, the Massachusetts Association of Health Boards and the Water Supply Citizens Advisory Committee. Since December 2001, drought status reports have been issued monthly for the regions of the state.

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 determine 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 and is available online at http://www.state.ma.us/dph/dcs/bb4_01.pdf. 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 2002a).

The National Shellfish Sanitation Program (NSSP) includes federal and states governments cooperatively administering a battery of public health regulations designed to assure the sanitary integrity of shellfish and shellfish products. A key regulatory role assigned to coastal states by the NSSP is shellfish classification. According to methods, procedures and standards set forth in the NSSP "Guide For The Control Of Molluscan Shellfish" (ISSC 2000) a designated state agency must determine whether shellfish from coastal growing waters are safe or may be made safe for human consumption. The determination is predicated, in large part, upon the presence of fecal coliform bacteria within the growing waters. Fecal coliform bacteria are an indicator of human and animal waste pollution, which represents the principle cause of shellfish transmitted illnesses via the fecal to oral route.

The DMF Shellfish Management Program maintains information used to classify (e.g., approved, conditionally approved, prohibited) their shellfish management areas. These classifications are subsequently used to regulate the harvesting of various shellfish (Churchill 1999). DMF shellfish

management areas also include acreage in the Ipswich River Watershed not designated as segments in this report. Appendix J includes the complete listing of DMF shellfishing closures as of July 2000 in the Ipswich River Watershed. Conservation of the shellfish resource, fisheries management and the protection of public health are goals of DMF's Shellfish Management Program.

DMF conducts fecal coliform bacteria sampling as part of their sanitary surveys by which a classification for the shellfish growing areas is assigned. These data are collected for the sole purpose of protecting public health. Shellfish species, habitat location, relative abundance and related fisheries must also be documented. A shoreline survey is conducted to identify pollution sources and evaluate potential impacts. Concomitantly, an understanding of hydrographic characteristics that may influence contaminant distribution and removal over the growing area is evaluated. Supplementary analysis may be required for naturally occurring pathogens (i.e., *Vibrio* spp.), marine biotoxins (i.e., Paralytic Shellfish Poisoning) or hazardous wastes in growing areas with a known history of contamination by these harmful substances.

Sanitary surveys are repeated at least every twelve years for growing areas classified other than Prohibited. Survey information is kept current through annual and triennial reports and classifications maintained with extensive monitoring. A growing area classification may be downgraded and management plans amended based on the findings of annual and triennial reviews. Classification upgrades can only be made based on the findings of a sanitary survey.

The Ipswich River Watershed Association (IRWA) is a non-profit organization, formed by volunteers in 1976 whose mission is to serve as the voice of the river, protect water quality and quantity, fish and wildlife habitat, recreational opportunities and scenic values of the Ipswich River Watershed. IRWA began its volunteer monitoring program in 1988 at only eight mainstem sites on a semi-monthly basis. Today, this volunteer monitoing program, the River Watch Program, conducts monthly water quality monitoring of temperature, color (visual inspection), odor, depth, velocity, dissolved oxygen, and nutrients at 30 sites. Additionally, IRWA conducts benthic macroinvertebrate monitoring, fish counts, and supports seven stream teams that conduct shoreline surveys and develop action plans (IRWA 9 July 2003).

The University of New Hampshire developed the Ipswich-Parker Suburban Watershed Channel (IPSWATCH), a web site dedicated to providing the public with environmental data for the Ipswich River and Parker River watersheds (http://www.ipswatch.sr.unh.edu/index.html), through an Environmental Monitoring for Public Access and Community Tracking (EMPACT) program grant awarded from EPA in December 2000. Additional information is available online at http://www.ipswatch.sr.unh.edu/. The goals of the project were as follows.

1. Increase environmental awareness of people living, working, or playing in the Ipswich River and Parker River Watersheds.
2. Gather and make available data sets collected by a number of different organizations monitoring water quality and conducting research in the Ipswich and Parker River Watersheds.
3. Provide real time water quantity and quality information for freshwater stream and river sites.
4. Monitor nutrient loading from different land use types.
5. Increase awareness of how land use and water withdrawal issues impact the health of aquatic ecosystems.
6. Address three important issues affecting the watersheds:
   - nutrient enrichment of lakes and streams,
   - reduction of fish habitat caused by low flow, and
   - fecal coliform contamination of freshwater and estuarine water bodies.

TOTAL MAXIMUM DAILY LOADS (TMDLs)

As part of the Federal Clean Water Act states are required to develop TMDLs for lakes, rivers and coastal waters that do not meet SWQS as indicated by a state's Section 303(d) List of Waters (see Table 3). A TMDL is the greatest amount of a pollutant that a waterbody can accept and still meet water quality standards. Further information on the 303(d) List and the TMDL Program are available on the MA DEP website at: http://www.mass.gov/dep/brp/wm/wmpubs.htm.

RIVERS

In the Ipswich River Watershed MA DEP is required to produce TMDLs for several different pollutants, but primarily bacteria. This work is not specifically scheduled yet. Of particular sensitivity is the lower portion of the Ipswich River, which has a substantial shellfish resource. The bacterial limits for such waters are very stringent.

LAKES

There are 24 lakes in the Ipswich River Watershed on the 1998 Section 303 (d) List of Waters for which the most common cause of impairment is noxious aquatic plants (Table 3). While the TMDLs for these waters are required to be completed by 2011, no specific timetable has been established. However, it is expected that all of these waterbodies likely will be addressed as part of one comprehensive TMDL report for lakes in the watershed.

OBJECTIVES

This report summarizes information generated in the Ipswich River Watershed through *Year 1* (information gathering in 1999) and *Year 2* (environmental monitoring in 2000) activities established in the "Five-Year Cycle" of the Watershed Initiative. Data collected by DWM in 2000 are provided in Appendices A, C, D, F, and G 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 lakes and rivers in the Ipswich River Watershed in accordance with EPA's and MA DEP's use assessment methods. Not all waters in the Ipswich River Watershed are included in the waterbody system database (WBS), the new 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 Ipswich River Watershed, defined as segments in the WBS database, currently support their designated uses (i.e., meet SWQS);
2. identify water withdrawals (habitat quality/water quantity) and/or major point (wastewater discharges) and nonpoint (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 Ipswich River Watershed action plan.

REPORT FORMAT

RIVERS

The rivers assessed in the Ipswich River Watershed are presented in the River Segment Assessment section of this report. The order of river segments follows the Massachusetts Stream Classification Program (Halliwell *et al*. 1982) hierarchy. River segments are organized hydrologically (from most upstream to downstream) and tributary segments follow after the river segment into which they discharge. Each river segment assessment is formatted as follows.

SEGMENT IDENTIFICATION

Name, water body identification number (WBID), location, length, classification.

Sources of information: coding system (waterbody identification number e.g., MA92-01) used by MA DEP to reference the stream segment in databases such as the WBS and the ADB, the Massachusetts SWQS (MA DEP 1996), and other descriptive information.

SEGMENT DESCRIPTION

Major land-use estimates (the top three uses for the subwatershed, excluding "open water") and other descriptive information.

Sources of information: descriptive information from USGS topographical maps, base geographic data from MassGIS, land use statistics from a 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).

SEGMENT LOCATOR MAP

Subbasin map, major river location, segment origin and termination points, and segment drainage area (gray shaded).

Sources of information: MassGIS data layers (stream segments and quadrangle maps from MassGIS 2001).

WATER WITHDRAWALS AND WASTEWATER DISCHARGE PERMIT INFORMATION

Water withdrawal, NPDES wastewater discharge

Sources of information: WMA Database Printout (LeVangie 2002 and 2003a) and open permit files located in the MA DEP Offices in Boston and Worcester (MA DEP 2003).

USE ASSESSMENT

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

Sources of information include: MA DEP DWM 2000 Survey data (Appendix A, C, D, and F) and MA DEP DWM Toxicity Testing Database "TOXTD". The MDPH Freshwater Fish Consumption Advisory Lists (MDPH 2001 and MDPH 2002c) are used to assess the *Fish Consumption Use*. Where other sources of information were used to assess designated uses, citations are included.

[Note: Although the *Drinking Water Use* itself was not assessed in this water quality assessment report the Class A waters are identified.]

SUMMARY

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

RECOMMENDATIONS

Additional monitoring and implementation needs.

LAKES

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

IPSWICH RIVER WATERSHED - RIVER AND COASTAL/MARINE SEGMENTS

There are a total of 18 named rivers, two unnamed freshwater tributaries and two tidal creeks in the Ipswich River Watershed that are assessed in this report (Figure 9). These include: the Ipswich and Miles rivers, Bear Meadow, Black, Boston, Fish, Gravelly, Howlett, Idlewild, Kimball, Long Causeway, Lubbers, Maple Meadow, Martins, Mile, Nichols, Norris, and Wills brooks. Labor in Vain Creek and the unnamed creek (locally known as "Greenwood Creek") and the two tidal creeks are also assessed. These rivers represent the entire mainstem Ipswich River and all of its direct freshwater tributaries that are named. Two small, unnamed tributaries to the Ipswich River are also assessed. There are a total of 101.6 river miles included in this report. The Ipswich River estuary, Labor in Vain Creek and an unnamed tidal creek account for 0.47 square miles. The remaining rivers and creeks are small and/or unnamed and are currently unassessed.

The following codes are used for representing the river and estuary segments in the Ipswich River Watershed included in this report and shown in Figure 9.

MA92-02	Ipswich River	MA92-10	Wills Brook	MA92-18	Gravelly Brook
MA92-03	Miles River	MA92-11	Norris Brook	MA92-19	Black Brook
MA92-04	Maple Meadow Brook	MA92-12	Unnamed Tributary	MA92-20	Long Causeway Brook
MA92-05	Lubbers Brook	MA92-13	Boston Brook		
MA92-06	Ipswich River	MA92-14	Fish Brook	MA92-21	Kimball Brook
MA92-07	Bear Meadow Brook	MA92-15	Ipswich River	MA92-22	Labor in Vain Creek
MA92-08	Martins Brook	MA92-16	Mile Brook	MA92-23	Unnamed Tributary
MA92-09	Unnamed Tributary	MA92-17	Howlett Brook		

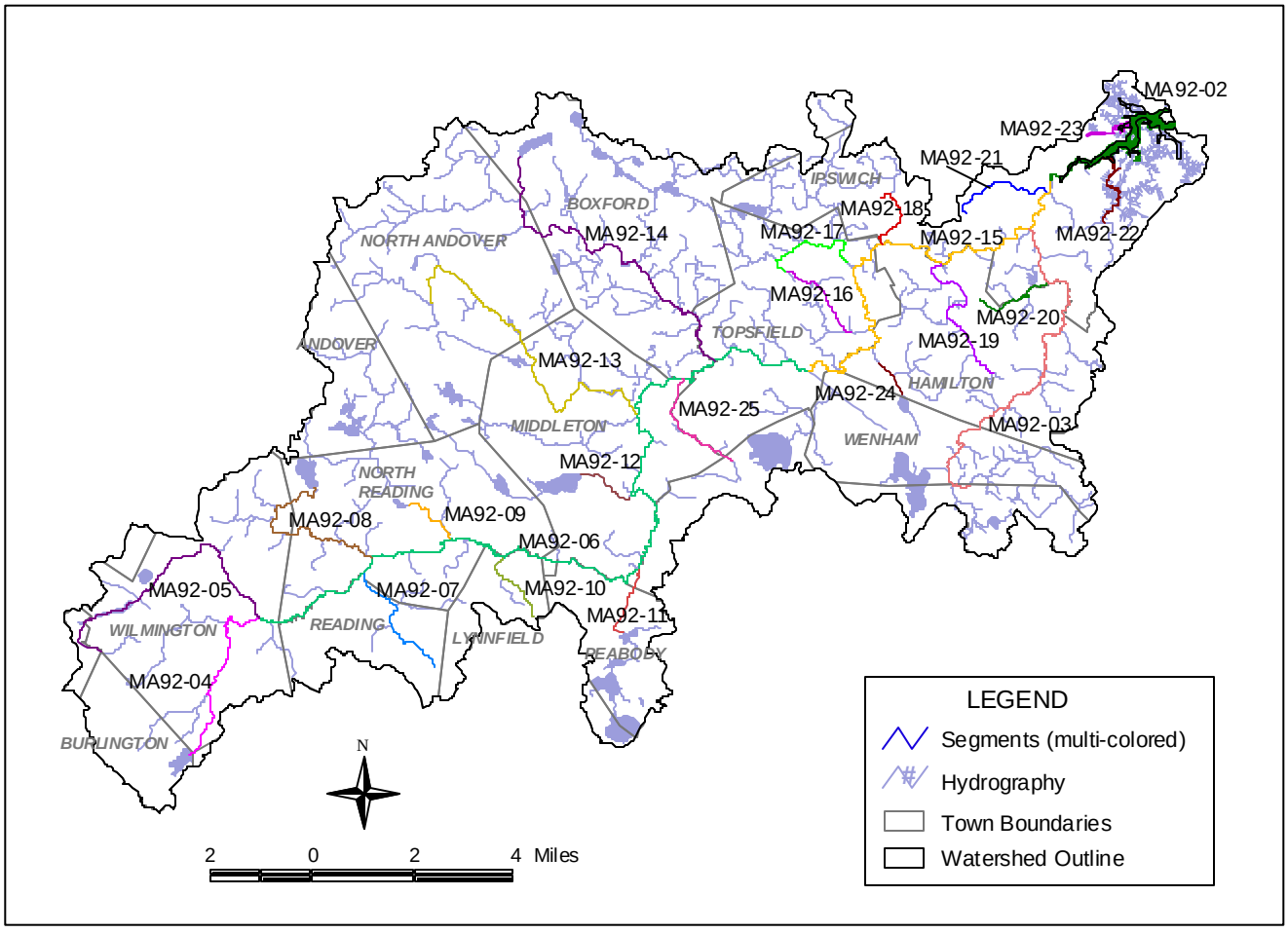
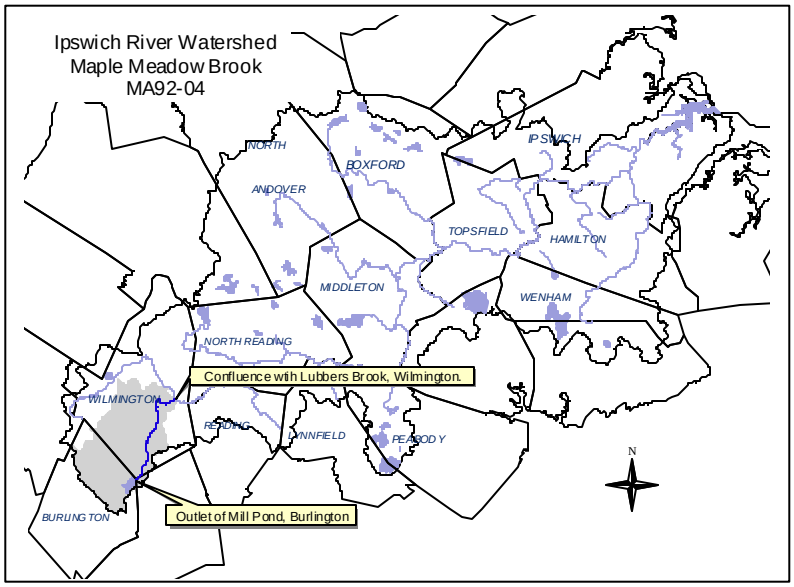


Figure 9. River and Coastal and Marine Segments in the Ipswich River Watershed

MAPLE MEADOW BROOK (SEGMENT MA92-04)

Location: Outlet of Mill Pond, Burlington to confluence with Lubbers Brook, Wilmington.
Segment Length: 4.2 miles
Classification: Class B.



The drainage area of this segment is approximately 8.5 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Residential 45%
Forest 34%
Open Land 7%

This segment of Maple Meadow Brook begins at the outlet of Mill Pond (a public water supply reservoir holding water pumped from the Shawsheen River) in Burlington and flows in a generally northeasterly direction to its confluence with Lubbers Brook in Wilmington forming the Ipswich River. Maple Meadow Brook receives flow from several unnamed tributaries and Mill and Sawmill brooks.

The use assessment for Mill Pond (MA92041) is provided in the Lake Assessment section of this report. Mill Pond is isolated from Maple Meadow Brook (Mackin 2003 and Tomczyk 2003). Department records indicate that the plans by Whitman and Howard, Engineers and Architects, for construction of the Dam, Dikes and Reservoir, Inc. were approved by the MA DEP on 16 May 1968 (O'Keefe 2004). Per conversation on 13 January 2004 with Bill Keene, Water Quality Manager, Burlington Water and Sewer Division, the dikes that were constructed in the headwaters of Maple Meadow Brook are hydrologically separate from Mill Pond, which is an off-stream reservoir filled solely by diversion of the Shawsheen River. Mill Pond does not overflow to the Ipswich River Basin; water levels in the reservoir are managed to avoid overflow.

This segment is on the 1998 303(d) List of Waters, needing confirmation, for flow alteration (Table 3).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX H, TABLE H4)

Facility Name Registration Permit	Authorized Withdrawal (MGD)		Reported Actual Use (MGD)				
	9/1/1994 to 8/31/1999	9/1/1999 to 5/18/2003	1998	1999	2000	2001	2002
Wilmington Water Department 31734201 9P31734201	2.91(reg) 0.45 (per)* 3.36 (total)**	2.91(reg) 0.65 (per)* 3.56 (total)**	2.84	3.07	2.91	2.80	2.58

*A modified permit issued in 2003 decreased the permitted withdrawal back to 0.45 MGD, however this modified permit is under appeal. The permit expires in 2009.
**Indicates system-wide withdrawal, five of the nine sources (the Maple Meadow Brook Aquifer wells, which include the two Butters Row wells, the two Chestnut Street wells, and the Town Park Well) along this segment. It should be noted, however, that due to concerns of contamination in and near the wellfield (wells contained elevated levels of N-Nitrosodimethylamine (NDMA) and ammonia thought to be from the Olin Corporation Facility site as well as volatile organic compounds not suspected to be coming from Olin). The Town of Wilmington has recently stopped using the wells in this subwatershed and is looking for other supplemental sources such as emergency connections to Woburn, Burlington and the MWRA (Tomczyk 2003b and Johnson 2003). Arsenic has also been detected in the untreated water in some Wilmington wells but the treatment processes have been able to remove it (Masel 2003). The source of arsenic may be natural or associated with the Maple Meadow Landfill (Johnson 2003). Studies are currently being conducted to determine sources of the contaminants.

The Burlington Public Water Supply withdraws water from the Shawsheen River and stores it in Mill Pond for later withdrawal. They have a WMA registration (31504801) and permit (9P3150480) to withdraw from

the Shawsheen River Basin. In 2002 Burlington withdrew 557.41 million gallons from Mill Pond (LeVangie 2003b).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLES H1, H2 AND H3)

The Town of Wilmington Water and Sewer Department is permitted (MAG640024 effective June 2001) to discharge 0.14 MGD (average monthly flow) of wastewater from the Butters Row Water Treatment Facility in Wilmington, MA to Maple Meadow Brook. A toxicity test on the effluent using *Ceriodaphnia dubia* was conducted in May 2002.

Textron Defense Systems, Wilmington, was permitted (MA0003468 issued August 1975) to discharge 0.03 MGY via outfall #001 and 0.008 MGD via outfall #002 of cooling water (not described as either contact or non-contact) to Maple Meadow Brook. The facility has gone to a closed-loop system and the permit was terminated in December 2001. The facility has a MultiSector General Permit (MAR05C305) for their stormwater discharge(s) that became effective in September 2001 and expires in September 2003.

The Wilmington Housing Authority, Wilmington, discharge (MA0102326) was tied into the municipal sewer system and, therefore, no permit is required (agency determination April 1999).

A closed loop system was installed at Zeneca Resins (MAG250902) (and/or Polyvinyl Chemical Industries, Wilmington - MA0027642) and, therefore, according to EPA no NPDES permits are required (determination made in March/April 1999).

There are five general stormwater permittees in this subwatershed. The following general permits were issued by the EPA in October 2001. They and will expire in October 2005.

- Analog Devices Inc., Wilmington, permit No. MAR05C391
- Koch Membrane Systems, Wilmington, permit No. MAR05B672
- Avecia, Wilmington, permit No. MAR05B955
- Surface Coatings Inc., Wilmington, permit No. MAR05B952
- Neoresins, Inc., Wilmington, permit Nos. MAR05C328, MAR05C337, and MAR05C345

Burlington, Wilmington, and Woburn are Phase II Stormwater communities. These communities were issued stormwater general permits from EPA and MA DEP in 2003/2004 and are authorized to discharge stormwater from their municipal drainage systems (MAR041030, MAR041234, and MAR041073, respectively). Over the five-year permit term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Although no current stream gaging data are available, it should be noted that there are two WMA permittees within this subwatershed area - the Burlington Water Department withdrawal from Mill Pond and the Wilmington Water Department withdrawals from five of their wells along the brook. The withdrawal volume from the Wilmington Water Department between 1998 and 2002 averaged 2.84 MGD. In 2002 the Burlington Water Department pumped 2.01 MGD from the Shawsheen River into Mill Pond and withdrew 1.53 MGD from Mill Pond. Nearly all of Burlington is sewered while approximately 15% of the Town of Wilmington's population is currently sewered. The wastewater from both towns is treated at MWRA Deer Island and discharged to the Boston Harbor Watershed (MA DEP 2002). Wilmington is in the process of developing a comprehensive water resource management plan. According to the Ipswich River Watershed Association flow alteration along Maple Meadow Brook occurred in the vicinity of the wellfield. They observed that there was flow upstream of the wellfield, the brook was dry near the wellfield, and flow was reversed downstream from the wellfield (IRWA 1998 and Mackin 2003).

Toxicity

Effluent

The effluent from the Butters Row Water Treatment Facility in Wilmington (MAG640024) was not acutely or chronically toxic to *C. dubia* during the test conducted in May 2002.

Chemistry – water

DWM collected *in-situ* measurements from one station on Maple Meadow Brook (Station MM01, Unique ID 143 - at Federal Street, Wilmington) between 8 August and 7 September 2000 (n=6). Parameters measured included dissolved oxygen, pH, temperature, conductivity, and total dissolved solids. On 1 August and 24 August grab samples were also collected and analyzed for alkalinity, hardness, chloride, suspended solids, ammonia-nitrogen, and total phosphorus (Appendices B and C of Appendix A). DWM also conducted water quality monitoring in Maple Meadow Brook in July 1995 at this location (Appendix B, Tables B3 and B4).

Through the IRWA's RiverWatch Volunteer Monitoring Program (RiverWatch) water quality monitoring has also been conducted at one site in Maple Meadow Brook (station MMB at Wildwood Street, Wilmington) since 1997 (IRWA 2000a).

DO

At Station MM01, DO readings recorded by DWM ranged between 0.4 mg/L to 2.1 mg/L (4 to 22% saturation). It should be noted that only two of these samples were collected during worse case, pre-dawn conditions (See Appendix B of Appendix A). Low DO's were also documented by RiverWatch in the summers of 1999, 2000, and 2001 (IRWA 2000b, 2001, and 2002).

Temperature

Temperatures recorded by DWM in Maple Meadow Brook ranged from 14.6°C to 22.2°C. No temperatures measured by RiverWatch were above 28.3°C (IRWA 2000b, 2001, and 2002).

pH

pH measurements recorded by DWM ranged from 6.2 SU to 6.5 SU.

Conductivity

Conductivity reported by DWM in Maple Meadow Brook ranged between 313 µS/cm to 403 µS/cm.

Suspended Solids

Suspended solids concentrations reported by DWM were 1.8 and 2.8 mg/L.

Alkalinity

The alkalinities reported by DWM were 23 and 32 mg/L.

Hardness

Hardness values reported by DWM were 39 and 50 mg/L.

Chloride

Chloride concentrations reported by DWM were 50 and 73 mg/L.

Ammonia-Nitrogen (as N)

Ammonia-nitrogen concentrations reported by DWM were below minimum detection limits (MDLs).

Total Phosphorus (as P)

Total phosphorus concentrations reported by DWM were 0.077 and 0.078 mg/L.

The *Aquatic Life Use* is assessed as impaired for Maple Meadow Brook because of habitat quality degradation resulting from streamflow depletion, especially during summer low flow periods. Whether or not the low dissolved oxygen concentrations/conditions are naturally occurring or anthropogenically induced (or a combination of both) needs further investigation.

PRIMARY AND SECONDARY CONTACT RECREATION

No recent quality assured bacteria data are available, so, the recreational uses are not assessed. DWM did conduct limited bacteria sampling in Maple Meadow Brook in 1995 at two stations; Lowell Street, Wilmington (Station MM03) and Federal Street, Wilmington (Station MM01) (Appendix B, Table B4).

AESTHETICS

No odors or objectionable color were reported by RiverWatch at their sampling station (MMB) in Maple Meadow Brook in 1999 (IRWA 2000b). The Ipswich River Watershed Association's Headwaters Stream Team conducted a shoreline survey of this segment on 3 May 1997. The Stream Team surveyed the brook from Mill Pond to Woburn Street, Wilmington. Although some areas were of concern, the overall riparian zone appeared to be healthy. An old landfill was identified as a possible contributor of nonpoint source pollution in the upper reach of the brook and the surveyors noted some pipes that were flowing in dry weather. In the vicinity of Rte 38, the surveyors noted oil sheens, trash, and algae. Theses same observations were noted near Wildwood Street where tires, a kitchen sink, and other miscellaneous trash items were observed in the brook. Purple loosestrife was noted throughout the stream reach sampled along the bordering wetlands. Construction debris and fill was dumped in the wetlands along Wildwood Street (HST 1997). IRWA received reports of brown sludge in Maple Meadow Brook in 1998 (Mackin 2003).

No objectionable odors or other conditions have been recently identified as a problem in Maple Meadow Brook. The *Aesthetics Use* is, therefore, assessed as support but is identified with an Alert Status because of isolated areas of trash and debris noted along the brook in 1997.

Maple Meadow Brook (MA92-04) Use Summary Table

Designated Uses		Status
Aquatic Life		IMPAIRED Cause: Low flow alterations Source: Unknown (Suspected Source: Baseflow depletion from groundwater withdrawals)
Fish Consumption		NOT ASSESSED
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		SUPPORT*

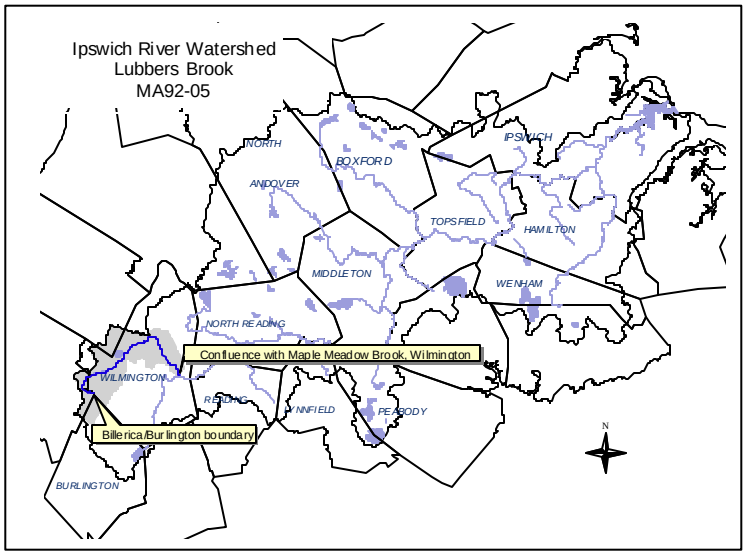
*Alert Status issues identified, see details in the use assessment section.

RECOMMENDATIONS MAPLE MEADOW BROOK (MA92-04)

- Biological and habitat quality monitoring should be conducted in Maple Meadow Brook to better evaluate the status of the *Aquatic Life Use* and to determine the effects, if any, resulting from groundwater withdrawals/water use.
- An analysis should be conducted to determine whether the low dissolved oxygen in Maple Meadow Brook is naturally occurring. The portion of the DO deficit in Maple Meadow Brook due to natural conditions versus anthropogenic sources should be determined by a mass balance analysis.
- *In-situ* monitoring should be conducted which includes, but not be limited to, dissolved oxygen/saturation, and BOD, as well as basic hydrologic and hydraulic data (i.e., stream widths, depths, and velocities).
- Support cleanup efforts identified in the Headwaters Stream Team Action Plan 1997 (HST 1997).
- Review Analog Devices Inc., Wilmington, (MAR05C391), Koch Membrane Systems, Wilmington (MAR05B672), Avecia, Wilmington, (MAR05B955), Surface Coatings Inc., Wilmington (MAR05B952), and Neoresins, Inc., Wilmington (MAR05C328, MAR05C337, and MAR05C345) SWPPPs. Evaluate the quality of their SWPPPs, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from these facilities.
- Monitor bacteria levels to document effectiveness of bacteria source reduction activities including treatment of stormwater discharges, sewering, and the Phase II community stormwater management programs and to assess the status of the *Primary* and *Secondary Contact Recreation* uses.
- Continue to monitor compliance with WMA registration/permit limits and other special conditions of the permit.

LUBBERS BROOK (SEGMENT MA92-05)

Location: Billerica/Burlington boundary to confluence with Maple Meadow Brook, Wilmington.
Segment Length: 6.3 miles
Classification: Class B.



The drainage area of this segment is approximately 5.9 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Residential 54%
Forest 31%
Wetlands..... 6%

Lubbers Brook flows in a meandering course along the Billerica/Burlington boundary into Billerica, through Lubber Pond West and Lubber Pond East in Wilmington and flows northeast into North Wilmington where it turns in a southerly direction and joins Maple Meadow Brook to form the Ipswich River.

The use assessments for Lubber Pond East (MA92035), Lubber Pond West (MA92036), and Silver Lake (MA92059) are provided in the Lake Assessment section of this report.

WMA WATER WITHDRAWAL SUMMARY (APPENDIX H, TABLE H4)

Facility Name Registration Permit	Authorized Withdrawal (MGD)		Reported Actual Use (MGD)				
	9/1/1994 to 8/31/1999	9/1/1999 to 5/18/2003	1998	1999	2000	2001	2002
Wilmington Water Department 31734201 9P31734201	2.91(reg) 0.45 (per)* 3.36 (total)**	2.91(reg) 0.65 (per)* 3.56 (total)**	2.84	3.07	2.91	2.80	2.58

*A modified permit issued in 2003 decreased the permitted withdrawal back to 0.45 MGD, however this modified permit is under appeal. The permit expires in 2009.
** Indicates system-wide withdrawal, all sources not necessarily within this segment. It should be noted that Wilmington Water Department's Aldrich Road Well (3342000-06G) is now inactive. The Shawsheen Well water is pumped to the Butter's Row Water Treatment Plant prior to distribution (Lamonte 2003).

It should be noted that the Town of Wilmington has recently stopped using the wells in the Maple Meadow Brook subwatershed because of contamination and is looking for other supplemental sources such as emergency connections to Woburn, Burlington and the MWRA (Tomczyk 2003b and Johnson 2003).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLES H2 AND H3)

Federal Express BED in Wilmington has a general stormwater permit (MAR05C073) that allows them to discharge to this subwatershed. This general permit was issued by the EPA in October 2001 and will expire in October 2005.

Burlington, Billerica, Tewksbury, and Wilmington are Phase II Stormwater communities. These communities were issued stormwater general permitsfrom EPA and MA DEP in 2003/2004 and are authorized to discharge stormwater from their municipal drainage systems (MAR041030, MAR041182, MAR041226, and MAR041234, respectively). Over the five-year permit term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Although no current stream gaging data are available, it should be noted that there is one WMA permittee within this subwatershed area – the Wilmington Water Department withdrawals from one of their wells along the brook (Appendix H, Table H4). The withdrawal volume from the Wilmington Water Department between 1998 and 2002 averaged 2.84 MGD. Approximately 15% of the Town of Wilmington is currently sewered; the wastewater from this sewered portion of the town is treated at MWRA Deer Island and discharged to the Boston Harbor Watershed (Felix 2002). Wilmington is in the process of developing a comprehensive water resource management plan.

Rapid bioassessment in Lubbers Brook was performed by MA DEP on 19 July 2000 at Concord Street, Wilmington, MA (station LB02) (Appendix D). The brook was about 20 m wide with an open canopy with water easily reaching the base of both banks. The depth was approximately 1.5m. The substrates were dominated (90%) by sand and silt. Aquatic vegetation included rooted emergent, rooted submergent and floating types (*Lemna* sp.) (Appendix D and MA DEP 2000a). The total habitat score was 158 out of 200.

Biology

Only a qualitative assessment of the benthic macroinvertebrate sample collected on 19 July 2000 from Lubbers Brook, at Concord Street, Wilmington, MA (Station LB02) could be conducted by DWM because of habitat quality differences with the reference station condition. The LB02 benthic community was comprised of a total of 14 taxa (mainly at the family-level) and included high densities of taxa (e.g., Gastropoda, Hemiptera, Amphipoda) commonly found in lentic stream systems (Appendix D). The assemblage displayed good trophic structure with virtually every major feeding guild represented. EPT taxa, generally not abundant in low-gradient wetland dominated stream systems such as Lubbers Brook, were represented by two fairly pollution-sensitive caddisfly genera, *Limnephilus* sp. and *Oecetis* sp. Due to the qualitative nature of the biosurvey conducted at LB02 an assessment of biological condition could not be made. However, the macroinvertebrate community encountered does not appear to suggest the presence of gross organic pollution in this portion of Lubbers Brook.

Chemistry – water

DWM collected *in-situ* measurements from one station on Lubbers Brook (Station LB02, Unique ID 139- at Concord Street, Wilmington) between 8 August and 7 September 2000 (n=6). Parameters regularly measured were dissolved oxygen, pH, temperature, conductivity, and total dissolved solids. On 1 August and 24 August grab samples were also collected and analyzed for alkalinity, hardness, chloride, suspended solids, ammonia-nitrogen, and total phosphorus (Appendices B and C of Appendix A). Additionally, Lubbers Brook was also sampled on 7 September 2000 at Station LB03 - Glen Road, Wilmington (upstream from Concord Street) for dissolved oxygen, pH, temperature, conductivity, and total dissolved solids. DWM also conducted water quality monitoring in Lubbers Brook in July 1995 at Concord Street (Station LB02) (Appendix B, Tables B3 and B4).

Through the IRWA's RiverWatch Volunteer Monitoring Program (RiverWatch) water quality monitoring has also been conducted at one site in Lubbers Brook (station LB at Glen Road, Wilmington) since 1997 (IRWA 2000a).

DO

The instream DO measured by DWM in Lubbers Brook at Glen Road was 5.7 mg/L (52% saturation). The DOs documented by RiverWatch in the summers of 1999, 2000, and 2001 were occasionally slightly below 5.0mg/L (IRWA 2000b, 2001, and 2002). Further downstream, however, the instream DOs measured by DWM were much lower ranging from <0.2 mg/L to 1.9 mg/L (<2 to 20% saturation). Only two of the six samples were collected during worse case, pre-dawn conditions (Appendix B of Appendix A).

Temperature

Temperatures recorded by DWM in Lubbers Brook ranged from 13.3°C to 22.5°C. No temperatures measured by RiverWatch were above 28.3°C (IRWA 2000b, 2001, and 2002).

pH
pH measurements recorded by DWM ranged from 6.0 SU to 6.8 SU.

Conductivity
Conductivity in Lubbers Brook reported by DWM ranged between 292 µS/cm to 371 µS/cm.

Solids
Total suspended solid concentrations reported by DWM were 1.5 and 1.9 mg/L.

Alkalinity
The alkalinity reported by DWM for Lubbers Brook was 24 and 30 mg/L.

Hardness
Hardness values reported by DWM were 39 and 43 mg/L.

Chloride
Chloride concentrations reported by DWM were 52 and 65 mg/L.

Ammonia-Nitrogen (as N)
Ammonia-nitrogen concentrations reported by DWM were below minimum detection limits (MDLs).

Total Phosphorus (as P)
Total phosphorus concentrations reported by DWM were 0.046 and 0.051 mg/L.

Although DOs in Lubbers Brook measured near Concord Road (near the mouth of the brook) were very low it was the opinion of the DWM biologists that the benthic community in the brook at this location was not indicative of gross organic pollution and the conditions in the brook were likely naturally occurring as a result of the wetlands. The *Aquatic Life Use* is, therefore, assessed as support for Lubbers Brook. This use, however, is identified with an Alert Status because of the low dissolved oxygen concentrations. Whether or not the low dissolved oxygen concentrations/conditions are naturally occurring or anthropogenically induced (or a combination of both) needs further investigation.

PRIMARY AND SECONDARY CONTACT RECREATION
No recent quality-assured bacteria data are available, so the recreational uses are not assessed. DWM did conduct limited bacteria sampling in Lubbers Brook in 1995 at three stations: LB03 at Glen Road, Wilmington; LB04 at Middlesex Avenue (Route 62) Wilmington; and LB02 at Concord Street, Wilmington (Appendix B, Table B4). It should also be noted that septic system failures in Wilmington are problematic in some areas (Felix 2002).

AESTHETICS
No objectionable odors or deposits were noted by DWM in 2000 during the benthic macroinvertebrate survey, but the brook was described as turbid (Appendix D and MA DEP 2000a).

The IRWA's Headwaters Stream Team conducted a shoreline survey of this segment on 5 October 1996. The entire reach sampled (from the Billerica town line to the confluence with Maple Meadow Brook) was littered with light trash. One area near Rte 129 adjacent to the Billerica town line was also strewn with automobile parts (HRT 1997).

The *Aesthetics Use* is assessed as support based primarily on the fact that no objectionable odors or deposits were noted during the biological monitoring survey in 2000. This use is identified with an Alert Status, however, because of the conditions noted during the shoreline survey in 1996.

Lubbers Brook (MA92-05) Use Summary Table

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

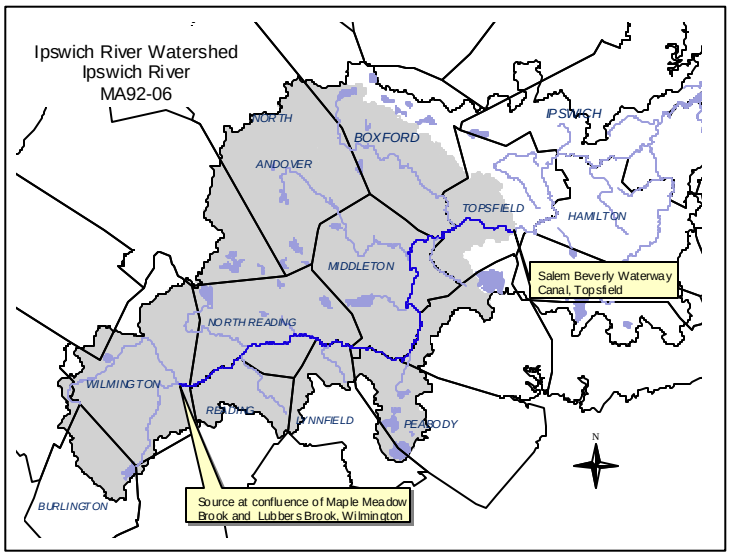
* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS LUBBERS BROOK (MA92-05)

- An analysis should be conducted to determine whether the low dissolved oxygen in Lubbers Brook is naturally occurring. The portion of the DO deficit in Lubbers Brook due to natural conditions versus anthropogenic sources should be determined by a mass balance analysis.
- *In-situ* monitoring should be conducted to include, but not be limited to, dissolved oxygen/saturation, and BOD, as well as basic hydrologic and hydraulic data (i.e., stream widths, depths, and velocities) to better evaluate the status of the *Aquatic Life Use*.
- Biological and habitat quality monitoring should be conducted in Lubbers Brook to better evaluate the status of the *Aquatic Life Use* and to determine the effects, if any, resulting from groundwater withdrawals/water use. Monitoring of instream habitat quality/flow is also recommended upstream and downstream from the Wilmington Water Department wells.
- Support cleanup efforts identified in the Headwaters Stream Team Action Plan 1997 (HST 1997).
- Review the Federal Express BED in Wilmington (MAR05C073) SWPPP. Evaluate the quality of their SWPPP, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from the facility.
- Monitor bacteria levels to document effectiveness of bacteria source reduction activities including treatment of stormwater discharges, sewering, and the Phase II community stormwater management programs and to assess the status of the *Primary* and *Secondary Contact Recreation* uses.
- Evaluate potential nonpoint sources of pollution that may contribute to instream turbidity in Lubbers Brook.
- Continue to monitor compliance with WMA registration/permit limits and other special conditions of the permit.

IPSWICH RIVER (SEGMENT MA92-06)

Location: Confluence of Maple Meadow Brook and Lubbers Brook, Wilmington, to Salem Beverly Waterway Canal, Topsfield.
Segment Length: 20.4 miles
Classification: Class B, Warm Water Fishery, Treated Water Supply, High Quality Water



The drainage area of this segment is approximately 100mi^2. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 50%
Residential 31%
Open Land 5%

Formed at the confluence of Maple Meadow and Lubbers Brooks near Woburn Street in Wilmington, the Ipswich River flows under Route 93 and forms the boundary between Reading and North Reading widening as it passes by the Reading Town Forest. It is joined by Bear Meadow Brook from the south and Martins Brook from the north where the river becomes more distinctly channelized and the velocity increases slightly. The channel then begins to widen as the river passes through the center of North Reading. The Ipswich flows eastward in a series of tight meanders and is joined by an unnamed tributary from the north and Wills Brook from the south before it enters the impoundment created by the Bostik Company Dam (formerly the USM Chemical Dam) in South Middleton. While it has followed an easterly course since its confluence with Martin's Brook, the Ipswich River is joined by Norris Brook from the south and turns abruptly to the north approximately 1.4 river miles below the USGS gage. As the Ipswich River meanders northward through Middleton it is joined by two unnamed tributaries and Boston Brook. It turns east again as it meanders through Topsfield and picks up flow from Nichols and Fish Brooks prior to entering the northern portion of Wenham Swamp, which is the basin's largest freshwater wetland (3 mi^2). It is here that the Salem Beverly Waterway Canal diverts Ipswich River water to supply the communities of Salem and Beverly with treated drinking water. This diversion is allowed between December 1st and May 31st when flow of the Ipswich River exceeds 28 MGD. There is public access to the Ipswich River via canoe ramps at Central Street in North Reading, at Route 114 in Middleton at West Street in Danvers, at Salem Road in Topsfield, and Route 97 (High Street) in Topsfield.

The use assessment for Emerson Brook Reservoir (MA92021), Farnum Street Pond (MA92018), Salem Pond (MA92057), Stearns Pond (MA92061), and Sudden Pond (MA92064) are in the Lake Assessment section of this report.

This segment is on the 1998 303(d) List of Waters, needing confirmation, for nutrients and flow alteration (Table 3).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX H, TABLE H4)

Facility Name Registration Permit	Authorized Withdrawal (MGD)	Reported Actual Use (MGD)				
		1998	1999	2000	2001	2002
Reading DPW 31724601 no permit	2.57	1.99	2.05	1.85	1.94	1.86
Meadow Brook Golf Club 31724602 no permit	0.16	0.14	0.15	0.15	0.27**	0.17
Lynn Water and Sewer Commission 31716301 9P31716301	9/1/1994 to 8/31/1999 5.31 (reg) 0.33 (per) 5.64 (total) 9/1/1999 to 5/18/2003 5.31 (reg) 1.28 (per) 6.59 (total)	1.46	1.21	0.88	0.52	3.59
Thomson Club, Inc. 31721303 9P231721301	0.15 (reg) 0.0 (per) 0.15 (total)	0.07	0.1	0.07	0.14	0.12
Bostik Division-Emhart Corp 31718402 no permit	0.79	0.01	0.01	0.01	0.01	0.01
Peabody Dept. of Public Services 31722901 9P31722901	9/1/1994 to 8/31/1999 3.89 (reg) 0.58 (per) 4.47 (total)* 9/1/1999 to 5/18/2003 3.89 (reg) 0.69 (per) 4.58 (total)*	3.68	4.01	3.54	3.07	4.02
Danvers Water Dept. 31707101 9P31707101	9/1/1994 to 8/31/1999 3.14 (reg) 0.56 (per) 3.70 (total)* 9/1/1999 to 5/18/2003 3.14 (reg) 0.69 (per) 3.83 (total)*	3.3	3.39	3.38	3.45	3.08

* Indicates system-wide withdrawal, all sources not necessarily within this segment.
**During June of 2002 the MA DEP investigated the alleged violation of the Water Management Act (O'Keefe 2003a). Following a site inspection of the golf course it was determined that no violation occurred. The MA DEP clarified the way Meadow Brook Golf Club should report their withdrawal on the annual form. Because well water is pumped continuously to an irrigation pond, which then spills over to a tributary to the Ipswich River, the MA DEP requested installation of meters at both the well field and the irrigation pond pump house. The withdrawal for purposes of irrigation is the withdrawal from the irrigation pond. The 2002 annual report reflects this distinction; the total annual withdrawal from the pond was 15,816,000 gallons or an average over 90 days (June, July, August) of 0.114 MGD (O'Keefe 2003a). The MA DEP will continue to work with Meadow Brook Golf Club to improve water conservation and operational changes needed to discontinue the practice of pumping the wells continuously to the pond.
Note: North Reading Water Department's Stickney Well (3213000-06G) located in this subwatershed is inactive.

The Lynn Water and Sewer Commission operates a pump station that withdraws water from the Ipswich River in North Reading. This water supplements the other sources that the Commission has in the North Coastal Watershed. The Ipswich River withdrawal is pumped to a reservoir system located in the North Coastal watershed. The Lynn Water and Sewer Commission is authorized to withdraw water from the Ipswich River (under their registration 31716301) only during the 180 days from December 1st through May 31st. Their permit issued 15 February 1991 allows additional withdrawal volumes when streamflow at the USGS South Middleton Gauge Station #01101500 exceeds 10 MGD. However, this permit was modified on 19 May 2003 to reflect new streamflow limitations. The Lynn Water and Sewer Commission is authorized under the modified permit issued 19 May 2003 to withdraw water from June 1 through

October 30 when streamflow at the South Middleton gauge is >141 cfs (91 MGD) and from November 1 through May 31 when streamflow is >44.5 cfs (29 MGD). The conditions of the modified permit are not in effect yet since the permit has been appealed.

The water withdrawn from the Ipswich River by the Peabody Department of Public Services goes to Winona Pond and Suntaug Lake. Depending on water levels in the lake or pond and the water demands, water can be shifted between the lake and pond. Both of these surface water reservoirs also have watershed areas, entirely in the Ipswich River watershed, that contribute to the total amount of water that can be stored in the reservoirs. However, the amount of water withdrawn from the Ipswich River is used for determining compliance with the WMA registration/permit. Water from Winona Pond and some water from Suntaug Lake is treated at the Winona Pond Water Treatment Facility. The remaining water from Suntaug Lake is treated at the Coolidge Avenue water treatment facility (as is all of the water from Spring Pond). Spring Pond is located in the North Coastal watershed. All water in Spring Pond is derived from the watershed area of Spring Pond. Water from Spring Pond is treated at the Coolidge Avenue water treatment facility. The city of Peabody also has an MWRA connection. Peabody utilizes this connection on an as needed basis and does not purchase much water from MWRA. This water goes directly into the South Peabody water distribution system and not to any of Peabody's reservoirs. The Peabody Department of Public Services is authorized to withdraw water from the Ipswich River, under their permit (issued 15 February 1991), when streamflow at the USGS South Middleton Gauge Station #01101500 exceeds 15 MGD. Their withdrawal may not exceed 1,500 million gallons per year. However, the permit was modified on 19 May 2003 to reflect new streamflow limitations. Peabody is authorized under the modified permit to withdraw water from June 1 through October 30 when streamflow at the South Middleton gauge is >141 cfs (91 MGD) and from November 1 through May 31 when streamflow is >44.5 cfs (29 MGD). The conditions of the modified permit are not in effect yet since the permit has been appealed.

The WMA Modified Permit dated 19 May 2003 (currently under appeal) for the Danvers Water Dept. included monitoring adjacent to Danvers wells under Special Condition # 7- Streamflow Maintenance. This monitoring required “A permanent staff gauge shall be maintained along the Ipswich River by Well No. 1. Weekly water level measurements shall be collected. Records of the weekly staff gauge measurements shall be kept and submitted to the MA DEP upon request.”

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLES H1, H2 AND H3)

- The Town of Reading Department of Public Works is permitted (MAG640038 effective April 2001) to discharge 0.1 MGD (maximum daily of emergency overflow) of wastewater from the Louanis Water Treatment Plant in Reading, MA to the Ipswich River.
- Ballard Realty & Trust, Wilmington applied for an NPDES permit (MA0029823) in 1986 to discharge stormwater to a 12” culvert. EPA has determined that no permit is required for this stormwater discharge (Vergara 2002).
- Martin Marietta Tank Farm, Wilmington was permitted (NPDES #MA0001635 issued December 1976) to discharge to the Ipswich River. The 1976 permit on file with the same NPDES # in the Worcester Office is for the General Electric Company Aerospace Instruments and Control Systems Department in Wilmington (which is now likely Ametek Aerospace Products, Inc.) The permit was for two NCCW outfalls 001 for 0.27 MGD and 002 for 0.0432 MGD to the Ipswich River. According to Betsy Davis, EPA permit writer, Martin Marietta (now Lockheed Martin) had a pump and treat discharge which has been discontinued. Ametek currently discharges their NCCW into the same outfall pipe used by Martin Marietta. This discharge is covered by a general permit MAG250021. Martin Marietta may also start up a new pump and treat operation and have a new discharge. Permitting will depend on the course of action taken.
- MSM Industries, Inc. North Reading installed a closed-loop cooling water system in October 1995. Their NPDES permits (MAG250899 and MA0027251) have been terminated.
- Bostik Findley, Inc. in Middleton, a manufacturer of industrial grade adhesives, was permitted (MA0001180 issued in July 1991) to discharge contact and non-contact cooling water and stormwater runoff via five outfalls to the Ipswich River, the canal and an unnamed tributary that discharges into the Ipswich River just upstream of the South Middleton Dam. The outfalls are described below:
  - 001: 1.5 MGD (2.1 max daily) of rod cement cooling water, NCCW and stormwater runoff
  - 001A: 0.85 MGD rod cement contact cooling water and rod cement chiller water.

The whole effluent toxicity limit (monitoring frequency of 2 times per year) was $LC_{50} \geq 100\%$ and CNOEC $\geq 83\%$ using *Ceriodaphnia dubia* (a daphnid) and *Pimephales promelas* (fathead minnows) on a composite sample of outfall 001 (which included the discharge from outfall 001A). These tests have not been required since 1993 (McSweeney 1993).

- 003: 0.0216 MGD web extruder and grinder NCCW
- 004: 0.10 MGD NCCW from polyamide heat exchangers
- 005: 0.22 MGD adhesive churn NCCW and stormwater runoff.

  The whole effluent toxicity limit (monitoring frequency of 2 times per year) was $LC_{50} \geq 100\%$ and CNOEC $\geq 56\%$ using *C. dubia* and *P. promelas* on a flow weighted composite sample of outfalls 003, 004, and 005. The facility installed a closed-loop cooling tower system between 1998 and 2000 to eliminate all contact and non-contact cooling water discharges from their facility. The permit is scheduled to be reissued.

- Bursaw Oil Corp., Middleton (a gas service station), applied for an NPDES permit (MA0033944) in 1991. The facility had a groundwater remediation system in place. The facility is no longer discharging and has been sold to Global Alliance Energy. The groundwater remediation equipment has been left in place until there is absolute certainty that the wells at the site do not produce contaminated ground-water (Alvarez 2003).
- Health & Education Services, Inc. (HES) wastewater treatment plant currently discharges to the far west cove of Wenham Swamp, Topsfield. The facility is the former military barracks site of 16 houses owned by the US Army Topsfield who applied for an NPDES permit (MA0090808) in 1986. Under a Consent Decree with the MA DEP HES is currently maintaining and operating the wastewater treatment and disposal system, however, the property is in the process of being connected to the municipal sanitary sewer (sewer connection to Danvers system, treatment at South Essex Sewage District) (Ottenheimer 2002). Construction for the sewer connection began in the fall of 2003 (Ottenheimer 2003).

There are four general stormwater permittees in this subwatershed. The following general permits were issued by the EPA in October 2001 and will expire in October 2005.

- Roadway Express Inc., North Reading, permit No. MAR05B805
- Aggregate Industries Northeast, Peabody, permit No. MAR05C110
- Riverpark, North Reading, permit No. MAR05C200
- Yellow Transportation, Inc., North Reading, permit No. MAR05C566

Boxford, Danvers, Lynnfield, Middleton, North Reading, Peabody, Reading, Topsfield, and Wilmington are Phase II Stormwater communities. These communities were issued stormwater general permits from EPA and MA DEP in 2003/2004, and are authorized to discharge stormwater from their municipal drainage systems (MAR041184, MAR041188, MAR041045, MAR041211, MAR041215, MAR041216, MAR041056, MAR041227, and MAR041234, respectively). Over the five-year permit term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

During the summer periods in 1995, 1997, 1999 and 2002 the Ipswich River (Wilmington, Reading and North Reading) dried up from approximately Route 93 in Wilmington to Route 28 in North Reading resulting in fish kills (Horsley & Witten 2003). No-flow events averaged over 10% of the time in the Reading area. Occasionally "summer flows in the upper river are significantly impacted and are evident in observation of flow upstream of a series of pumping wells along the river, no flow adjacent to the well, and reverse flow downstream of the well (as water is pulled upstream by the well pumpage)" (Horsley & Witten 2003). Municipal wells in Reading date back to the 1880's (Felix 2002). During the last five years (1998 to 2002) two major droughts were recorded: the summer of 1999 and the fall/winter/spring of 2001/2002. The Massachusetts Drought Management Task Force (DMTF) issued a drought advisory in the Northeast Region of Massachusetts (including the Ipswich River Watershed) between December 28, 2001 and December 20, 2002. From January 2002 to April 2002 the region was in a DMTF drought watch (one step higher or worse than a drought advisory) (Marler 2003). In the 1998 'water year' (reported by USGS from October to September) runoff was above normal in eastern Massachusetts and no droughts were reported (Socolow *et al*. 1999). Runoff was

generally below normal in the 1999 water year when, between June and early September, drought conditions were recorded in eastern MA. New low-flows were recorded in the Ipswich River in June and August at the South Middleton gage and at the Ipswich gage in May (Socolow *et al*. 2000). This drought was broken with tropical storm Floyd in mid-September. In 2000 runoff was normal with no floods or droughts recorded (Socolow *et al*. 2001). Runoff was also generally normal in 2001 with the exception of a flood event in March (Socolow *et al*. 2002). Extremely low flows were then documented in the late fall, winter, and spring of 2001-2002 (Socolow *et al*. 2003).

There are four municipal water suppliers, two golf courses and one industry with WMA permits and/or registrations along this segment of the Ipswich River. All of these withdrawals from upstream to downstream, the number of sources, average use, and wastewater discharge location, are summarized in Table 4.

Table 4. WMA registered and/or permitted suppliers along the Ipswich River between the confluence with Lubbers and Maple Meadow Brooks and the Salem Beverly Waterway Canal and the location of wastewater discharges.

Facility Name Registration Permit	Number of sources in Segment MA92-06	Average Use (MGD) 1998 - 2002	% town population sewered	Wastewater discharge location
Reading DPW 31724601 no permit	9	1.94	90%	MWRA Deer Island and discharged to the Boston Harbor Watershed
Meadow Brook Golf Club 31724602 no permit	2	0.18	Not Applicable	
Lynn Water and Sewer Commission 31716301 9P31716301	1	1.53	Area served is out of Ipswich River Watershed	Lynn Water and Sewer Commission and discharged to Lynn Harbor in the North Coastal Watershed
Thomson Club, Inc. 31721303 9P231721301	3	0.1	Not Applicable	
Bostik Division-Emhart Corp 31718402 no permit	7	0.01	Not Applicable	
Peabody Dept. of Public Services 31722901 9P31722901	1	3.46	100	South Essex Sewage District and discharge to Salem Sound in the North Coastal Watershed
Danvers Water Dept.* 31707101 9P31707101	3	3.32	85-90%*	South Essex Sewage District and discharge to Salem Sound in the North Coastal Watershed.

*The Danvers Water Dept. services both the towns of Danvers and Middleton. Middleton is serviced primarily by on-site septic systems. Water from Emerson Brook Reservoir, which serves as a backup water supply, is pumped to Middleton Pond.

Prior to May 2003 the direct surface water withdrawals from the Ipswich River by both the Lynn Water and Sewer Commision and the Peabody Department of Public Services were limited to the period from 1 December to 31 May. Between 1998 and May 2003 both water supplies were also allowed to withdraw from the Ipswich if flows at the USGS Middleton gage exceeded 10 and 15 MGD (15.47 and 23.21 cfs), respectively. The USGS recommended a minimum flow of 18.69 to 21.8 cfs at the South Middleton Gage during the summer period to allow for the restoration of a target fish community (Armstrong *et al*. 2001). The recent USGS modeling results of flow conditions in the Ipswich River determined that "surface water withdrawals have little effect on the duration and frequency of low-flows, but the cumulative groundwater withdrawals substantially decrease low-flows" (Zarriello and Ries 2000). However, the effects of all water withdrawals (both surface and groundwater) and the

export of wastewater via sewering (Table 4), contribute to the alteration of the river's natural hydrograph.

The Ipswich River Fisheries Restoration Task Group recommended certain conditions (e.g., flow over the riffles, water to the channel margins, and seasonal variations in flows that closely approximates a natural hydropgraph) be maintained in order to restore the Ipswich River's aquatic habitat and fisheries. Their current recommendations are for 0.49 cfsm between June to October, 1.0 cfsm between November and February, and 2.5 cfsm between March and May (Task Group 2002). At the South Middleton gage on the Ipswich River the recommended flows would be 21.8 cfs from June to October, 44.5 cfs from November to February and 111.3 cfs from March to May. An analysis of the USGS water year records indicate that the Ipswich River was frequently below the Task Group's recommended flows throughout the entire year (Table 5). USGS also conducted a simulation model for the predicted impact of the Task Group's recommended flows on the municipal surface water supply systems (Appendix I, 104(b) project 97-07).

Table 5. Percentage of time (number of days) from June 1998 to May 2003 flows in the Ipswich River at the South Middleton gage were below the Ipswich River Fisheries Restoration Task Group recommended flows to restore the Ipswich River's aquatic habitat and fisheries.

Recommended Flow	June 1998 to May 1999	June 1999 to May 2000	June 2000 to May 2001	June 2001 to May 2002	June 2002 to May 2003
	1998 water year (wet year)	1999 water year (dry year)	2000 water year (normal year)	2001 water year (normal year)	2002 water year (dry year)
June to October 21.8 cfs (153 days in time period)	40% (62)	83% (127)	61% (94)	65% (100)	76% (93*)
November to February ** 44.5 cfs (120 days in time period)	48% (57)	42% (50)	28% (33)	94% (113)	Not available
March to May ** 111.3 cfs (92 days in time period)	77% (71)	45% (41)	58% (53)	85% (78)	Not available

* Represents June to September 2002 (a total of 122 days), data for October not yet available
**Provisional recommendations of the Ipswich River Fisheries Restoration Task Group. The monthly median flows at the South Middleton gage for the period of record 1939 to 1997 from November to May is as follows: November 36.6 cfs (0.82 cfsm), December 60.6 cfs (1.36 cfsm), January 59.0 cfs (1.33 cfsm), February cfs 76.2 (1.71 cfsm), March cfs 135.2 (3.04 cfsm), April cfs 122.9 (2.76 cfsm), and May 72.5 cfs (1.63 cfsm) (Task Group 2002).

Habitat assessments were performed by DWM at two locations in this segment of the Ipswich River approximately 170 meters downstream from Mill Street, Reading/North Reading, MA (Station IP01.5) and approximately 100 meters downstream from Boston Street, Middleton, MA (Station IP06) in July 2000 (Appendix D). DFWELE conducted habitat assessments at 21 reaches along this segment of the Ipswich River in August and September 1998. The average habitat score for this entire segment was 148.9 out of 200 (Armstrong *et al.* 2001). Stream gaging data for the Ipswich River are available from the USGS gage 01101500 located downstream from the Boston Street Bridge in South Middleton from 1938 to the present.

At the most upstream reach of this segment of the Ipswich River (upstream of the Reading wells) DFWELE sampled one reach between Woburn Street and I-93. The channel type was described as a glide with sand and FPOM substrates. Physical habitat was comprised of submergent and emergent vegetation, overhanging vegetation, and undercut banks. Riparian vegetation was dominated by emergent wetland species. This reach had an open canopy. The RBP habitat assessment score was 177 out of 200 (Armstrong *et al.* 2001).

The Ipswich River was sampled by DWM downstream from Mill Street, Reading/North Reading, MA (Station IP01.5) in July 2000. This site was located downstream from the Reading Wellfield. At the time of the survey the river was roughly 5 m wide with depths ranging from 0.25 m to 0.4 m in the riffles and runs to approximately 1m in the pool. The substrates were comprised primarily of cobble and boulder with lesser amounts of sand and gravel. Mosses and rooted emergent/submergent macrophytes provided instream cover and a thin film of algae (cover estimated as 10%) was found on

cobble substrates in the riffles in this primarily shaded stream reach (canopy cover approximately 75%). The overall habitat score was 180 out of 200 (Appendix D and MA DEP 2000a).

Downstream from the Reading well field and upstream of the confluence with Bear Meadow Brook two reaches were sampled by DFWELE; downstream from Mill Street and upstream/downstream from Rte 28. The channel type at these sites was described as a glide/run with sand, CPOM, and FPOM substrates. Physical habitat was comprised of boulder, large and small woody debris, submerged vegetation, exposed roots, overhanging vegetation, and undercut banks. Riparian vegetation was dominated by wetland forest/shrub species, and upland forest/shrub species and both reaches had closed canopies. The reach downstream from Mill Street was documented to be dry (or nearly dry) during the survey and was noted by Armstrong *et al.* (2001) to be one of the first to have extreme low flows or to be dry on the mainstem. This site also has a highly altered stream channel and banks (Mill Street may have been built on the historic site of the mill dam). A small, partially collapsed, tile culvert extended from the base of the riffle to the wetland upstream of the bridge. The RBP habitat assessment score for the reach near Mill Street was 142 out of 200 due to instream sediment deposition, marginal/suboptimal epifaunal substrate, limited velocity/depth combinations, channel alteration, and channel sinuosity. No score was given for the Rte 28 reach (Armstrong *et al.* 2001).

Between the confluence with Bear Meadow Brook and Martins Brook one reach was sampled by DFWELE upstream of the powerlines. The channel type was described as a run with sand, gravel, and FPOM substrates. Physical habitat was comprised of large and small woody debris, moss, exposed roots, undercut banks, and overhanging vegetation. Riparian vegetation was dominated by upland forest/shrub species. This reach had a closed canopy. The RBP habitat assessment score was 163 out of 200. Habitat was limited most by available epifaunal cover, velocity/depth combinations, and sediment deposition (Armstrong *et al.* 2001).

Between the confluence with Martins Brook and an unnamed tributary (Segment MA92-09) four reaches of the Ipswich River in North Reading were sampled by DFWELE. The river downstream from Martins Brook was primarily a glide habitat with sand/gravel and FPOM substrates. The canopy cover at this location was open and the riparian zone was dominated by wetland shrub/emergent vegetation. The habitat assessment score was 159 and was limited most by channel sinuosity, limited velocity/depth combinations and some sediment deposition. The river near Parrish Park (downstream from Chestnut Street) was described as a riffle/run with boulder, sand and gravel and FPOM substrates. The canopy was closed and the surrounding riparian zone was upland forest. The habitat assessment score was 178. DFWELE also sampled the river at the “Ipswich Park Pond” downstream from Central Street with a shock boat and gill nets. The canopy at this location was open. Further downstream behind the North Reading Fire station the Ipswich River was comprised of glide/run habitat with sand, FPOM and gravel substrates. This reach of the river had a partially open canopy. Riparian vegetation was dominated by upland forest/shrub species. The RBP habitat assessment score was 147 out of 200. Habitat was limited most by the lack of channel sinuosity, limited instream cover and velocity/depth combinations (Armstrong *et al.* 2001).

Installation of a fish ladder or breaching of the Bostik Company Dam would help to restore fisheries to the upper Ipswich River Watershed. The River Restore Program of DFWELE has included this dam on their list of sites for consideration for removal.

The Ipswich River was sampled by DWM downstream from the Bostik Company Dam approximately 100 meters downstream from Boston Street, Middleton, MA (Station IP06) in July 2000. At the time of the survey the river was roughly 10 m wide with depths of 0.3 m in the riffles and runs up to 1m in the pools. The substrates were comprised primarily of sand with lesser amounts of cobble, pebble and gravel. Mosses and rooted emergent macrophytes provided a limited amount of instream cover and a thin film of algae (cover estimated as <5%) was found on cobble substrates in the riffles in this primarily shaded stream reach (canopy cover approximately 75%). The overall habitat score was 123 (Appendix D and MA DEP 2000a). Habitat quality was limited most by sediment deposition resulting from erosion on the south bank, where bank vegetative stability was lacking, and the lack of instream cover for fish.

DFWELE sampled two reaches of the Ipswich River downstream from the Bostik Company Dam (1998 and 1999) and upstream of the South Middleton USGS Gage. At the time of their 1998 survey the river channel was described as riffle and glide with gravel, cobble, boulder, sand, CPOM, and FPOM substrates. Physical habitat was comprised of small woody debris, overhanging vegetation, and exposed roots. Riparian vegetation was dominated by upland forest species. These reaches had closed canopies. The RBP habitat assessment scores were 158 and 157 out of 200. Habitat was limited most by the channel sinuosity, and limited velocity/depth combinations (Armstrong *et al.* 2001).

Stream gaging data for the Ipswich River are available from the USGS gage 01101500 located downstream from the Boston Street Bridge in South Middleton from 1938 to the present. The drainage area at this gage is 44.5 mi^2 and the average annual discharge over the period of record is 63.7 cfs (Socolow *et al.* 2003). According to USGS (remarks of their gaging station on the Ipswich River in South Middleton – 01101500) the flow in this segment of the Ipswich River is regulated by upstream diversions for municipal supply and occasional regulation by a mill upstream (Socolow *et al*. 2003). Data from the USGS gage revealed that the 2000 water year annual mean flow (68.2cfs) was greater than the mean annual flow for the 62-year period of record (64 cfs) (Socolow *et al*. 2001). The estimated 7Q10 flow at the gage is 0.41 cfs (USGS 2003a). This estimate should increase because of the 141 cfs mimimum flow required at the USGS gage between June 1 through October 30 for both the Lynn Water and Sewer Commission and Peabody Department of Public Services water withdrawals from the Ipswich River.

Between the confluence with Norris Brook and another unnamed tributary (segment MA92-12) and downstream from the Danvers wells DFWELE sampled one reach near Burleys Corner (downstream from Log Bridge Road). The channel type was described as a glide with FPOM and sand substrates. It should be noted that there is a riffle at Log Bridge Road, that consists of a sharp drop over a cobble and boulder rock control near the old railroad abutment. (The Ipswich River has been observed to go dry or experience extremely low flows in this area when the Danvers wells were in operation (Mackin as cited in Armstrong *et al.* 2001). Physical habitat in the reach sampled by DFWELE was comprised of large woody debris, as well as exposed roots, undercut banks, and overhanging vegetation. Wetland forest/shrub species and wetland emergents dominated riparian vegetation. This reach had a partially open canopy. The RBP habitat assessment score was 162 out of 200. Habitat was limited most by channel sinuosity, and velocity/depth combinations as well as slight embeddedness (Armstrong *et al.* 2001).

Between the confluence with the unnamed tributary and Boston Brook DFWELE sampled two reaches of the Ipswich River in Middleton; upstream of Route 62 near Middleton Colony and upstream of Maple Street (Rt 62). The channel types were described as glides. Substrates were comprised of sand, boulder/cobble, gravel, and FPOM substrates. Other habitat was provided by large and small woody debris and submerged, floating, and emergent and overhanging vegetation. Riparian vegetation included wetland shrub/emergent species, wetland forest/shrub species and upland forest species. Both reaches had partially open canopies. The RBP habitat assessment scores were 167 and 163 out of 200. Habitat quality was limited most by channel sinuosity and limited velocity/depth combinations (Armstrong *et al.* 2001).

Between the confluence with Boston Brook and Nichols Brook two reaches were sampled by DFWELE in Middleton; upstream of Peabody Street and downstream from Thunder Bridge. The channel types were described as run/riffle and glide with sand, cobble, gravel, boulder, CPOM, and FPOM substrates. Large and small woody debris; submerged, floating, and emergent vegetation; overhanging vegetation; and exposed roots also provided cover. Riparian vegetation was dominated by upland forest and wetland forest/shrub species. These reaches had closed canopies. The RBP habitat assessment scores were 154 and 147 out of 200 and habitat was limited most by lack of epifaunal substrate, sediment deposition, embeddedness, channel alteration upstream of Peabody Street, channel flow status, and channel sinuosity (Armstrong *et al.* 2001).

Between the confluence with Fish Brook and the Salem Beverly Waterway Canal DFWELE sampled four reaches of the Ipswich River in Topsfield; upstream of Rowley Bridge Road (at Fish Brook), downstream from Salem Street, upstream of Rte 1 (near Topsfield Fairgrounds), and Rte 97 near the canoe launch. With the exception of the reach near the Topsfield Fairgrounds, where there was a

natural riffle with a closed canopy, the river was primarily a run/glide type habitat with a partially closed canopy. Substrates were comprised of sand, cobble, gravel, boulder, and FPOM substrates while large woody debris, exposed roots, undercut banks and overhanging vegetation provided additional habitat at most or all of the four reaches sampled. The RBP habitat assessment scores were 151, 146, 170, and 141 out of 200, respectively. Habitat quality was limited by embeddedness/sediment deposition at the Rte 97 canoe launch and sediment deposition upstream of Rowley Bridge. It should also be noted that the Salem-Beverly Water Supply Board maintains a gaging station in the Ipswich River downstream from Route 1 adjacent to the Topsfield Fairgrounds (Armstrong *et al.* 2001).

Biology

Compared to the Fish Brook reference station (station FB00) the RBP III analysis conducted by DWM biologists indicated the benthic community was moderately impacted in the Ipswich River approximately 170 meters downstream from Mill Street, Reading/North Reading, MA (station IP01.5) in July 2000 (Appendix D).

Compared to the Fish Brook reference station (station FB00) the RBP III analysis conducted by DWM biologists indicated the benthic community was slightly impacted in the Ipswich River approximately 100 meters downstream from Boston Street, Middleton, MA (Station IP06) in July 2000 (Appendix D). This reach was also sampled by DWM in July 1995 (Appendix E).

DFWELE conducted fish population sampling at 21 reaches along this segment of the Ipswich River in August and September 1998. A total of 3,650 fish were collected from this segment of the Ipswich River in 1998 (Armstrong *et al.* 2001). Table 6 provides the number of each species collected for reaches of the river in this segment (MA92-06).

The assemblage of fish from the 21 reaches of this segment of the Ipswich River was dominated by macrohabitat generalist species. Of the 19 species collected only three species are fluvial dependants/specialists (creek chubsucker, fallfish, and white sucker). Of the fluvial specialists/dependants only creek chubsucker is considered intolerant of pollution, particularly silt (Hartell *et al*. 2002). In addition, there is one macrohabitat generalist, the swamp darter, which is also considered an intolerant species. Overall, "fluvial species are rare or absent … [and the] fish community is dominated by warm-water fish that are tolerant of extended periods of low flow or impoundment" (Armstrong *et al.* 2001).

Toxicity

Ambient

Bostik Findley, Inc. collects Ipswich River water (just downstream from the Lynn Water & Sewer Commission intake) for use as dilution water in their whole effluent toxicity tests. Between August 1998 and August 2002 survival of *C. dubia* exposed (7-day) to the river water was good (≥ 90%) while survival of *P. promelas* exposed (7-day) to the river water ranged from 60 to 100%. Survival of the minnows exposed to the Ipswich River water was less than 75% in two of the 10 tests conducted. The instream toxicity was detected in the August and September 2000 test events.

Effluent

A total of 10 modified acute and chronic whole effluent toxicity tests were conducted on the Bostik Findley, Inc. effluent (samples comprised of a composite from outfalls 003, 004, and 005) using both *C. dubia* and *P. promelas* between August 1998 and August 2002. No acute or chronic toxicity has been detected (LC_{50}'s ≥ 100% effluent and CNOEC = 100% effluent).

Chemistry – water

DWM collected water quality samples from two stations on this segment of the Ipswich River; at Mill Street, North Reading/Reading (Station IP1.5, aka 113) and at Route 28, North Reading/Reading (Station IP02, aka 114) between 8 August and 7 September 2000 (n=12) (Appendices B and C of Appendix A). Parameters measured included: dissolved oxygen, pH, temperature, conductivity, and total dissolved solids. On 1 August and 24 August 2000 samples were also collected for alkalinity, hardness, chloride, suspended solids, ammonia-nitrogen, and total phosphorus (Appendix C of Appendix A).

Table 6. DFWELE fish population data for reaches of the Ipswich River in segment MA92-06 (August and September 1998) where n=number of reaches sampled (Armstrong *et al.* 2001). (Fluvial dependant/specialist species are noted in bold).

Species	Upstream Reading Wellfield (n=1)	Mill Street to Bear Meadow Brook (n=3)	Bear Meadow Brook to Martins Brook (n=1)	Martins Brook to unnamed tributary (n=4)	Bostik Dam to USGS gage in Middleton (n=2)	Norris Brook to unnamed tributary downstream Danvers Wellfield (n=1)	Unnamed tributary to Boston Brook (n=2)	Boston Brook to Nichols Brook (n=2)	Fish Brook to Salem-Beverly Water Supply Canal (n=4)
redfin pickerel (*Esox americanus americanus*)	186	230	28	123	53	58	313	242	511
banded sunfish (*Enneacanthus obesus*)	2				2			2	2
pumpkinseed (*Lepomis gibbosus*)	1	24	3	136	111	7	3	3	105
yellow bullhead (*Ameiurus natalis*)	1				21	6	3	3	8
white sucker (*Castomus commersoni*)		23	4	43	13				1
American eel (*Anguilla rostrata*)		9	2	41	78	41	77	134	245
chain pickerel (*Esox niger*)		9	1	38	6	3	28	19	42
swamp darter (*Etheostoma fusiforme*)		8	1	10		2	2	1	2
yellow perch (*Perca flavescens*)		3	1	80	20		4	12	5
creek chubsucker (*Erimyzon oblongus*)		3		77	6	4	3	2	
golden shiner (*Notemigonus crysoleucas*)		1		23	11		1		
largemouth bass (*Micropterus salmoides*)		1		13	4		3		3
bluegill (*Lepomis macrochirus*)				88	28		4	2	39
black crappie (*Pomoxis nigromaculatus*)				3					
brown bullhead (*Ameiurus nebulosus*)				5	6		2	1	
redbreast sunfish (*Lepomis auritus*)					17	11	12	28	15
green sunfish (*Lepomis cyanellus*)					3			7	2
sea lamprey (*Petromyzon marinus*)					3	2		5	13
fallfish (*Semotilus corporalis*)									4
Total number of fish collected	190	311	40	680	382	134	455	461	997

As part of the IPSWATCH Project funded by the EPA EMPACT Program, the University of New Hampshire (UNH) deployed a YSI meter in the Ipswich River approximately 200m upstream of the Route 28 in Reading. Between June and December 2001, April and December 2002 and in March 2003 measurements of DO, temperature, pH and conductivity were taken every 15 minutes when the meters were deployed (Lantagne 2002 and UNH 2003). These data, however, are not summarized below because quality assurance/quality control information were not available to the MA DEP.

In 1995 DWM also conducted water quality sampling at five stations along this segment of the Ipswich River; at Mill Street North Reading/Reading (Station IP01.5), at Route 28, North Reading/Reading (Station IP02), at Central Street, North Reading (Station IP04.5, at South Middleton USGS Gauge Station downstream from Bostik Company, Boston Street, Peabody/Middleton (Station IP06), and at Peabody Street, Middleton (Station IP09)(Appendix B, Tables B3 and B4).

The USGS, as part of their National Water-Quality Assessment (NAWQA) Program in the New England Coastal Basins (Maine, Massachusetts, New Hampshire, and Rhode Island) study unit, conducted water quality sampling in the Ipswich River between 1998 and 2000 at their gaging station (01101500) at South Middleton, MA. These data were published in the Water Resources Data Massachusetts and Rhode Island Water Year 1999, 2000, and 2001 reports (Socolow *et al.* 2000, Socolow *et al*. 2001, and Socolow *et al*. 2002). As part of their mercury studies total and methyl mercury samples from the water column were also collected from the Ipswich River at South Middleton by USGS on 23 September 1998, 26 April and 22 August 2000 (USGS 2003b).

Water from the Ipswich River was also collected for use as dilution water in the Bostik Findley, Inc. whole effluent toxicity tests just downstream from the Lynn Water & Sewer Commission intake (Lynnfield/North Reading) on 10 occasions between August 1998 and August 2002. Data from these reports (maintained in the TOXTD database) were also summarized below.

Through the IRWA's RiverWatch Volunteer Monitoring Program (RiverWatch) water quality monitoring has also been conducted at 13 sites along this segment of the Ipswich River (stations IP00 through IP16) since 1997 and one additional site (IP08) since 1998 (IRWA 2000a).

DO

Instream DOs measured by DWM in the Ipswich River near Mill Street, North Reading/Reading (Station IP01.5), in the summer of 2000 ranged from 1.8 to 4.1 mg/L and saturation was between 21 and 41%. DO was slightly higher near Route 28, North Reading/Reading (Station IP02), ranging from 2.8 to 5.8 mg/L and between 32 and 57% saturation. It should be noted that two of the six surveys were early morning, representing worse case (pre-dawn) conditions (Appendix B of Appendix A). Low DOs in the upper reaches of this segment of the Ipswich River were also documented by RiverWatch in the summers of 1999, 2000, and 2001 (IRWA 2000b, 2001, and 2002). The instream DO data reported by USGS from the Ipswich River near their gage in South Middleton ranged between 6.3 and 12.6 mg/L (n=45) but were not representative of worse-case conditions (Socolow *et al*. 2000, Socolow *et al*. 2001, and Socolow *et al*. 2002). Instream DOs reported by RiverWatch were occasionally low at their sampling locations in the river downstream from the Bostik Dam and their Thunder Bridge sampling station in Middleton (downstream from the confluence with Boston Brook). RiverWatch documented higher DOs in this segment of the river downstream from Thunder Bridge (IRWA 2000b, 2001, and 2002).

Temperature

Temperatures recorded by DWM at their two monitoring locations in the summer of 2000 ranged between 16.3 and 23.1 °C. The maximum temperature reported by USGS for the Ipswich River at the South Middleton gage was 26.5°C (24 July 2001). No temperatures measured by RiverWatch were above 28.3°C (IRWA 2000b, 2001, and 2002).

pH and Alkalinity

The pH measured by DWM in the upper reach of this segment of the Ipswich River ranged between 6.3 and 6.5 SU and alkalinity ranged between 19 and 28 mg/L. Measurements of pH in the river just downstream from the Lynn Water & Sewer Commission intake recorded in the TOXTD database ranged between 6.3 and 7.1 SU with two of the 10 measurements <6.5 SU while alkalinities ranged between 10 and 40 mg/L. The pH of the river reported by USGS at the South Middleton gage ranged between 6.4 and 7.4 SU with seven of the 46 measurements (15%) <6.5 SU.

Conductivity

Specific conductivity in the upper reach of this segment of the Ipswich River recorded by DWM ranged between 303 µS/cm and 342 µS/cm. Downstream from the Lynn Water & Sewer Commission intake, conductivities recorded in the TOXTD database ranged from 239 to 493 µS/cm. USGS reported conductivity ranging from 166 to 439 µS/cm in the river at the USGS gage in South Middleton.

Suspended Solids

The suspended solids concentrations reported by DWM in the upper reach of this segment of the Ipswich River ranged between 1.3 and 2.8 mg/L. Downstream from the Lynn Water & Sewer Commission intake reported suspended solid concentrations recorded in the TOXTD database

ranged from below detection to 30 mg/L. The maximum suspended sediment concentration reported by USGS was 32 mg/L although of the 41 measurements reported, only one exceeded 25 mg/L.

Ammonia-Nitrogen
With the exception of one measurement (0.11 mg/L) the ammonia-nitrogen concentrations in the upper reach of this segment of the Ipswich River reported by DWM were less than the detection limit of 0.02 mg/L. Downstream from the Lynn Water & Sewer Commission intake reported ammonia-nitrogen concentrations (recorded in the TOXTD database) ranged from 0.2 to 0.4 mg/L. Total ammonia and organic nitrogen (mg/L as N) in the Ipswich River reported by USGS near their gage in South Middleton ranged between <0.10 and 1.0 mg/L. All of these measurements were below 1.98 mg/L N (chronic instream criteria for ammonia at pH of 7.4 and temperature of 28°C) (EPA 1999).

Total Phosphorus
Total phosphorus concentrations in the upper reach of this segment of the Ipswich River reported by DWM ranged between 0.045 and 0.063 mg/L. Total phosphorus concentrations reported by USGS in the river at the South Middleton gage ranged between 0.011 and 0.069 mg/L (n=37).

Total Residual Chlorine
Downstream from the Lynn Water & Sewer Commission intake the maximum total residual chlorine (TRC) concentration in the Ipswich River recorded in the TOXTD database was 0.07 mg/L. Seven of the nine measurements were below the minimum quantification level of 0.05 mg/L.

Hardness
Hardness measurements in the upper reach of this segment of the Ipswich River reported by DWM ranged from 40 to 50 mg/L. Downstream from the Lynn Water & Sewer Commission intake hardness measurements of the river recorded in the TOXTD database ranged from 22 to 64 mg/L (only one of the 10 measurements was <25 mg/L).

Other
Bostik Findley detected methyl tertiary butyl ether (MTBE), an additive used to raise the octane rating of gasoline, in the Ipswich River during their Massachusetts Contingency Plan related river sampling during the time period (August and September 2000) when survival of minnow exposed to river water was unusually low (see ambient toxicity data above). Bostik Findley also detected MTBE in subsequent sampling (as recently as May/June 2001)(Welsh 2002).

The concentrations of total and methyl mercury samples from the water column of the Ipswich River reported by USGS (samples collected on 23 September 1998, 26 April and 22 August 2000 ranged between 2.72 and 6.48 and 0.438 to 1.245 ng/L, respectively (USGS 2003b).

Chemistry – sediment
USGS collected sediment from the Ipswich River near the USGS gaging station in South Middleton (downstream from the Bostik Company Dam) in September 1998 and again in August 2000 as part of their Toxics Substances Hydrology Program (an extension of the National Mercury Pilot Study) and the Urban Land Use Gradient Study (part of the NAWQA program). The sediment was analyzed for trace elements and organic compounds. Cadmium, chromium, copper, lead, mercury, nickel and zinc concentrations all exceeded the L-EL guidelines while arsenic, iron and manganese exceeded the S-EL guidelines (Chalmers 2002 and USGS 2003b).

Chemistry – tissue
The USGS, as part of their mercury studies, collected white suckers from this segment of the Ipswich River in September 1998 and again in August 2000 (Chalmers 2001). A total of seven white suckers were collected near the USGS gage in Middleton (downstream from the Bostik Company Dam) in September 1998. The total PCB concentration in the "whole fish" composite sample was 63 ppb wet weight (Chalmers 2002). Total PCB in this "whole fish" sample did not exceed the NAS/NAE guideline for total PCB (in Coles 1998) of 500 ppb wet weight for the protection of fish-eating wildlife.

The *Aquatic Life Use* for this segment of the Ipswich River is assessed as impaired primarily as a result of the flow limitations from water withdrawals that impact instream habitat and the general lack of fish

species that are either intolerant and/or fluvial dependant/specialists. Moderate impacts to the benthic community and low dissolved oxygen in the upper reach of this segment (upstream of the Bostik Company Dam) were also documented. The concentrations of metals in the sediment sample from the river near the USGS gage in South Middleton are also somewhat elevated (above S-EL guidelines). Whether or not the low dissolved oxygen concentrations/conditions are naturally occurring or anthropogenically induced (or a combination of both) needs further investigation.

FISH CONSUMPTION

In August 2000 DWM collected fishes from two reaches in this segment of the Ipswich River for the purpose of toxics monitoring. Electrofishing was conducted downstream from Central Street in North Reading. Three-fillet composites each of chain pickerel, yellow perch, and creek chubsucker were analyzed at the Wall Experiment Station for cadmium, lead, mercury, arsenic, selenium, percent lipids, PCB arochlors and congeners, and pesticides. These data can be found in Appendix G (Table G2). A second reach of the Ipswich River, upstream of the Bostik Company Dam, was also sampled by DWM in October 1995. A two fish composite of chain pickerel and a three fish composite each of yellow perch, brown bullhead, creek chubsucker, and white sucker were analyzed at the Wall Experiment Station for the same analytes described above. These data can be found in Appendix G (Table G1). It should be noted that while mercury in the chain pickerel composite sample exceeded the trigger level of 0.5 mg/kg, the composite was only comprised of two fish rather than three and, therefore, MDPH did not issue an advisory.

An edible fillet composite sample (scales off, skin on) from seven white suckers collected by USGS from this segment of the Ipswich River in September 1998 was analyzed for trace metals (Chalmers 2002). The concentration of mercury in the edible fillet sample was 0.31 ppm wet weight (1.61 ppm dry weight). Additional five fish composite fillet samples (two bluegill and two pumpkinseed) were collected from this site by USGS in August 2000. The total mercury concentrations in these composite samples ranged from 0.34773 to 0.45227 ppm wet weight (USGS 2003b).

Because no site-specific MDPH fish consumption advisory has been issued this segment of the Ipswich River is not assessed for the *Fish Consumption Use*. However, this use is identified with an Alert Status because the two fish composite of chain pickerel collected by DWM in 1995 exceeded the MDPH trigger level for mercury. It should be noted that the chain pickerel collected by DWM in 2000 were small fish (below the legal length limit).

PRIMARY AND SECONDARY CONTACT RECREATION

In 1995 DWM conducted limited bacteria and water quality sampling at six stations along this segment of the Ipswich River; at Woburn Street, Wilmington (Station IP01), at Mill Street North Reading/Reading (Station IP01.5), at Route 28, North Reading/Reading (Station IP02), at Central Street, North Reading (Station IP04.5), at South Middleton USGS Gauge Station downstream from Bostik Company, Boston Street, Peabody/Middleton (Station IP06), at Peabody Street, Middleton (Station IP09), and from a storm drain near Route 28 North Reading/Reading (Station IP02SD) (Appendix B, Table B4).

The Middleton Board of Health posted the Thunder Bridge swimming area on this segment of the Ipswich River near Peabody Street and East Street in Middleton on 14 August 2001 due to an elevated *E. coli* bacteria count. The area was reopened on 15 August 2001 (MDPH 2002b).

Too little recent bacteria data are available so the *Recreational Uses* are not assessed for this segment of the Ipswich River.

AESTHETICS

No objectionable odors, deposits, oils, color or other conditions were noted by DWM biologists at their survey sites in July 2000 (MA DEP 2000a). No objectionable odors or other conditions were noted by RiverWatch volunteers at their sampling stations along this segment of the Ipswich River (stations IP00 through IP16) during their 1999 surveys when the river was flowing (IRWA 2000b).

The Reading-North Reading Stream Team conducted a shoreline survey on this segment of the Ipswich River on 21 June 1997 between the canoe launch near Woburn Street in Wilmington (the Jenks Bridge)

to the Middleton town line. The surveyors noted isolated areas of trash and debris (Reading-North Reading Stream Team 1997). Oil sheens were also noted near several road crossings and developments but were not described as a problem throughout the reach surveyed.

The *Aesthetics Use* is assessed as support based primarily on field observations by DWM biologists and RiverWatch volunteers in 1999 and 2000.

Ipswich River (MA92-06) Use Summary Table

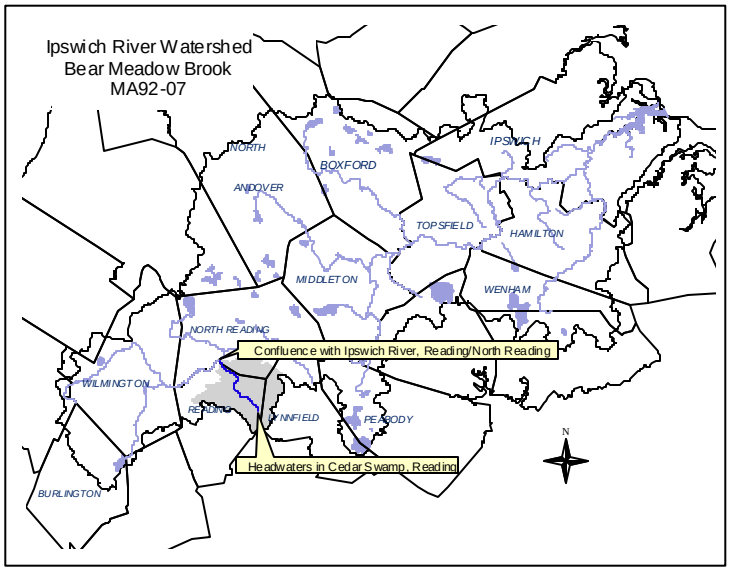
Designated Uses		Status
Aquatic Life		IMPAIRED Causes: Low flow alterations, DO, Combined biota/habitat bioassessments Source: Baseflow depletion from groundwater withdrawals
Fish Consumption		NOT ASSESSED
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		SUPPORT

RECOMMENDATIONS IPSWICH RIVER (MA92-06)

- Biological and habitat quality monitoring should continue to be conducted in this segment of the Ipswich River to further evaluate the status of the *Aquatic Life Use* and to determine the effects, if any, resulting from improving flows in the Ipswich River by reducing/optimizing groundwater withdrawals/water use.
- Continue to periodically evaluate fish community data against the target fish community developed by the Ipswich River Fisheries Restoration Task Force http://www.ipswichriver.org/FishRestReportA.pdf).
- *In-situ* monitoring for dissolved oxygen/saturation should be conducted to determine the frequency and duration of low dissolved oxygen in the river and to what extent it is related to reduced baseflow resulting from water withdrawals and/or natural conditions and to better evaluate the status of the *Aquatic Life Use*.
- Installation of a fish ladder or breaching of the Bostik Company Dam would help to restore anadromous fisheries to the upper Ipswich River Watershed. Review and implement recommendations in the DMF anadromous fish assessment report when available.
- Support cleanup efforts identified in the Reading-North Reading Stream Team Action Plan 1997 (Reading-North Reading Stream Team 1997).
- Review Roadway Express Inc., North Reading (MAR05B805), Aggregate Industries Northeast, Peabody, (MAR05C110), Riverpark, North Reading (MAR05C200), and Yellow Transportation, Inc., North Reading (MAR05C566) SWPPPs. Evaluate the quality of their SWPPPs, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from these facilities.
- Monitor bacteria levels to document effectiveness of bacteria source reduction activities including treatment of stormwater discharges, sewering, and the Phase II community stormwater management programs and to assess the status of the *Primary* and *Secondary Contact Recreation* uses.
- Additional fish toxics mercury monitoring in predator species is recommended for this segment of the Ipswich River. The MA DPH should review results of all edible fish fillet contaminant monitoring data (including USGS study results) when they become available.
- The MA DEP should continue to work with Meadow Brook Golf Club to improve water conservation and operational changes needed to discontinue the practice of pumping the wells continuously to the pond. The MA DEP should also continue to review Meadow Brook Golf Club's compliance with their WMA registration.
- Continue to monitor compliance with WMA registration/permit limits and other special conditions of the permits including flow records of the gauges (i.e., Danvers Water Department) along this segment of the Ipswich River.
- MSM Industries, Inc. is a hazardous waste site. Determine need for any additional monitoring activities.

BEAR MEADOW BROOK (SEGMENT MA92-07)

Location: Headwaters in Cedar Swamp, Reading to confluence with Ipswich River, Reading/North Reading.
Segment Length: 2.8 miles
Classification: Class B.



The drainage area of this segment is approximately 4.8 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 61%
Residential 29%
Open Land 6%

Bear Meadow Brook flows out of Cedar Swamp in Reading draining in a generally northwesterly direction along the Reading/North Reading boundary to its confluence with the Ipswich River.

WMA WATER WITHDRAWAL SUMMARY

Based on the available information there are no WMA regulated water withdrawals in this subwatershed.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLES H2 AND H3)

Camp Curtis Guild in Reading has a permit (MAR05C074) that allows them to discharge stormwater in this subwatershed. This general permit was issued by the EPA in October 2001, and will expire in October 2005.

Lynnfield, North Reading and Reading are Phase II Stormwater communities. These communities were issued stormwater general permits from EPA and MA DEP in 2003, and are authorized to discharge stormwater from their municipal drainage systems (MAR041045, MAR041215, and MAR041056, respectively). Over the five-year permit term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

No recent water quality data are available so all uses for Bear Meadow Brook are not assessed. A single bacteria sample was collected in 1995 by DWM in the brook at Haverhill Street near town line and conservation area in Reading (Station BM01) (Appendix B, Table B4).

Bear Meadow Brook (MA92-07) Use Summary Table

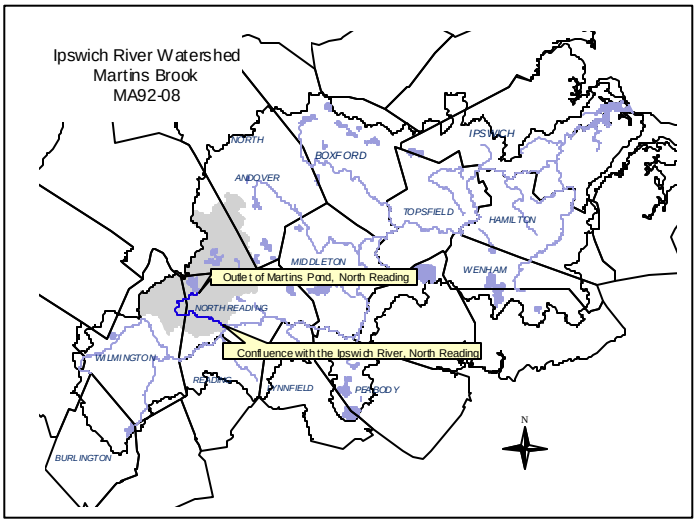
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
				
NOT ASSESSED				

RECOMMENDATIONS BEAR MEADOW BROOK (MA92-07)

- Review Camp Curtis Guild in Reading (MAR05C074) SWPPP. Evaluate the quality of their SWPPP, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from the facility.
- Baseline water quality data should be collected in Bear Meadow Brook to assess the status of the designated uses.

MARTINS BROOK (SEGMENT MA92-08)

Location: Outlet of Martins Pond, North Reading to the confluence with the Ipswich River, North Reading.
Segment Length: 4.6 miles
Classification: Class B.



The drainage area of this segment is approximately 13 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 46%
Residential 31%
Wetlands..... 6%

Martins Brook flows out of Martins Pond in North Reading in a westerly direction into Wilmington and turns south then easterly and joins the Ipswich River in North Reading. Martins Pond receives flow from the Skug River, which drains the southeast corner of Andover.

The use assessments for Brackett Pond (MA92004), Bradford Pond (MA92005), Collins Pond (MA92010), Field Pond (MA92019), Frye Pond (MA92023) and Martins Pond (MA92038) are in the Lake Assessment section of this report.

Galerucella beetles were released as part of a Merrimack College student's biology research project at three sites along Martins Brook in June 2002 to control purple loosestrife (MPA 2002).

This segment is on the 1998 303(d) List of Waters for organic enrichment/low DO, other habitat alterations, and pathogens (Table 3).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX H, TABLE H4)

Facility Name Registration Permit	Authorized Withdrawal (MGD)		Reported Actual Use (MGD)				
	9/1/1994 to 8/31/1999	9/1/1999 to 5/18/2003	1998	1999	2000	2001	2002
North Reading Water Department 31721301 9P31721301	0.96 (reg) 0.15 (per) 1.11 (total)	0.96 (reg) 0.20 (per) 1.16 (total)	0.57	0.53	0.55	0.67	0.57
Wilmington Water Department 31734201 9P31734201	2.91(reg) 0.45 (per) 3.36 (total)*	2.91(reg) 0.65 (per) 3.56 (total)*	2.84	3.07	2.91	2.80	2.58

* Indicates system -wide withdrawal, all sources not necessarily within this segment.
Note: North Reading Water Department Stickney Well (213-06G), which is in Ipswich River segment MA92-06, is inactive.

The WMA Modified Permit dated 19 May 2003 (currently under appeal) for the Wilmington Water Dept. included monitoring adjacent to Wilmington wells under under Special Condition # 2-Maximum Authorized Daily Withdrawal Volume. "As of the issuance date of this Modified Permit, the Town has been unable to pump the Browns Crossing Well, the Barrows Wellfield and the Salem Street Well (collectively "the Sargent Treatment Plant Wells") at their approved capacity. To protect Martin's Brook the MA DEP requires that the Town notify MA DEP in writing at least thirty days prior to commencing the design of any improvements to the Sargent Treatment Plant Wells. The MA DEP reserves the right to establish streamflow thresholds and/or impose any other conditions limiting the use of the Sargent Treatment Plant Wells that the MA DEP deems appropriate to achieve the purposes of the Water Management Act" (O'Keefe 2004).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLES H1, H2 AND H3)

The owners of a Sunoco Service Station in North Reading applied for an NPDES permit (MA0036749) in 1996 to discharge to Rapier Brook, a tributary of Martins Brook. The facility has a groundwater remediation system in place. The discharge will be covered by an EPA general NPDES permit for groundwater remediation discharges when it becomes available.

The Town of Wilmington Water and Sewer Department is permitted (MAG640020 effective August 2001) to discharge 0.174 MGD (average monthly flow) of wastewater from the E. H. Sargent Water Treatment Plant in Wilmington, MA to Martins Brook. A toxicity test on the effluent using *Ceriodaphnia dubia* was required in May 2002.

There are three general stormwater permittees in this subwatershed. The following general permits were issued by the EPA in October 2001 and will expire in October 200:

Benevento Sand & Gravel, Wilmington permit number MAR05B949
FedEx Ground, Wilmington, permit number MAR05B774
Heffron Asphalt Corporation, Wilmington, permit number MAR05B907

Andover, North Reading and Wilmington are Phase II Stormwater communities. These communities were issued stormwater general permits from EPA and MA DEP in 2003 and are authorized to discharge stormwater from their municipal drainage systems (MAR041178, MAR041215, and MAR041234, respectively). Over the five-year permit term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Although no current stream gaging data are available, it should be noted that there are two WMA permittees within this subwatershed area – the Wilmington Water Department withdraws from three of their wells and the North Reading Water Department withdraws from six wells in this subwatershed (Appendix H, Table H4). The withdrawal volume from the Wilmington Water Department between 1998 and 2002 averaged 2.84 MGD while North Reading averaged 0.58 MGD in the same period. Approximately 15% of the Town of Wilmington is currently sewered. The wastewater from the town is treated at MWRA Deer Island and discharged to the Boston Harbor Watershed (Felix 2002). Wilmington is in the process of developing a comprehensive wastewater management plan. North Reading relies almost 100% on septic systems (Felix 2002).

The DFWELE sampling reach, sampled in July 1999, was located upstream of Park Street in North Reading (Armstrong *et al.* 2001). The channel type was described as glide and the predominant streambed substrate was sand. Physical habitat was comprised primarily of woody debris as well as exposed roots, undercut banks, and overhanging vegetation. The riparian vegetation was dominated by a shrub wetland on the left bank and a mix of forest and shrub on the right bank. This site received the highest RBP habitat assessment score (173 of 200) of all the tributaries sampled in the Ipswich River Basin (Armstrong *et al.* 2001).

Martins Brook was sampled by DWM approximately 50m downstream from Park Street, North Reading, MA (Station MB02) in July 2000. At the time of the survey the river was roughly 4 m wide, with depths of 0.25 m in the riffles and runs. The substrates were comprised primarily of cobble with lesser amounts of sand, gravel, and boulder. Mosses and rooted emergent macrophytes providing instream cover were noted to have a thin film of algae. The reach was approximately 40% shaded. The overall habitat score was 108 (Appendix D and MA DEP 2000a). Severe bank erosion, instream deposition and sedimentation, and a marginal channel flow status and reduced riparian zone all contributed to the low habitat score.

Currently there is no fish passage at the dam at Martins Pond. However, the Division of Marine Fisheries does note that there is the long-term potential for river herring (*Alosa pseudoharlengus* or *Alosa aestivalis*) restoration to Martins Pond, but it would first require improved passage at the Willowdale Dam and the construction of a fishway at the Bostik Company Dam (Chase 2003b).

Biology

Fish community sampling was conducted by DFWELE in July 1999 (Armstrong *et al.* 2001). A total of 139 fish (nine species) were collected. Dominant fish species included creek chubsucker, redfin pickerel, American eel, and white sucker. Pumpkinseed, chain pickerel, swamp darter, yellow bullhead, and a bluegill were also present. Sixty-two percent of the fish collected can be classified as macrohabitat generalists, while fluvial dependants and specialists comprised only 38% of the sample.

Compared to the Fish Brook reference station (station FB00) the RBP III analysis conducted by DWM biologists indicated the benthic community was moderately impacted in Martins Brook approximately 50m downstream from Park Street, North Reading, MA (Station MB02) in July 2000 (Appendix D). The community was unbalanced and appeared to be responding to an abundance of organic matter (both deposited and suspended forms) (Appendix D). This brook was also sampled by DWM in July 1995 (Appendix E).

Toxicity

Effluent

The effluent from the E.H. Sargeant Water Treatment Facility in Wilmington (MAG640020) was not acutely or chronically toxic to *C. dubia* during the test conducted in May 2002.

Chemistry – water

DWM collected water quality samples between 8 August and 7 September 2000 (n=13) from three stations on Martins Brook; outlet of Martins Pond at Burroughs Road, North Reading (Station MB01 aka 137), downstream/south at Salem Street, Wilmington (Station MB03, aka 753) and downstream/east at Park Street (near intersection with Winter Street (Route 62), North Reading (Station MB02B aka 755). Parameters measured included dissolved oxygen, pH, temperature, conductivity, and total dissolved solids. On 1 August and 24 August samples were also collected for alkalinity, hardness, chloride, suspended solids, ammonia-nitrogen, and total phosphorus (Appendix B and C of Appendix A). DWM also conducted water quality monitoring at two stations (MB01 and MB02) on Martins Brook in 1995 (Appendix B, Tables B3 and B4).

Through the IRWA's RiverWatch Volunteer Monitoring Program (RiverWatch) water quality monitoring has also been conducted at one site in Martins Brook (station MB at Park Street, North Reading) since 1997 (IRWA 2000a).

DO

At Station MB01 DO readings recorded by DWM ranged between 5.7 to 8.3 mg/L (68 to 96% saturation). The concentration of DO at station MB03 was only 1.8 mg/L (18% saturation) on 7 September 2000 and did not represent worse-case (pre-dawn) conditions. The DO concentration near the mouth of Martins Brook (Station MB02B) measured by DWM in the summer of 2000 was also low ranging between 2.5 to 4.6 mg/L (28 to 44% saturation) (Appendix B of Appendix A). DOs documented by RiverWatch in the summers of 1999, 2000 and 2001 were slightly below standards on several occasions (IRWA 2000b, 2001, and 2002).

Temperature

Temperatures recorded by DWM in Martins Brook at Station MB01 ranged from 23.1°C to 28.1°C. At Station MB03 the temperature was 16.8 °C and at Station MB02B temperatures ranged between 15.2°C and 22.2 °C. No temperatures measured by RiverWatch were above 28.3°C (IRWA 2000b, 2001, and 2002).

pH and alkalinity

pH measurements recorded by DWM in the brook near the outlet of Martins Pond (Station MB01) ranged from 6.6 to 7.0 SU and alkalinity was 14 mg/L. The pH in the brook downstream of Salem Street (Station MB03) was 6.1 SU and the pH in the brook near Park Street (Station MB02B) ranged between 6.3 and 6.5 SU with alkalinities of 21 and 28 mg/L.

Conductivity

Conductivity in Martins Brook at Station MB01 ranged between 212 and 224 µS/cm. Conductivity at Station MB03 was 260 µS/cm and at Station MB02B it ranged between 266 and 363 µS/cm.

Suspended Solids
The suspended solid concentrations from all three stations monitored by DWM in the summer of 2000 ranged between 1.5 and 2.8 mg/L.

Hardness
The hardness values reported by DWM in Martins Brook ranged between 27 and 43 mg/L.

Ammonia-Nitrogen (as N)
The ammonia-nitrogen concentrations measured in Martins Brook ranged from BDL (<0.02) to 0.04 mg/L.

Total Phosphorus (as P)
The total phosphorus concentrations in Martins Brook near the outlet of Martins Pond were 0.038 and 0.042 mg/L and near the mouth of the brook near Park Street (Station MB02B) were slightly higher (0.061 and 0.070 mg/L)

The *Aquatic Life Use* is assessed as impaired for Martins Brook primarily as a result of the benthic macroinvertebrate community analysis. Habitat quality degradation resulting from severe bank erosion, instream sedimentation (sand) and riparian zone disruption was noted as were low dissolved oxygen and slightly elevated total phosphorus levels. Sediment inputs probably originate from multiple sources including the large Benevento Sand & Gravel operation, point source discharge(s), road runoff, and eroding stream banks.

PRIMARY AND SECONDARY CONTACT RECREATION
No recent quality assured bacteria data are available so the recreational uses are not assessed. DWM did conduct limited bacteria sampling in Martins Brook in 1995 at two stations; MB01 at the outlet of Martins Pond, North Reading and MB02 at Park Street, North Reading (Appendix B, Table B4). It should also be noted that septic system failures around Martins Pond are problematic and the town is considering sewering the area (Felix 2002).

AESTHETICS
A slight petroleum slick and odor was noted by DWM biologists in the sediment and water column of Martins Brook near the Park Street Bridge in 2000 during the benthic macroinvertebrate survey. Downstream from the bridge the water column was reported to be slightly tea-stained, but clear, and no other objectionable odors or other conditions were described (Appendix D and MA DEP 2000a). No objectionable deposits or other conditions were reported by RiverWatch at their sampling station (MB) in Martins Brook in 1999 (IRWA 2000b).

A petroleum cleanup site (Sunoco Service Station, North Reading) is located in the Rapier Brook subwatershed (a tributary to Martins Brook) slightly upstream from the Park Street Bridge where slight petroleum odors were noted in Martins Brook by DWM biologists in July 2000. Too limited data are available, however, to determine the extent and source of these conditions. Therefore, the *Aesthetics Use* is not assessed but is identified with an Alert Status because of the documented petroleum odors/slick.

Martins Brook (MA92-08) Use Summary Table

Designated Uses		Status
Aquatic Life		IMPAIRED Causes: Combined biota/habitat bioassessment, Fish bioassessment (Suspected Causes: DO, Total phosphorus) Source: Streambank modification/destabilization (Suspected Sources: Highway/road/bridge runoff, Loss of riparian habitat, Sand and gravel operations)
Fish Consumption		NOT ASSESSED
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		NOT ASSESSED*

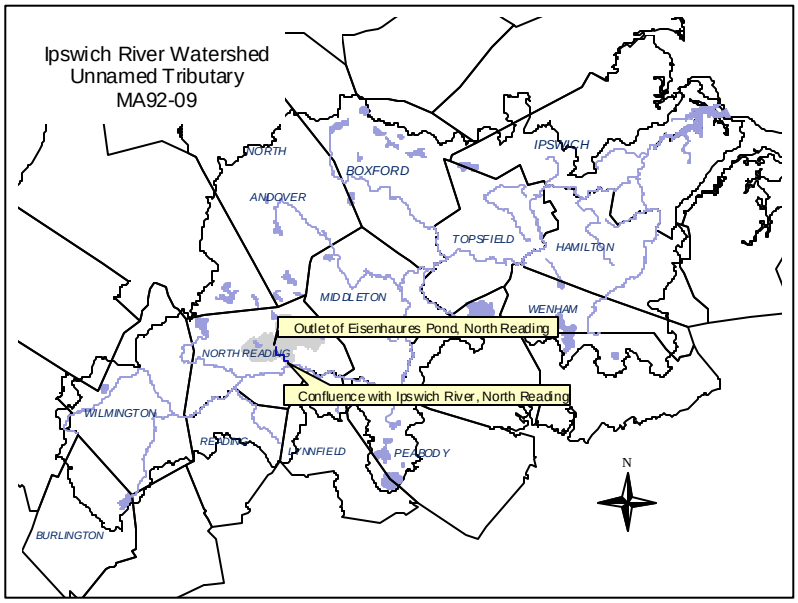
* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS MARTINS BROOK (SEGMENT MA92-08)

- Biomonitoring in Martins Brook should be conducted by DWM during the next Ipswich River Watershed survey. Field reconnaissance and, if deemed necessary, additional biomonitoring locations should be established to better evaluate the potential impacts of pollution, both point and nonpoint sources, to Martins Brook to assess the status of the *Aquatic Life Use*.
- Evaluate outlet control practices at Martins Pond dam and determine if current operations are negatively impacting streamflow in Martins Brook. To the extent possible releases at the dam should be optimized to mimic natural flow regimes.
- Additional *in-situ* monitoring for dissolved oxygen/saturation should be conducted to determine the frequency and duration of low dissolved oxygen in the brook and to what extent it is related to anthropogenic and/or natural conditions to better assess the status of the *Aquatic Life Use*. Additional total phosphorus sampling may also be warranted.
- A site visit should be conducted at the E.H. Sargeant Water Treatment Plant to document filter backwash treatment and release procedures and any potential impacts to Martins Brook.
- A site investigation should be conducted at the Sunoco Service Station, North Reading, to evaluate the status of the remediation project and determine whether or not the emergency exclusion permit should be administratively continued. Evaluate any off site impacts from this facility.
- A shoreline survey should be conducted in Martins Brook to document the location and extent of any petroleum product impacts (e.g., odors, slicks, etc.) to assess the status of the *Aesthetics Use*. Additional information should be collected during the shoreline survey to identify any areas of sediment inputs (nonpoint and point source), streambank erosion, and/or riparian zone disturbances.
- Restore the vegetative riparian buffer along the left bank of Martins Brook near Park Street, North Reading to alleviate the streambank erosion (Appendix D).
- Review Benevento Sand & Gravel, Wilmington (MAR05B949), FedEx Ground, Wilmington (MAR05B774) and Heffron Asphalt Corporation, Wilmington (MAR05B907) SWPPPs. Evaluate the quality of their SWPPPs, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from their facilities.
- Monitor bacteria levels to document effectiveness of bacteria source reduction activities including treatment of stormwater discharges, sewering around Martins Pond, and the Phase II community stormwater management programs and to assess the status of the *Primary* and *Secondary Contact Recreation* uses.
- Review and implement recommendations in the DMF anadromous fish assessment report for improving effectiveness of fish passage to Martins Pond.
- Continue to monitor compliance with WMA registration/permit limits and other special conditions of the permit.

UNNAMED TRIBUTARY (SEGMENT MA92-09)

Location: Outlet of Eisenhaures Pond, North Reading to confluence with Ipswich River, North Reading.
Segment Length: 1.4 miles
Classification: Class B.



The drainage area of this segment is approximately 2.0 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 55%
Residential 40%
Agriculture..... 3%

This unnamed tributary flows from the outlet of Eisenhaures Pond in North Reading to its confluence with the Ipswich River in North Reading.

The use assessment for Eisenhaures Pond (MA92016) is in the Lake Assessment section of this report.

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLE H3)

Based on the available information there are no WMA regulated water withdrawals in this subwatershed.

North Reading is a Phase II Stormwater community. North Reading was issued a stormwater general permit from EPA and MA DEP in 2003, and is authorized to discharge stormwater from their municipal drainage system (MAR041215). Over the five-year permit term the community will develop, implement and enforce a stormwater management program to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

No recent water quality data are available so all uses for this unnamed tributary are not assessed. A single bacteria sample was collected in 1995 by DWM in the brook near intersection of Elm Street and Willow Street (downstream of Eisenhaures Pond), North Reading (Station EP01) (Appendix B, Table B4).

Unnamed Tributary (MA92-09) Use Summary Table

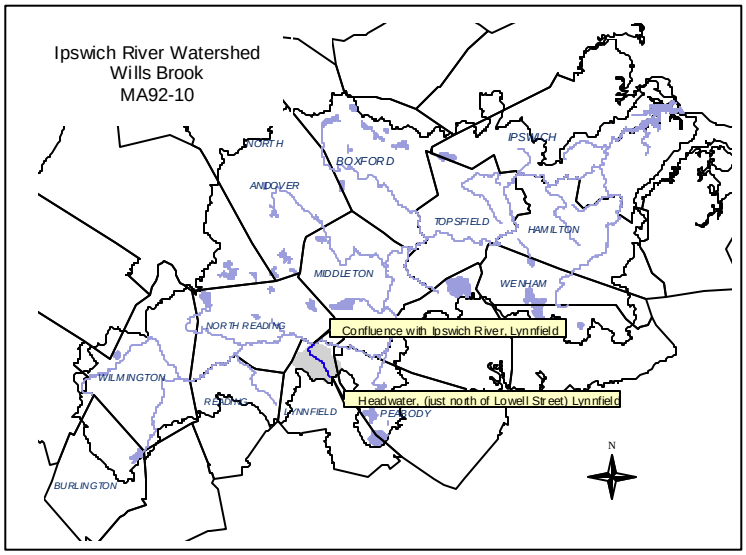
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
				
NOT ASSESSED				

RECOMMENDATIONS UNNAMED TRIBUTARY (MA92-09)

- Additional monitoring will be necessary on this tributary before it can be assessed for its designated uses.

WILLS BROOK (SEGMENT MA92-10)

Location: Headwater, (just north of Lowell Street) Lynnfield to confluence with Ipswich River, Lynnfield.
Segment Length: 1.7 miles
Classification: Class B.



The drainage area of this segment is approximately 1.5 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 56%
Residential 30%
Open Land 13%

Wills Brook flows from the outlet of a small (unnamed) pond just north of Lowell Street in Lynnfield in a northerly direction through Sagamore Springs Golf Club and flows northwest through a large wetland before turning east to its confluence with the Ipswich River in Lynnfield at the North Reading boundary.

This segment is on the 1998 303(d) List of Waters for organic enrichment/low DO and pathogens (Table 3).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX H, TABLE H4)

Facility Name Registration Permit	Authorized Withdrawal (MGD)	Reported Actual Use (MGD)				
		1998	1999	2000	2001	2002
Lynnfield Center Water District 31716401 9P31716401	0.29 (reg) 0.0 (per)* 0.29 (total)	0.42**	0.46**	0.36	0.32	0.33
Sagamore Spring Golf Club 31716402	0.12	0.13	0.13	0.13	0.13	0.07

* Permit was for a new source not an increase in withdrawal volume (LeVangie 2002). **Withdrawal exceeded the WMA permitting threshold of more than 100,000 GPD.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLE H3)

Lynnfield is a Phase II Stormwater community. Lynnfield was issued a stormwater general permit from EPA and MA DEP in 2003 and is authorized to discharge stormwater from the municipal drainage system (MAR041045). Over the five-year permit term the community will develop, implement and enforce a stormwater management program to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Although no current stream gaging data are available, it should be noted that there is one WMA permittee and one WMA registered user within this subwatershed area - the Lynnfield Center Water District withdrawals from their Glen Drive Wellfield (4 wells) and their station #2 and the Sagamore Spring Golf Club withdraws from their five sources. The withdrawal volume from the Lynnfield Center Water District between 1998 and 2002, which exceeded their permitted volume by more than 100,000 GPD in 1998 and 1999, averaged 0.38 MGD. MA DEP issued the Town an Administrative Consent Order in 2000 not to exceed their authorized withdrawal volume in either the Ipswich or the North Coastal Basins by more that 100,000 gallons per day. The ACO required LCWD not to exceed its approved maximum daily withdrawal from the Glen Drive Wellfield. The ACO required issuance of a water conservation notice whenever streamflow in the Ipswich River fell below 9.6 cubic feet per second at South Middleton USGS gauge. The LCWD was required to implement recommended

actions from a Camp, Dresser and McKee study intended to enable compliance with the Water Management Act. These actions included repairing and rehabilitation of the Phillips Road tubular well field and cleaning of wells, replacement of filter media at the Water Treatment plant, installation of an alarm at the Glen Drive Wellfield, and submission of a water conservation plan to include varying levels of outdoor watering restrictions based on water usage. LCWD has complied with the ACO requirements (O'Keefe 2003b). The Sagamore Spring Golf Club water withdrawal averaged 0.12 MGD between 1998 and 2002. With the exception of two restaurants, all of Lynnfield is serviced by on-site septic systems (Felix 2002).

Chemistry-water

Limited water quality and bacteria sampling was conducted by DWM in the brook near Elm Street (Route 62 near the railroad bed), Lynnfield (Station WB01) in 1995 (Appendix B, Tables B3 and B4).

No recent water quality data are available so all uses for Wills Brook are not assessed. Although the *Aquatic Life Use* is not assessed for Wills Brook, habitat and water quality degradation resulting from streamflow depletion, especially during summer low flow periods, is of concern given the small drainage area (<10 square miles) and the water withdrawals so the *Aquatic Life Use* is identified with an Alert Status.

Wills Brook (MA92-10) Use Summary Table

Aquatic Life*	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
				
NOT ASSESSED				

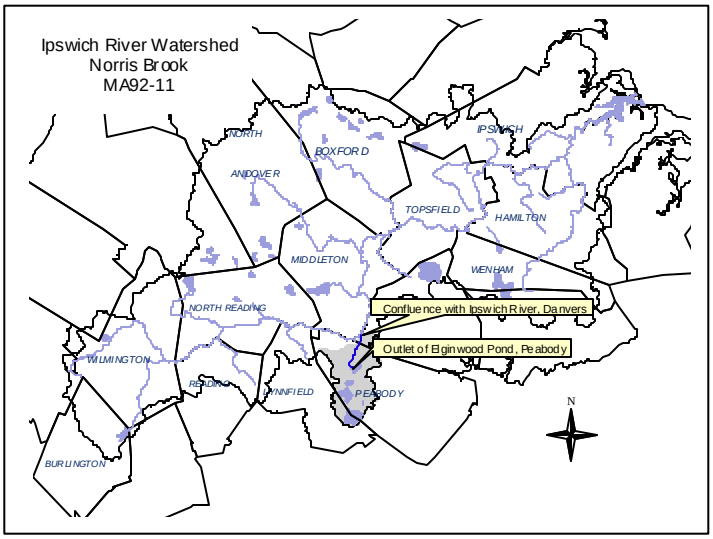
* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS WILLS BROOK (SEGMENT MA92-10)

- *In-situ* monitoring for dissolved oxygen/saturation should be conducted to determine the frequency and duration of low dissolved oxygen in the brook and to what extent it is related to reduced baseflow resulting from water withdrawals and/or natural conditions and to assess the status of the *Aquatic Life Use*.
- Continue to carefully evaluate the Lynnfield Center Water District's compliance with their WMA registration/permit and take additional compliance and enforcement actions as necessary.
- Monitoring of flow and instream habitat quality conditions in Wills Brook should be conducted to determine whether or not there are impacts from the Lynnfield Center Water District's withdrawals and to better assess the status of the *Aquatic Life Use*.
- Monitor bacteria levels 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.
- Continue to monitor compliance with WMA registration/permit limits and other special conditions of the permit.

NORRIS BROOK (SEGMENT MA92-11)

Location: Outlet of Elginwood Pond, Peabody to confluence with Ipswich River, Danvers (Danvers/Middleton town line).
Segment Length: 1.5 miles
Classification: Class B.



The drainage area of this segment is approximately 4.5 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Residential 48%
Forest 23%
Open Land 7%

Norris Brook flows from the outlet of Elginwood Pond in Peabody and joins the mainstem Ipswich River in Danvers. The headwaters of the Norris Brook subwatershed drain an area in west Peabody that flows into Crystal then Elginwood Ponds as well as a tributary system to Crystal Pond that flows from Suntaug Lake in South Lynnfield/Peabody through several other smaller ponds.

The use assessments for Crystal Pond (MA92013), Devils Dishfull Pond (MA92015), Elginwood Pond (MA92017), Pierces Pond (MA92048), Suntaug Pond (MA92065) and Winona Pond (MA92077) are in the Lake Assessment section of this report.

This segment is on the 1998 303(d) List of Waters for organic enrichment/low DO, suspended solids and turbidity (Table 3).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX H, TABLE H4)

Facility Name Registration Permit	Authorized Withdrawal (MGD)		Reported Actual Use (MGD)				
	9/1/1994 to 8/31/1999	9/1/1999 to 5/18/2003	1998	1999	2000	2001	2002
Peabody Dept. of Public Services 31722901 9P31722901	3.89 (reg) 0.58 (per) 4.47 (total)*	3.89 (reg) 0.69 (per) 4.58 (total)*	3.68	4.01	3.54	3.07	4.02

* Indicates system -wide withdrawal, all sources not necessarily within this segment.

The water withdrawn from the Ipswich River by the Peabody Department of Public Services goes to Winona Pond and Suntaug Lake. Depending on water levels in the lake or pond and the water demands water can be shifted between the lake and pond. Both of these surface water reservoirs also have watershed areas, entirely in the Ipswich River watershed, that contribute to the total amount of water that can be stored in the reservoirs. However, the amount of water withdrawn from the Ipswich River is used for determining compliance with the WMA registration/permit. Water from Winona Pond and some water from Suntaug Lake is treated at the Winona Pond Water Treatment Facility. The remaining water from Suntaug Lake is treated at the Coolidge Avenue water treatment facility (as is all of the water from Spring Pond). Spring Pond is located in the North Coastal watershed. All water in Spring Pond is derived from the watershed area of Spring Pond. Water from Spring Pond is treated at the Coolidge Avenue water treatment facility. The city of Peabody also has an MWRA connection. Peabody utilizes this connection on an as needed basis and does not purchase much water from MWRA. This water goes directly into the South Peabody water distribution system and not to any of Peabody's reservoirs.

The WMA Modified Permit dated 19 May 2003 (currently under appeal) for the Peabody Dept. of Public Services includes monitoring adjacent to the Peabody wells under Special Condition # 2-Maximum Authorized Daily Withdrawal Volume. “As of the issuance date of this Modified Permit, the City has

suspended use of the Pine Street Well and the Johnson Street Well because of concerns about water quality. The City shall not resume use of these wells without obtaining the prior written approval of the MA DEP's Drinking Water Program. The MA DEP reserves the right to establish streamflow thresholds that limit the use of these wells" (O'Keefe 2004).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLE H1 AND H3)

The City of Peabody Department of Public Services was permitted (MAG640028 effective September 1995) to discharge 0.12 MGD (average monthly) of wastewater from the Winona Pond Water Treatment Facility in Peabody, MA to Winona Pond. The City needs to reapply for coverage under the currently effective general permit.

Based on the available information there are no other NPDES regulated surface wastewater discharges in this subwatershed. Amoco Oil Company (MA0033065) near the Ipswich/North Coastal Watershed basin divide completed their remediation discharge in 1994.

Danvers, Lynnfield and Peabody are Phase II Stormwater communities. These communities were issued stormwater general permits from EPA and MA DEP in 2003 and are authorized to discharge stormwater from their municipal drainage systems (MAR041188, MAR041045, and MAR041216, respectively). Over the five-year permit term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Although no current stream gaging data are available, it should be noted that there is one WMA permittee within this subwatershed area – the Peabody Dept. of Public Services withdraws from their two wells and two of their surface water sources in this subwatershed (Appendix H, Table H4). The withdrawal volume from the Peabody Dept. of Public Services between 1998 and 2002 averaged 3.46 MGD. All of Peabody is sewered. The wastewater from the city is treated at South Essex Sewerage District and wastewater is discharged to Salem Harbor in the North Coastal Watershed (Felix 2002).

The DFWELE sampling reach, sampled in July 1999, was located beneath the power lines near the Peabody Water Supply in Peabody (Armstrong *et al.* 2001). The channel type was described as a pool and the predominant streambed substrate was sand and FPOM. The canopy was open. No habitat assessment score or other habitat quality information was given.

Biology

Fish community sampling was conducted by DFWELE in July 1999 (Armstrong *et al.* 2001). A total of 80 fish (five species) were collected. Dominant fish species included redfin pickerel, golden shiner, and bluegill. Pumpkinseed and largemouth bass were also present. All of the fish collected can be classified as macrohabitat generalists. Given the number of impoundments in the headwaters of this subwatershed and the low stream gradient of this segment the dominance by macrohabitat generalists is to be expected.

Chemistry – water

In 1995 DWM collected water quality samples from one station in Norris Brook at Russell Street, Peabody (Station NB01) and two other stations in the subwatershed; inlet to Elingwood Pond (Station NB02) and inlet to Crystal Pond (Station NB03) (Appendix B, Table B3 and B4).

Too limited data are available, so the *Aquatic Life Use* is not assessed for Norris Brook. This use is, however, identified with an Alert Status because of the small drainage area (<10 square miles), the water withdrawals, and the lack of recharge to the subwatershed.

PRIMARY AND SECONDARY CONTACT RECREATION

No recent quality assured bacteria data are available so the recreational uses are not assessed. DWM did conduct limited bacteria sampling in the Norris Brook subwatershed in 1995; Norris Brook at Russell Street, Peabody (Station NB01), Norris Brook at Lake and Lowell Streets, Peabody (Station NB04), and

four other stations in the subwatershed; inlet to Elginwood Pond (Station NB02), inlet to Crystal Pond (Station NB03), NBRP01 mall retention pond outlet, drains to unnamed tributary to Norris Brook at Goodale Street (Station NBRP01), and a stormdrain into Norris Brook at Lake Street and Lowell Street, Peabody (Station NBSD01) (Appendix B, Table B4).

Norris Brook (MA92-11) Use Summary Table

Aquatic Life*	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
				
NOT ASSESSED				

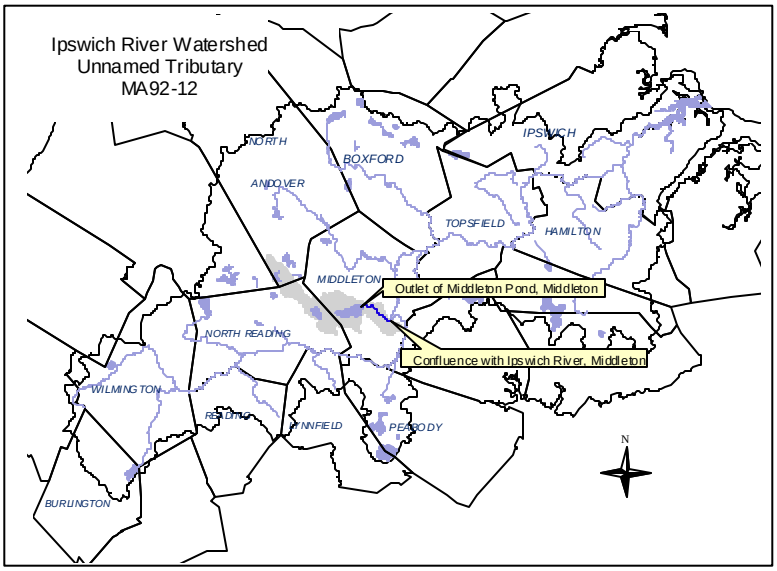
* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS NORRIS BROOK (SEGMENT MA92-11)

- *In-situ* monitoring for dissolved oxygen/saturation should be conducted to determine the frequency and duration of low dissolved oxygen in the brook and to what extent it is related to reduced baseflow resulting from water withdrawals and/or natural conditions to assess the status of the *Aquatic Life Use*.
- Monitor bacteria levels to document effectiveness of bacteria source reduction activities associated with the Phase II community stormwater management programs and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.
- The City of Peabody Department of Public Services needs to reapply for coverage under the currently effective general NPDES permit for water treatment plant discharges for their Winona Pond Water Treatment Facility discharge to Winona Pond.
- Continue to monitor compliance with WMA registration/permit limit and other special conditions of the permit.

UNNAMED TRIBUTARY (SEGMENT MA92-12)

Location: Outlet of Middleton Pond, Middleton to confluence with Ipswich River, Middleton.
Segment Length: 1.3 miles
Classification: Class B.



The drainage area of this segment is approximately 3.5 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 63%
Residential 15%
Open Land 7%

This unnamed segment flows in an easterly direction from the outlet of Middleton Pond in Middleton to the confluence with the Ipswich River, Middleton.

The use assessments for Middleton Pond (MA92039) and Swan Pond (MA92066) are in the Lake Assessment section of this report.

This segment is on the 1998 303(d) List of Waters for pathogens (Table 3).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX H, TABLE H4)

Facility Name Registration Permit	Authorized Withdrawal (MGD)		Reported Actual Use (MGD)				
	9/1/1994 to 8/31/1999	9/1/1999 to 5/18/2003	1998	1999	2000	2001	2002
Danvers Water Dept. 31707101 9P31707101	3.14 (reg) 0.56 (per) 3.70 (total)*	3.14 (reg) 0.69 (per) 3.83 (total)*	3.3	3.39	3.38	3.45	3.08

* Indicates system-wide withdrawal, all sources not necessarily within this segment.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLES H1 AND H3)

The Town of Danvers, Vernon Russell Water Filtration Plant, was permitted (MAG640062) in December 2002 to discharge 0.08 MGD of treated filter backwash and sedimentation basin drainage via outfall 001 to this unnamed tributary of the Ipswich River.

Middleton, North Andover and North Reading are Phase II Stormwater communities. These communities were issued stormwater general permits from EPA and MA DEP in 2003 and are authorized to discharge stormwater from their municipal drainage systems (MAR041211, MAR041214, and MAR041215, respectively). Over the five-year permit term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

There are no required releases of water from Middleton Pond to this unnamed tributary. The segment just downstream from the pond's spillway does go dry in the summer, likely affecting water quality and aquatic habitat. This outlet from Middleton Pond is not noted in the DMF anadromous fish survey (Reback et al., in preparation). There is no passage into the pond and anadromous fish restoration appears to have low potential (Chase 2003b).

Although no current stream gaging data are available it should be noted that there is one WMA permittee within this subwatershed area – the Danvers Water Department withdrawals from their surface water source (Middleton Pond) in this subwatershed (Appendix H, Table H4). The withdrawal volume from the Danvers Water Department between 1998 and 2002 averaged 3.32 MGD. The Water Department services both the towns of Danvers and Middleton. Approximately 85-90% of

Danvers is sewered; the wastewater from the town is treated at South Essex Sewerage District and discharged to Salem Harbor in the North Coastal Watershed (Felix 2002). The unsewered areas of Danvers are located along the Ipswich River. Middleton is approximately 95% serviced by on-site subsurface sewage disposal systems.

Chemistry – water

In 1995 DWM conducted limited water quality sampling on this unnamed tributary at King Street, (Station KS01) near Middleton Center (Appendix B, Table B4).

Too limited data are available so the *Aquatic Life Use* is not assessed for this unnamed tributary. This use is, however, identified with an Alert Status because of the small drainage area (<10 square miles), the water withdrawals, and the limited recharge to the subwatershed.

PRIMARY AND SECONDARY CONTACT RECREATION

No recent quality assured bacteria data are available and so the recreational uses are not assessed. DWM did conduct limited bacteria sampling in the unnamed tributary in 1995; at King Street (Station KS01) near Middleton Center (Appendix B, Table B4). A septic system was found to be leaching into a storm drain at Lake Street that discharged to this unnamed tributary. The owner was ordered to upgrade the system (MST 1999).

AESTHETICS

The Middleton Stream Team conducted a shoreline survey of this unnamed brook (locally known as Middleton Brook) between June and August 1998. Isolated areas of trash and debris were noted in the vicinity of Main Street. Dead fish were also observed near Main Street and the water appeared degraded with a rusty look and a dead fish odor. The stream bank in the area was composed of car parts and tires. Except for the area between Main Street and South Main Street this segment appeared reasonably healthy with beautiful habitat along the stream banks (MST 1999).

The *Aesthetics Use* is assessed as support for this unnamed tributary. The use is, however, identified with an Alert Status because of the trash and debris in the isolated area between Main and South Main Streets.

Unnamed Tributary (MA92-12) Use Summary Table

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

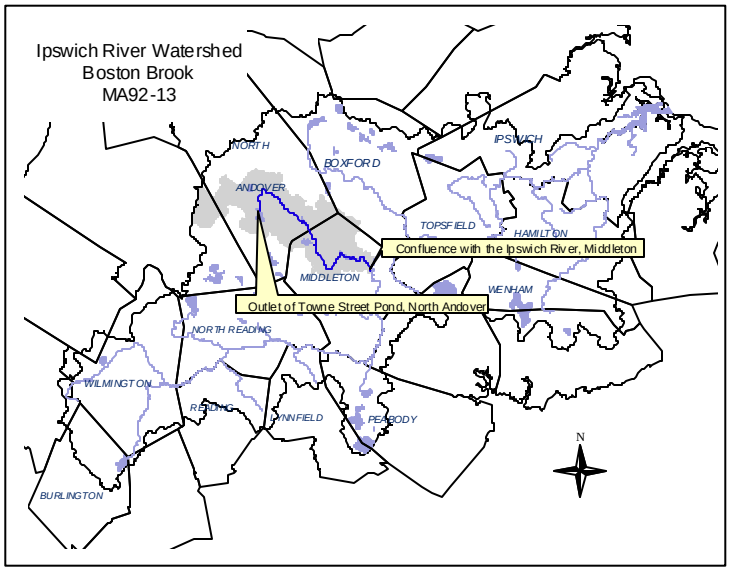
* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS UNNAMED TRIBUTARY (SEGMENT MA92-12)

- Monitoring of flow and instream habitat quality conditions in this unnamed tributary should be conducted to determine whether or not there are impacts from the outlet control practices at Middleton Pond and to better assess the status of the *Aquatic Life Use*. The outlet control practices at Middleton Pond should also be evaluated. To the extent possible, artificial impacts from the operation of the outlet control at Middleton Pond on the streamflow in the unnamed tributary should be minimized.
- Monitor bacteria levels to document effectiveness of bacteria source reduction activities associated with septic system upgrades and the Phase II community stormwater management programs; to bracket potential sources of bacteria identified by the Middleton Stream Team (MST 1999); and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.
- A stream cleanup should be conducted.
- Evaluate operations and determine the potential for instream impacts from the Town of Danvers Vernon Russell Water Filtration Plant (MAG640062) discharge. If necessary, develop recommendations for releases of water to the unnamed tributary.
- Continue to monitor compliance with WMA registration/permit limits and other special conditions of the permit.

BOSTON BROOK (SEGMENT MA92-13)

Location: Outlet of Towne Street Pond, North Andover to confluence with the Ipswich River, Middleton.
Segment Length: 7.5 miles
Classification: Class B.



The drainage area of this segment is approximately 10.8 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 70%
Residential 19%
Open Land 3%

Boston Brook flows from the outlet of Towne Street Pond in North Andover along a generally southeasterly course to the confluence with the Ipswich River in Middleton. The headwater drainage area of the Boston Brook subwatershed includes drainage from Boston Hill near the Salem Turnpike in North Andover through Brook Street Pond into Towne Street Pond.

The use assessments for Creighton Pond (MA92011), Lower Boston Brook Pond (MA92031), Salem Street Pond (MA92076), Towne Street Pond (MA92069) and Upper Boston Brook Pond (MA92070) are in the Lake Assessment section of this report.

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLES H2 AND H3)

Based on the available information there are no WMA regulated water withdrawals in this subwatershed.

Morton International, Inc. and Laidlaw Transit, both in North Andover, have general stormwater permits (MAR05C044 and MAR05C353, respectively) that allow them to discharge to this subwatershed (Appendix H, Table H2). The general permits were issued by EPA in October 2001 and will expire in October 2005.

Andover, Boxford, Middleton, and North Andover are Phase II Stormwater communities. These communities were issued stormwater general permits from EPA and MA DEP in 2003, and are authorized to discharge stormwater from the municipal drainage systems (MAR041178, MAR041184, MAR041211, and MAR041214). Over the five-year permit term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Boston Brook was sampled by DWM approximately 250 m upstream from Liberty Street, Middleton, MA (Station BB01) in July 2000. At the time of the survey the river was roughly 3 m wide with depths of approximately 0.25 m in the riffles and pools. The substrates were comprised primarily of boulder and cobble with lesser amounts of sand and gravel. Mosses provided additional instream cover. The percent algal cover was estimated to be less than 5%. The reach was approximately 75% shaded. The overall habitat score was 191, the highest evaluation in the Ipswich River Watershed (Appendix D and MA DEP 2000a).

The DFWELE sampling reach, sampled in July 1999, was located upstream and downstream from Peabody Street in Middleton (Armstrong *et al.* 2001). The channel type was described as pool/glide/riffle and the predominant streambed substrate was sand and CPOM. Physical habitat in this shaded sampling reach was comprised primarily of woody debris, overhanging vegetation,

exposed roots, and undercut banks. The riparian vegetation was dominated by upland forest/shrub species. The RBP habitat assessment score was 100 (out of 200) (Armstrong *et al.* 2001).
An old mill dam (Curtis Pond Dam) exists on Boston Brook in Middleton. This dam is reportedly in very poor condition (Mackin 2003). There is very little river herring spawning habitat upstream, but sea lamprey have been caught and observed in the brook (Chase 2003b).

Biology

Compared to the Fish Brook reference station (station FB00) the RBP III analysis conducted by DWM biologists indicated the benthic community was moderately impacted in Boston Brook approximately 250m upstream from Liberty Street, Middleton, MA (Station BB01) in July 2000 (Appendix D). DWM intended to conduct benthic macroinvertebrate sampling in Boston Brook in July of 1995, but the brook was dry at that time.

The lentic nature of much of Boston Brook and the extensive wetlands drained by the upper portions of the stream may account for the organic loading and potentially low levels of dissolved oxygen reflected in the BB01 macroinvertebrate community. In addition, there are several impoundments in the upper portion of the Boston Brook subwatershed that may contribute FPOM loads to downstream lotic communities such as BB01 and may also be significant because flow regulation at outlet structures may result in occasional baseflow reductions downstream.

The periphyton community was conspicuously depauperate at Station BB01 (percent algal cover was <5% and algal grazers were virtually absent despite substrate availability) and may be indicative of flow-related stress to the biota in this portion of Boston Brook during the July 2000 survey (Beskenis undated and Appendix F). Reduced algal growth may also be the result of poor sunlight penetration caused by instream turbidity, which was noted during the biosurvey at BB01.

Fish community sampling was conducted by DFWELE in July 1999 (Armstrong *et al.* 2001). A total of 133 fish (12 species) were collected. Dominant fish species included: American eel, redfin pickerel, and pumpkinseed. Bluegill, green sunfish, chain pickerel, yellow perch, brown bullhead, fallfish, sea lamprey, yellow bullhead and a largemouth bass were also present. All of the fish species present are classified as macrohabitat generalists with the exception of fallfish (a fluvial specialist) and sea lamprey (anadromous). All fish collected are either tolerant or moderately tolerant of pollution. DFWELE also conducted backpack electrofishing in Boston Brook near Liberty Street in Middleton in July 2002. A total of 93 fish (10 species) were identified. Three additional species, two of which are fluvial dependant/specialists (white sucker and creek chubsucker), were collected in 2002 (Richards 2003).

Chemistry – water

In 1995 DWM conducted limited water quality sampling at one station in Boston Brook near Liberty Street, Middleton (Station BO01) (Appendix B, Table B3 and B4).

Although the RBP III analysis indicated that the benthic community was moderately impacted and the fish community is dominated by macrohabitat generalists (three fluvial dependant/specialist fish species were also present) it is the opinion of the DWM biologists that the conditions in Boston Brook are likely naturally occurring (biota may be responding to organic inputs from upstream wetlands and/or flow related stress) and, therefore, the *Aquatic Life Use* is assessed as support. This use, however, is identified with an Alert Status.

AESTHETICS

No objectionable odors, deposits, or oils were noted by DWM biologists during their survey in Boston Brook in July 2000 (Appendix D and MA DEP 2000a). The water column was described as tea-stained and slight turbidity was observed.

Based primarily on the observations of the DWM biologists the *Aesthetics Use* is assessed as support.

Boston Brook (MA92-13) Use Summary Table

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

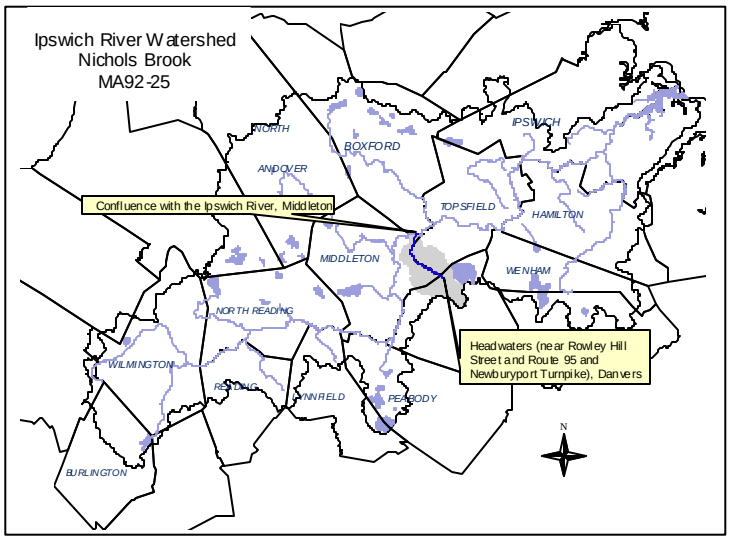
* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS BOSTON BROOK (MA92-13)

- Document the frequency, duration, and extent of low/no flow conditions in Boston Brook.
- Evaluate the outlet control practices at Creighton, Lower Boston Brook, Salem Street, Towne Street, and Upper Boston Brook ponds to determine if current operations are negatively impacting streamflow in Boston Brook. To the extent possible, operate the outlet control structures to mimic natural flow regimes.
- Investigate the potential to remove the old mill dam (Curtis Pond Dam) to improve river habitat and remove a barrier to anadromous fish passage.
- Conduct *in-situ* monitoring for dissolved oxygen/saturation to determine the frequency and duration of low dissolved oxygen in the brook and to what extent it is related to natural conditions and/or reduced baseflow and to assess the status of the *Aquatic Life Use*.
- Evaluate potential nonpoint sources of pollution that may contribute to instream turbidity in Boston Brook.
- Review Morton International Inc. (MAR05C044) and Laidlaw Transit (MAR05C353) SWPPPs. Evaluate the quality of their SWPPPs, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from the facilities.
- Monitor bacteria levels to document effectiveness of bacteria source reduction activities including treatment of stormwater discharges and the Phase II community stormwater management programs and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.

NICHOLS BROOK (SEGMENT MA92-25)

Location: Headwaters (near Rowley Hill Street and Route 95 and Newburyport Turnpike) in Danvers to confluence with the Ipswich River, Middleton.
Segment Length: 2.5 miles
Classification: Class B.



The drainage area of this segment is approximately 3.1 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 38%
Residential 20%
Open Land 13%

Nichols Brook drains a small area in Danvers and flows in a northwesterly direction forming the boundary between Middleton and Topsfield and joins the Ipswich River in Middleton.

WMA WATER WITHDRAWAL SUMMARY (APPENDIX H, TABLE H4)

Facility Name Registration Permit	Authorized Withdrawal (MGD)	Reported Actual Use (MGD)				
		1998	1999	2000	2001	2002
The Flatley Co.-Ferncroft C. C. 31721001 no permit	0.12	0.1	0.12	Not available	0.12	0.08

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLE H3)

Danvers, Middleton, and Topsfield are Phase II Stormwater communities. These communities were issued stormwater general permits from EPA and MA DEP in 2003/2004, and are authorized to discharge stormwater from the municipal drainage systems (MAR041188, MAR041211, and MAR041227). Over the five-year permit term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from the storm sewer systems to protect water quality (Domizio 2004).

USE ASSESSMENT

There are no data available so all uses are currently not assessed for Nichols Brook.

Nichols Brook (MA92-25) Use Summary Table

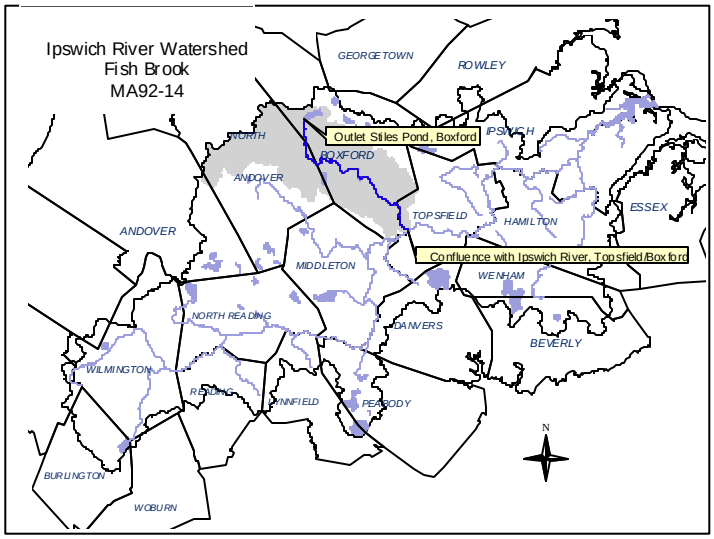
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
				
NOT ASSESSED				

RECOMMENDATIONS NICHOLS BROOK (SEGMENT MA92-25)

- The Flatley Co.-Ferncroft Country Club should use best management practices to minimize any potential impacts to Nichols Brook in their use of fertilizers, pesticides, and herbicides.
- Continue to monitor the Flatley Co. – Ferncroft C.C.'s compliance with WMA registration/permit limits.
- Monitor bacteria levels to document effectiveness of bacteria source reduction activities including treatment of stormwater discharges and the Phase II community stormwater management program and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.
- A monitoring plan should be developed and conducted to generate data that can be used to evaluate the status of the *Aquatic Life Use*.

FISH BROOK (SEGMENT MA92-14)

Location: Outlet Stiles Pond, Boxford to confluence with Ipswich River, Topsfield/Boxford.
Segment Length: 8.2 miles
Classification: Class B.



The drainage area of this segment is approximately 18.1 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 61%
Residential 27%
Agriculture..... 4%

From the outlet of Stiles Pond in Boxford Fish Brook flows in a southerly direction and picks up drainage from Mosquito Brook and a large wetland area in North Andover. Fish Brook then turns slightly and flows in a meandering easterly direction through Howes Pond in Boxford after which it turns in a southeasterly direction towards its confluence with the Ipswich River. Fish Brook forms the boundary between Boxford and Topsfield as it flows into the Ipswich River.

The use assessments for Howes Pond (MA92026), Kimballs Pond (MA92027), Stiles Pond (MA92063), and Towne Pond (MA92068) are in the Lake Assessment section of this report.

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLES H2 AND H3)

Based on the available information there are no WMA regulated water withdrawals in this subwatershed.

The Shipley Company, LLC in North Andover has a general permit (MAR05C390) that allows them to discharge stormwater to this subwatershed (Appendix H, Table H2). The general permit was issued by the EPA in October 2001 and will expire in October 2005.

North Andover, Boxford, and Topsfield are Phase II Stormwater communities. These communities were issued stormwater general permits from EPA and MA DEP in 2003/2004, and are authorized to discharge stormwater from the municipal drainage systems (MAR041214, MAR041184, and MAR041227, respectively). Over the five-year permit term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Fish Brook was sampled by DWM approximately 350m upstream from Middletown Road, Boxford (Station FB00) in July 2000. At the time of the survey the river was roughly 4 m wide with depths of 0.25 – 0.5 m in the riffles and runs and 0.5 m in the pools. The substrates were comprised primarily of cobble and pebble. Mosses and rooted emergent macrophytes provided instream cover. A thin film of algae was also noted (cover estimated as <5%). The reach was approximately 50% shaded. The overall habitat score was 182 (Appendix D and MA DEP 2000a). This was the designated regional reference station by virtue of its good habitat evaluation score, presumed good water quality, and minimal upstream/near-stream land use impacts (i.e., absence of point source inputs, lack of channelization, minimal development or agricultural activity nearby, undisturbed and well-vegetated riparian zone, and minimal NPS inputs).

DFWELE sampled three reaches along Fish Brook in July 1999. From upstream to downstream these include; downstream from Lost Pond Road (and Mosquito Brook), North Andover, downstream from Lockwood Lane, Boxford, and upstream of Washington Street, Topsfield (Armstrong *et al.* 2001).

The channel type was described as a riffle/glide with sand, gravel cobble, boulder substrates at the most upstream reach to a riffle/run channel type with cobble, gravel, boulder, sand substrates at the middle reach to a glide/run channel type with sand, gravel, cobble, FPOM substrates at the most downstream reach. Physical habitat was comprised primarily of boulder and overhanging vegetation at the upstream sampling reach; boulder/cobble in the middle reach; and boulder/cobble, overhanging vegetation, and riprap at the most downstream sampling reach. All three reaches sampled had a closed canopy. The riparian vegetation was dominated by upland forest/shrub at the most upstream reach, upland forest in the middle reach, and upland shrub/herbaceous vegetation on the left bank and upland forest on the right bank at the most downstream sampling reach. The RBP habitat assessment scores ranged from 144 to 161 (out of 200). The downstream station receiving the lowest of the scores primarily as a result of sediment deposition and a reduced riparian zone (Armstrong *et al.* 2001).

Biology

Fish Brook was sampled by DWM biologists in July 2000 (Appendix D). This brook was designated as the reference station and the macroinvertebrate assemblage indicated a healthy aquatic community. This brook was also sampled by DWM in July 1995 (Appendix E).

Fish community sampling was conducted by DFWELE in July 1999 (Armstrong *et al.* 2001). A total of 444 fish (16 species) were collected in Fish Brook. Dominant fish species at the most upstream sampling reach included: redfin pickerel, golden shiner, pumpkinseed, chain pickerel, and creek chubsucker while American eel, banded sunfish, bluegill and swamp darter were also present (a total of 139 fish represented by nine species). In the middle reach American eel and fallfish dominated the sample while sea lamprey, chain pickerel, green sunfish, brook trout (*Salvelinus fontinalis*), pumpkinseed and a yellow perch were also present (a total of 133 fish represented by eight species). At the most downstream sampling reach fallfish and American eel dominated the sample while chain pickerel; green sunfish; redfin pickerel; and an individual each of brown trout (*Salmo trutta*), pumpkinseed, sea lamprey, and white sucker were also present (a total of 172 fish represented by nine species). Five species collected from Fish Brook – brook trout, brown trout, creek chubsucker, white sucker, and fallfish are classified as fluvial dependants/specialists. Bridle shiner (*Notropis bifrenatus*) have been collected during research by New England Aquarium, but they were not collected by DWFELE during these surveys (Tomczyk 2003). Fish community sampling was also conducted by DFWELE in Fish Brook just downstream from Mill Road in Boxford with backpack electrofishing equipment in July 2002. A total of 46 fish (seven species) were collected. The dominant species was pumpkinseed followed by American eel; redfin pickerel; redbreast sunfish; and an individual each of brown bullhead, banded sunfish and bluegill (Richards 2003).

Chemistry – water

In 1995 DWM conducted limited water quality sampling at two stations in Fish Brook; near Washington and Endicott Streets, Topsfield/Boxford (station FB01) and near Lockwood Lane, Boxford (Station FB02). Limited water quality sampling was also conducted on an unnamed tributary to Fish Brook at Middleton Road, Boxford (Station FB03) (Appendix B, Tables B3 and B4).

Through the IRWA's RiverWatch Volunteer Monitoring Program (RiverWatch) water quality monitoring has also been conducted at three sites in Fish Brook (stations FB-BV at Brookview Road in Boxford, FB-MI at Middleton Road in Boxford and FB-WA at Washington Street in Boxford/Topsfield). Sampling has been conducted at the most upstream location since 1997 and the downstream two stations since 1999 (IRWA 2000a).

It should also be noted that as part of the IPSWATCH Project funded by the EPA EMPACT Program the University of New Hampshire (UNH) deployed a YSI meter in Fish Brook near Middleton Road in Boxford. Between June and December 2001 and March and December 2002 measurements of DO, temperature, pH and conductivity were taken every 15 minutes when the meters were deployed (Lantagne 2002 and UNH 2003). These data, however, are not summarized below because quality assurance/quality control information were not available to the MA DEP.

DO

None of the DO readings documented by RiverWatch in the summer of 1999 at their sampling locations were below 5 mg/L (IRWA 2000b). It should be noted that the brook was nearly dry on the 25 July 1999 sampling date. In the summers of 2000 and 2001 the DO was slightly low on two occasions. The brook was dry on the September and October 2001 sampling dates at the most upstream sampling location (FB-BV), but no low DO's were documented at either of the two downstream locations (IRWA 2001 and 2002).

Temperature

No temperatures measured by RiverWatch were above 28.3°C (IRWA 2000b, 2001, and 2002).

The *Aquatic Life Use* is assessed as support for Fish Brook based primarily on the benthic macroinvertebrate community (selected as the reference condition). The fish community includes five fluvial specialist/dependants, but two of these species (brook and brown trout) appear to be stocked fish and two others (creek chubsucker and white sucker) were represented by only 14 individual fish. In addition, other than the two stocked trout, all fish collected are classified as tolerant or moderately tolerant to increased temperature, habitat alteration, and/or low dissolved oxygen. Therefore, the *Aquatic Life Use* is also identified with an Alert Status.

AESTHETICS

No objectionable odors, deposits, or oils were noted by DWM biologists during their survey in Fish Brook in July 2000 or the RiverWatch volunteers (Appendix D, MA DEP 2000a, and IRWA 2000b). The water column was described as tea-stained and slight turbidity by both sampling groups.

The *Aesthetics Use* is assessed as support based on field observations by DWM biologists and the RiverWatch volunteers.

Fish Brook (MA92-14) Use Summary Table

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

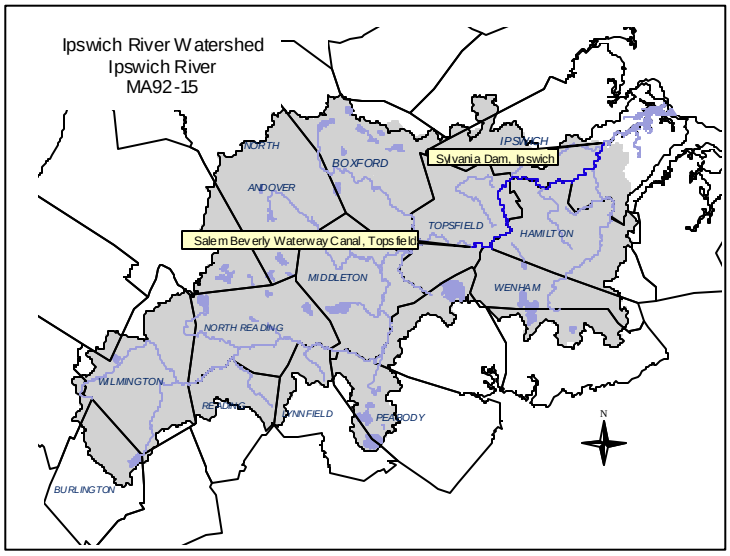
* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS FISH BROOK (MA92-14)

- Document the frequency, duration, and extent of low/no flow conditions in Fish Brook.
- Evaluate the outlet control practices at Stiles, Howes, Kimballs, and Towne ponds to determine if current operations are negatively impacting streamflow in Fish Brook. To the extent possible, operate the outlet control structures to mimic natural flow regimes.
- Conduct *in-situ* monitoring for dissolved oxygen/saturation to determine the frequency and duration of low dissolved oxygen in the brook and to what extent it is related to natural conditions and/or reduced baseflow to better assess the status of the *Aquatic Life Use*.
- Evaluate potential nonpoint sources of pollution that may contribute to instream turbidity in Fish Brook.
- Monitor bacteria levels to document effectiveness of bacteria source reduction activities including treatment of stormwater discharges and the Phase II community stormwater management programs and utilize these data to assess the status of the *Primary* and *Secondary Contact Recreational* uses.
- Adequate buffer zones associated with new home construction in this subwatershed should be maintained to protect water and habitat quality and biological potential in Fish Brook (Appendix D).
- Review the Shipley Company LLC (MAR05C390) SWPPP. Evaluate the quality of their SWPPP, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from the facility.

IPSWICH RIVER (SEGMENT MA92-15)

Location: Salem Beverly Waterway Canal, Topsfield to the Ipswich Dam (formerly known as the Sylvania Dam), Ipswich.
Segment Length: 11.0 miles
Classification: Class B, Warm Water Fishery, High Quality Water.



The drainage area of this segment is approximately 150 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 50%
Residential 28%
Agriculture..... 6%

As the meandering journey of the Ipswich again turns north the rate of flow is so slow and the surface of the stream so level with the surrounding wetlands that several rather large backwater ponds are formed adjacent to the main "channel". As the Ipswich flows northward it is joined in order by Idlewild and Mile Brooks, an unnamed tributary, Howlett Brook and Gravelly Brook. The stream channel widens considerably and the Ipswich begins to flow at a higher velocity in the northeasterly direction, which will carry it into Ipswich Bay. The channel widens further as the river enters the impoundment created by the Willowdale "Dam", which was constructed in 1829 (Foote Brothers 2003). A small, concrete weir dam is located just downstream from the Willowdale Dam. This is the location of the second USGS flow gage on the mainstem Ipswich (station 01102000 near Ipswich, MA). The drainage area at this gage is 125 mi^2 and the average annual discharge is 187 cfs. Downstream from the USGS gage the Ipswich is joined by Black Brook and the Miles River. The most noticeable vertical fall in the Ipswich River occurs in the stretch between the Willowdale Dam and the Miles River, where there are riffles in the stream. The river slows as it enters the impoundment created by the Ipswich Dam (formerly known as the Sylvania Dam), located in the central village of Ipswich.

A mixed-use development project (including a championship style golf course, hotel, restaurant, conference center, residential and corporate office buildings) of the Turner Hill estate is currently underway near a portion of this segment of the Ipswich River in Ipswich.

The use assessment for Putnamville Reservoir (MA92052) can be found in the Lake Assessment section of this report.

This segment is on the 1998 303(d) List of Waters, needing confirmation, for organic enrichment/low DO and flow alteration (Table 3).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX H, TABLE H4)

Facility Name Registration Permit	Authorized Withdrawal (MGD)	Reported Actual Use (MGD)				
		1998	1999	2000	2001	2002
Ipswich Water Department 31714402 (no permit)	0.2*	0.39	0.39	0.2	0.24	0.27
Corliss Brothers, Inc. 31714401 (no permit)	0.22 (147 days)	0.04	0.05	0.05	0.05	0.05
Salem & Beverly Water Supply Board 31725801 9P31725801	9/1/1994 to 8/31/1999 10.17 (reg) 1.14 (per) 11.31 (total)*	10.05	10.3	10.19	10.66	10.60
	9/1/1999 to 5/18/2003 10.17 (reg) 1.70 (per) 11.87 (total)*					

Facility Name Registration Permit	Authorized Withdrawal (MGD)	Reported Actual Use (MGD)				
		1998	1999	2000	2001	2002
Hamilton Water Department 31711901 9P31711901	5/7/1997 to 8/31/1999 0.92 (reg) 0.11 (per) 1.03 (total)*	0.64	0.66	0.5	0.69	0.57
	9/1/1999 to 5/18/2003 0.92 (reg) 0.19 (per) 1.11 (total)*					

*Indicates system-wide withdrawal; all sources not necessarily within this segment

The Salem & Beverly Water Supply Board diverts water from the Ipswich River in Topsfield. Water is pumped to Wenham Lake. Water from Wenham Lake is also diverted to Longham Reservoir and Putnamville Reservoir for additional storage. Water is also collected from the surrounding watersheds of these three reservoirs. All water ultimately is distributed from Wenham Lake after treatment. Under their permit, issued 5 February 1991, the Salem & Beverly Water Supply Board is allowed to withdraw water from the Ipswich River between 1 December and 31 May when streamflow at the USGS Ipswich Gauge Station #01102000 exceeds 28 MGD. However, the permit was modified on 19 May 2003 to reflect new streamflow limitations. Salem & Beverly is authorized under the modified permit to withdraw water from June 1 through October 30 when streamflow at the Ipswich gauge is >381 cfs (246 MGD) and from November 1 through May 31 when streamflow is >125 cfs (80 MGD). However, since the modified permit was appealed the previous permit remains in effect pending a decision on the appeal.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLES H1 AND H3)

Turner Hill Preservation Associates, LLC, Ipswich (transferred from Missionaries of La Salette) is permitted (MA0021661 issued November 2002) to discharge 0.01 MGD of treatment plant effluent via outfall 001 to a wetland tributary of the Ipswich River. The whole effluent toxicity limits (monitoring frequency of 2 times per year) are $LC_{50} \geq 100\%$ and CNOEC ≥ monitor only using *Ceriodaphnia dubia* (daphnid). According to their NPDES reapplication, the facility now utilizes ultraviolet light for disinfection (use of chlorine discontinued in 1996). A new treatment system has been constructed and when functioning (expected in the spring of 2005) the discharge will go to groundwater (Tomaszewski 2004).

Beverly, Hamilton, Ipswich, Topsfield and Wenham are Phase II Stormwater communities. These communities were issued stormwater general permits from EPA and MA DEP in 2003, and are authorized to discharge stormwater from the municipal drainage systems (MAR041181, MAR041196, MAR041199, MAR041227, and MAR041230, respectively). Over the five-year permit term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

There are three municipal water suppliers and one agricultural user with WMA permits and/or registrations along this segment of the Ipswich River. From upstream to downstream these WMA suppliers, number of sources, average use, and wastewater discharge location is summarized in Table 7.

Table 7. WMA registered and/or permitted suppliers along the Ipswich River between the Salem Beverly Waterway Canal, Topsfield and the Ipswich Dam, Ipswich and the location of wastewater discharges.

Facility Name Registration Permit	Number of sources in Segment MA92-15	Average Use 1998 – 2002 (MGD)	% of town population sewered	Wastewater discharge location
Salem & Beverly Water Supply Board 31725801 9P31725801	2	10.36	Beverly - 100%. Salem is in the North Coastal Watershed	South Essex Sewerage District discharged to Salem Harbor in North Coastal Watershed

Facility Name Registration Permit	Number of sources in Segment MA92-15	Average Use 1998 – 2002 (MGD)	% of town population sewered	Wastewater discharge location
Hamilton Water Department 31711901 9P31711901	1	0.61	0	On-site septic systems
Ipswich Water Department 31714402 no permit	3	0.3	33% (proposed expansion to an additional 20%)	Ipswich Wastewater Treatment Plant discharge to "Greenwood Creek"
Corliss Brothers, Inc. 31714401	1	0.05	Not applicable (garden center)	

Under their permit, issued 5 February 1991, the Salem & Beverly Water Supply Board is allowed to withdraw water from the Ipswich River between 1 December and 31 May when streamflow at the USGS Ipswich Gauge Station #01102000 exceeds 28 MGD. The recent USGS modeling results of flow conditions in the Ipswich River determined that "surface water withdrawals have little effect on the duration and frequency of low-flows, but the cumulative groundwater withdrawals substantially decrease low-flows" (Zarriello and Ries 2000). However, the effects of all water withdrawals (both surface and groundwater) and the export of wastewater via sewering (Table 7) contribute to the alteration of the river's natural hydrograph.

The Ipswich River Fisheries Restoration Task Group recommended certain conditions (e.g., flow over the riffles, water to the channel margins, and seasonal variations in flows that closely approximates a natural hydropgraph) be maintained in order to restore the Ipswich River's aquatic habitat and fisheries. Their current recommendations are for 0.49 cfsm between June to October, 1.0 cfsm between November and February, and 2.5 cfsm between March and May (Task Group 2002). An analysis of the USGS water year records indicate that the Ipswich River was frequently below the Task Group's recommended flows throughout the entire year (Table 8). USGS also conducted a simulation model for the predicted impact of the Task Group's recommended flows on the municipal surface water supply systems (Appendix I, 104(b) project 97-07). It should be noted that during the last five years (1998 to 2002) two major droughts were recorded; the summer of 1999 and the fall/winter/spring of 2001/2002. In the 1998 'water year' (reported by USGS from October to September) runoff was above normal in eastern Massachusetts and no droughts were reported (Socolow *et al*. 1999). Runoff was generally below normal in the 1999 water year when drought conditions were recorded between June and early September in eastern MA. New low-flows were recorded in the Ipswich River in June and August at the South Middleton gage and at the Ipswich gage in May (Socolow *et al*. 2000). This drought was broken with tropical storm Floyd in mid-September. In 2000 runoff was normal with no floods or droughts recorded (Socolow *et al*. 2001). Runoff was also generally normal in 2001 with the exception of a flood event in March (Socolow *et al*. 2002). Extremely low flows in the late fall, winter and spring of 2001-2002 were then documented (Socolow *et al*. 2003).

Table 8. Percentage of time (number of days) from June 1998 to May 2003 flows in the Ipswich River at the Ipswich gage were below the Ipswich River Fisheries Restoration Task Group recommended flows to restore the Ipswich River's aquatic habitat and fisheries.

Recommended Flow	June 1998 to May 1999	June 1999 to May 2000	June 2000 to May 2001	June 2001 to May 2002	June 2002 to May 2003
June to October 61cfs (153 days in time period)	38% (58)	75% (115)	44% (67)	63% (96)	72% (88*)
November to February ** 125 cfs (120 days in time period)	64% (77)	71% (85)	38% (45)	100% (120)	Not available
March to May ** 312.5 cfs (92 days in time period)	68% (63)	42% (39)	59% (54)	88% (81)	Not available

* represents June to September 2002 (a total of 122 days); data for October not yet available

**Provisional recommendations of the Ipswich River Fisheries Restoration Task Group. The monthly median flows at the Ipswich gage for the period of record 1939 to 1997 from November to May is as follows: November 101.3 cfs (0.81 cfsm), December 180.8 cfs (1.45 cfsm), January 180.8 cfs (1.45 csfm), February cfs 220.6 (1.76 cfsm), March cfs 379 (3.03 cfsm), April cfs 357.1 (2.86 cfsm), and May 215.5 cfs (1.72 cfsm) (Task Group 2002).

DMF conducted a survey of anadromous fish passage (focus on river herring) in the Ipswich River in 2001 (Reback *et al*. in preparation). The survey found significant potential for anadromous fish restoration based on the large amount of suitable river spawning habitat for blueback herring (*Alosa aestivalis*) and American shad (*Alosa sapidissima*). The report identifies the Willowdale Dam as the next obstruction upstream of the Ipswich Mills Dam that could be modified or removed to improve fish passage. The Willowdale Dam fish ladder is old and less than optimal, but still functional (Reback *et al*. in preparation). The survey evaluated all state fishways and classified the Willowdale fishway's *condition* as poor and *function* as providing inefficient passage. The report also acknowledges that the seasonal loss of river flow due to watershed withdrawals is a critical issue that must be addressed before the depleted status of anadromous fish can be improved (Reback *et al*. in preparation). A modest river herring population exists in the Ipswich River and has been supported by recent restoration efforts. The fish ladder at the Ipswich Dam was replaced in 1995 with a modern Denil design and DMF stocked approximately 31 thousand blueback herring in the Ipswich River from 1990 to 2002. Despite these efforts the numbers of returning adult river herring have shown little improvement. Massachusetts DMF is currently evaluating the potential causes for poor recruitment from the stocked herring and natural production (Chase 2003b). Willowdale Dam flows can be regulated by placing boards on the top of the dam to pond water up for canoeing. Flows can also be regulated by boards in the fishway on the side of the dam. Most flow spills over the dam (Chase 2003a).

DFWELE sampled five reaches along this segment of the Ipswich River in September 1998. From upstream to downstream these were: Ipswich River Wildlife Sanctuary canoe launch, Topsfield; downstream from the Willowdale Dam; Ipswich gage upstream of Winthrop Street, Ipswich/Hamilton; Winthrop Road downstream from a private bridge, Topsfield; upstream of Mill Street at a riffle Hamilton/Ipswich; and downstream of Mill Road, Ipswich/Hamilton (Armstrong *et al.* 2001).

- At the Ipswich River Wildlife Sanctuary reach the channel type was described as a glide with sand and FPOM substrates. Physical habitat was comprised of large woody debris, exposed roots, undercut banks, and overhanging vegetation. Riparian vegetation was dominated by wetland forest/shrub and wetland shrub/emergent. This reach had a partial canopy. The RBP habitat assessment score was 171 out of 200.
- Downstream fro, the Willowdale Dam the channel type was described as a riffle with cobble, gravel, sand and boulder substrates. Physical habitat was comprised of boulder/cobble, large woody debris, exposed roots, and undercut banks. Riparian vegetation was dominated by upland forest. The reach had both open/closed canopy. The RBP habitat assessment score was 156 out of 200. The score was less than optimally because of channel alteration, channel flow status, and the velocity depth regime/lack of riffle zones.
- At Winthrop Street, downstream from a private bridge, the channel type was described as a run.
- Upstream of Mill Road the channel type was described as a riffle with cobble, gravel, boulder, and sand substrates. Physical habitat was comprised of boulder/cobble, large woody debris, submerged vegetation, and overhanging vegetation. Riparian vegetation was dominated by upland forest and upland shrub. This reach had a partial canopy. The RBP habitat assessment score was 163 out of 200 due to channel alteration and lack of riffles.
- Downstream from Mill Road the channel type was described as a riffle with cobble, boulder, gravel, and sand substrates. Physical habitat was comprised of boulder/cobble, large woody debris, moss, submerged vegetation, and overhanging vegetation. Riparian vegetation was dominated by upland forest. This reach had a partial canopy. The RBP habitat assessment score was 173 out of 200 due to channel alteration and channel flow status. This riffle is the largest on the mainstem and has historically housed a crib dam and two mills. There is a canal on the left bank that is partially blocked with brush. On the right bank a canal, in poor condition, conveys flows that seeps through the foundation of the old mill. During low flow conditions (which were documented during this study) flow is split between the main channel and canal. During extreme low flows almost all of the streamflow is in the canal and substrates of the main channel are exposed. This site has been altered and possibly widened.

Biology

Fish community sampling was conducted by DFWELE in September 1998 along five reaches (Armstrong *et al.* 2001). A total of 950 fish were collected from this segment of the Ipswich River.

- In the Audubon reach 224 fish (nine species) were collected. Dominant species included: redfin pickerel, American eel, and chain pickerel while bluegill, pumpkinseed, redbreast sunfish, creek chubsucker, banded sunfish, and yellow bullhead were also present.
- Downstream from the Willowdale Dam 232 fish were collected (14 species). American eel, redbreast sunfish, pumpkinseed, yellow bullhead, and redfin pickerel dominated the sample while sea lamprey, brown trout, creek chubsucker, white sucker, fallfish, yellow perch, banded sunfish, largemouth bass, and swamp darter were also present.
- At Winthrop Road, downstream from a private bridge, 63 fish were collected (eight species). American eel, redbreasted sunfish, and pumpkinseed dominated the sample. Also present were: bluegill, redfin pickerel, yellow bullhead, and sea lamprey.
- A total of 262 fish were collected upstream of Mill Road at the riffle. Twelve species were represented. American eel, redbreast sunfish, pumpkinseed, and redfin pickerel dominated the sample. Creek chubsucker, chain pickerel, sea lamprey, yellow bullhead, bluegill, and yellow perch were also present.
- Downstream from Mill Road 169 fish were collected and 11 species were present. American eel and redbreast sunfish dominated the sample. Redfin pickerel, chain pickerel, sea lamprey, brown trout, creek chubsucker, fallfish, white sucker, banded sunfish, and rainbow trout (*Oncorhynchus mykiss*) were also present.

Although six fluvial dependent/specialist species were present two species (brown and rainbow trout) were most likely stocked by the Division of Fisheries and Wildlife. The fish community was dominated by macrohabitat generalists (97% of the fish collected). Overall the number of fluvial species was low. It should be noted that this survey classified American eel, a catadromous fish, as a macrohabitat generalist due to the wide range of habitats occupied during the freshwater portion of its life cycle.

Toxicity

Effluent

Nine modified acute and chronic whole effluent toxicity tests were conducted on the Turner Hill Preservation Associates discharge using *C. dubia* between April 1998 and November 2001. Whole effluent LC_{50} results were all ≥ 100% effluent in the eight valid tests. The CNOEC results ranged between <6.26 to 100% effluent.

Chemistry – water

In 1995 DWM conducted water quality sampling at two stations on this segment of the Ipswich River; off Topsfield Road, Ipswich (Station IP15.5) and downstream from Willowdale Dam at Topsfield Road, Ipswich (station IP16) (Appendix B, Tables B3 and B4).

Through the IRWA's RiverWatch Volunteer Monitoring Program (RiverWatch) water quality monitoring has also been conducted at five stations along this segment of the Ipswich River; near the Canoe Launch in Topsfield (Station IP16), near Asbury Road Bridge in Ipswich (Station IP18), near Foote Brothers Canoe in Ipswich (Station IP19), at the Winthrop Street Bridge in Ipswich (Station IP20), and near Mill Street Bridge in Ipswich (Station IP22). Sampling has been conducted at these locations since 1997 (IRWA 2000a).

DO

At the two most upstream stations occasionally low DOs were documented by RiverWatch in the summers of 1999, 2000, and 2001 but DOs were generally not less than 5.0 mg/L at the three downstream sampling stations (IRWA 2000b, 2001, and 2002).

Temperature

No temperatures measured by RiverWatch were above 28.3°C (IRWA 2000b, 2001, and 2002).

The *Aquatic Life Use* is assessed as impaired for this segment of the Ipswich River based primarily on the fish community (dominated by macrohabitat generalists) and best professional judgment. Flow

manipulation associated with water withdrawals are suspected causes of impairment. Naturally occurring conditions associated with the wetland nature of the system and the presence of the two impoundments may also exacerbate stress on the biota.

PRIMARY AND SECONDARY CONTACT RECREATION

No recent quality assured bacteria data are available so the recreational uses are not assessed. DWM did conduct limited bacteria sampling in this segment of the Ipswich River in 1995 at two stations; off Topsfield Road, Ipswich (Station IP15.5) and downstream from Willowdale Dam at Topsfield Road, Ipswich (station IP16) (Appendix B, Table B4).

AESTHETICS

Although no objectionable odors or other conditions were noted by the RiverWatch volunteer samplers, too limited data are available so the *Aesthetics Use* is not assessed.

Ipswich River (MA92-15) Use Summary Table

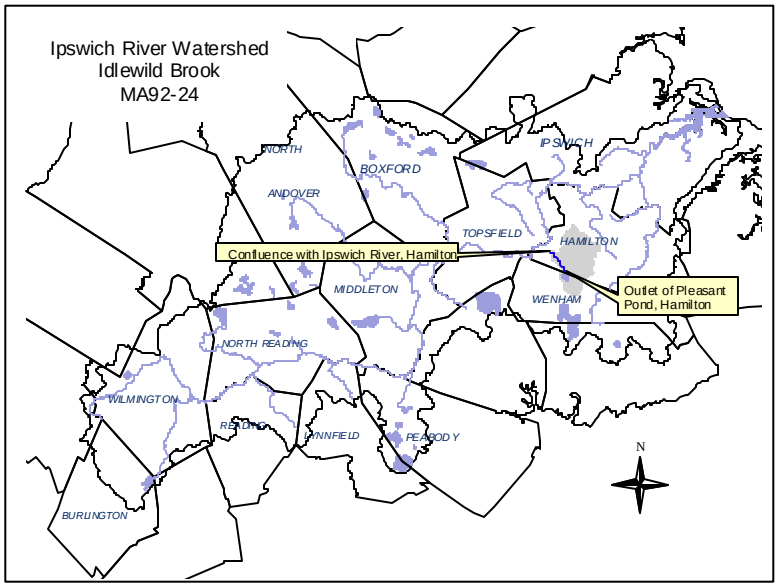
Designated Uses		Status
Aquatic Life		IMPAIRED Cause: Combined biota/habitat bioassessments (Suspected Cause: Low flow alterations) Source: Unknown (Suspected Source: Baseflow depletion from groundwater withdrawals)
Fish Consumption		NOT ASSESSED
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		NOT ASSESSED

RECOMMENDATIONS IPSWICH RIVER (MA92-15)

- Biological and habitat quality monitoring should continue to be conducted in this segment of the Ipswich River to evaluate the status of the *Aquatic Life Use* and to determine the effects, if any, resulting from improved flows in the Ipswich River by reducing/optimizing groundwater withdrawals/water use. Continue to periodically evaluate fish community data against the target fish community developed by the Ipswich River Fisheries Restoration Task Force http://www.ipswichriver.org/FishRestReportA.pdf).
- *In-situ* monitoring for dissolved oxygen/saturation should be conducted to determine the frequency and duration of low DO in the river, determine to what extent low DOs are is related to reduced baseflow resulting from water withdrawals and/or natural conditions, and to better assess the status of the *Aquatic Life Use*.
- Monitor bacteria levels to document the effectiveness of bacteria source reduction activities, including treatment of stormwater discharges, sewering, and the Phase II community stormwater management programs and to assess the status of the *Primary* and *Secondary Contact Recreational* uses.
- Review and implement recommendations in the DMF anadromous fish assessment report for improving effectiveness of fish passage in this segment.
- Continue to monitor compliance with WMA registration/permit limits and other special conditions of the permits.

IDLEWILD BROOK (SEGMENT MA92-24)

Location: Outlet of Pleasant Pond, Hamilton to confluence with Ipswich River, Hamilton.
Segment Length: 0.8 miles
Classification: Class B.



The drainage area of this segment is approximately 2.1 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 50%
Residential 35%
Agriculture..... 9%

Idlewild Brook flows from the outlet of Pleasant Pond in Wenham/Hamilton through a portion of Wenham Swamp to its confluence with the Ipswich River in Hamilton.

The use assessment for Pleasant Pond (MA92049) is in the Lake Assessment section of this report.

WMA WATER WITHDRAWAL SUMMARY (APPENDIX H, TABLE H4)

Facility Name Registration Permit	Authorized Withdrawal (MGD)	Reported Actual Use (MGD)				
		1998	1999	2000	2001	2002
Hamilton Water Department 31711901 9P31711901	5/7/1997 to 8/31/1999 0.92 (reg) 0.11 (per) 1.03 (total)*	0.64	0.66	0.5	0.69	0.57
	9/1/1999 to 5/18/2003 0.92 (reg) 0.19 (per) 1.11 (total)*					
Wenham Water Department 31732001 9P231732001	5/7/1997 to 8/31/1999 0.29 (reg) 0.10 (per) 0.39 (total)	0.37	0.39	0.34	0.40	0.37
	9/1/1999 to 5/18/2003 0.29 (reg) 0.11 (per) 0.40 (total)					

* Indicates system-wide withdrawal, all sources not necessarily within this segment.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLE H3)

Hamilton and Wenham are Phase II Stormwater communities. These communities were issued stormwater general permits from EPA and MA DEP in 2003/2004, and are authorized to discharge stormwater from the municipal drainage systems (MAR041196 and MAR041230, respectively). Over the five-year permit term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from their storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Although no current stream gaging data are available it should be noted that there are two WMA permittees within this subwatershed area – the Hamilton Water Department withdraws from four of their six wells and the Wenham Water Department withdraws from their two wells in this

subwatershed (Appendix H, Table H4). The withdrawal volume from the Hamilton Water Department between 1998 and 2002 averaged 0.61 MGD, while the Wenham Water Department averaged 0.37 MGD in the same period. Both Hamilton and Wenham (with the exception of one new development) are on septic systems (Felix 2002).

No recent water quality data are available so all uses for Idlewild Brook are not assessed. Although the *Aquatic Life Use* is not assessed habitat and water quality degradation resulting from streamflow depletion, especially during summer low flow periods, is of concern given the small drainage area (<10 square miles) and the water withdrawals, so the *Aquatic Life Use* is identified with an Alert Status.

Idlewild Brook (MA92-24) Use Summary Table

Aquatic Life*	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
				
NOT ASSESSED				

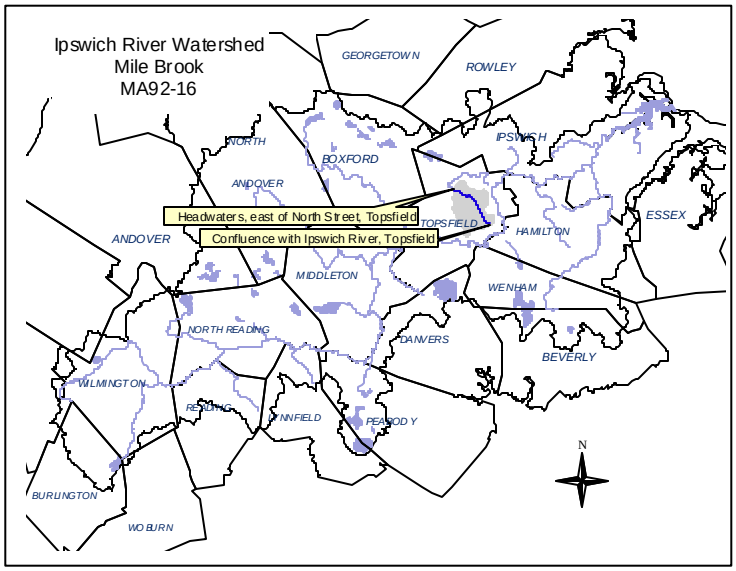
* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS IDLEWILD BROOK (MA92-24)

- *In-situ* monitoring for dissolved oxygen/saturation should be conducted to determine the frequency and duration of low dissolved oxygen in the brook, determine to what extent low DO is related to reduced baseflow resulting from water withdrawals and/or natural conditions, and to assess the status of the *Aquatic Life Use*.
- Evaluate outlet control practices at Pleasant Pond and determine if current operations are negatively impacting streamflow in Idlewild Brook. To the extent possible, releases at the dam should be optimized to mimic natural flow regimes.
- Monitor bacteria levels to document effectiveness of bacteria source reduction activities associated with the Phase II community stormwater management program and to evaluate the status of the *Primary* and *Secondary Contact Recreational* uses.
- Continue to monitor compliance with WMA registration/permit limits and other special conditions of the permits.
- Monitoring of streamflow should be conducted to evaluate the effects of water withdrawals and outlet control practices and to provide data to better assess the status of the *Aquatic Life Use*.

MILE BROOK (SEGMENT MA92-16)

Location: Headwaters, east of North Street, Topsfield to confluence with Ipswich River, Topsfield.
Segment Length: 2.1 miles.
Classification: Class B.



The drainage area of this segment is approximately 1.8 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 51%
Residential 30%
Wetlands.....13%

Mile Brook flows in a generally southeasterly direction from its headwaters just east of North Street, Topsfield through a wetland area and Waterfowl Pond to its confluence with the Ipswich River, Topsfield. The lower portion of Mile Brook flows through a portion of the Ipswich River Wildlife Sanctuary. Within the Mill house area of the sanctuary there is an old (1700's) earthen dam that was built to hold water in Mill Pond to serve a grist and/or saw mill (Decker 2004).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX H, TABLE H4)

Facility Name Registration Permit	Authorized Withdrawal (MGD)		Reported Actual Use (MGD)				
	9/1/1994 to 8/31/1999	9/1/1999 to 5/18/2003	1998	1999	2000	2001	2002
Topsfield Water Department 31729801 9P31729801	0.43 (reg) 0.17 (per) 0.60 (total)*	0.43 (reg) 0.23 (per) 0.66 (total)*	0.51	0.53	0.51	0.53	0.46

* Indicates system-wide withdrawal, all sources not necessarily within this segment.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLES H2 AND H3)

A permit was on file for the CYR Oil Company/Texaco Gas Station, Topsfield (MA0035912). In May 1998 EPA determined that no permit was required.

Boxford, Ipswich, Rowley, and Topsfield are Phase II Stormwater communities. These communities were issued stormwater general permits from EPA and MA DEP in 2003/2004, and are authorized to discharge stormwater from the municipal drainage systems (MAR041184, MAR041199, MAR041218, and MAR041227, respectively). Over the five-year permit term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Although no current stream gaging data are available it should be noted that there is one WMA permittee within this subwatershed area – the Topsfield Water Department withdrawals from one of their two wells along the brook (Appendix H, Table H4). The withdrawal volume from the Topsfield Water Department between 1998 and 2002 averaged 0.51 MGD. The Town of Topsfield is currently on septic systems and has no long-term sewering plans (Felix 2002).

There are no current water quality data so the *Aquatic Life Use* is not assessed for Mile Brook. Although the *Aquatic Life Use* is not assessed habitat and water quality degradation resulting from streamflow depletion, especially during summer low flow periods, is of concern given the small drainage area (<10 square miles), and the water withdrawals, so the *Aquatic Life Use* is identified with an Alert Status. IRWA also noted that Mile Brook was drawn down during heavy pumping of the wells (Mackin 2003).

PRIMARY AND SECONDARY CONTACT RECREATION

No recent quality assured bacteria data are available so the recreational uses are not assessed. DWM did conduct limited bacteria sampling in Mile Brook in 1995 at Brookside Street, Topsfield (Station MLB01) (Appendix B, Table B4).

Mile Brook (MA92-16) Use Summary Table

Aquatic Life*	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
				
NOT ASSESSED				

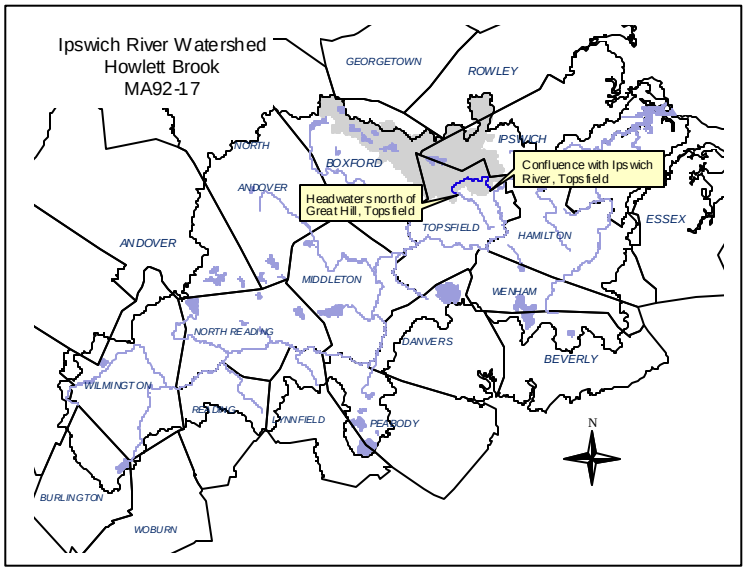
* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS MILE BROOK (MA92-16)

- *In-situ* monitoring for dissolved oxygen/saturation should be conducted to determine the frequency and duration of low dissolved oxygen in the brook, determine to what extent low DO is related to reduced baseflow resulting from water withdrawals and/or natural conditions, and to assess the status of the *Aquatic Life Use*.
- Evaluate outlet control practices at dams in this subwatershed and determine if current operations are negatively impacting streamflow in Mile Brook. To the extent possible, releases at the dam should be optimized to mimic natural flow regimes.
- Monitor bacteria levels to document effectiveness of bacteria source reduction activities associated with the Phase II community stormwater management program and to evaluate the status of the *Primary* and *Secondary Contact Recreational* uses.
- Continue to monitor Topsfield Water Department's compliance with WMA registration/permit limits and other special conditions of the permit.
- Monitoring of streamflow should be conducted to evaluate the effects of water withdrawals and outlet control practices and to provide data to better assess the status of the *Aquatic Life Use*.

HOWLETT BROOK (SEGMENT MA92-17)

Location: Headwaters north of Great Hill, Topsfield to confluence with Ipswich River, Topsfield.
Segment Length: 2.5 miles
Classification: Class B.



The drainage area of this segment is approximately 10.8 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 57%
Residential 29%
Wetlands..... 5%

From its headwaters north of Great Hill in Topsfield near the intersection of Ipswich Road and Newburyport Turnpike Howlett Brook flows in a northwesterly direction to a confluence with Pye Brook. Here the flow of Howlett Brook turns northeast and meanders to its confluence with the Ipswich River in Topsfield.

DFWELE has proposed that Howlett Brook be reclassified in the SWQS as a cold water fishery (MassWildlife 2001).

The use assessments for Fourmile Pond (MA92022), Hood Pond (MA92025), Lowe Pond (MA92034), Lower Fourmile Pond (MA92032), Spofford Pond (MA92060) and Stevens Pond (MA92062) are in the Lake Assessment section of this report.

This segment is on the 1998 303(d) List of Waters for pathogens (Table 3).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX H, TABLE H4)

Facility Name Registration Permit	Authorized Withdrawal (MGD)		Reported Actual Use (MGD)				
	9/1/1994 to 8/31/1999	9/1/1999 to 5/18/2003	1998	1999	2000	2001	2002
Topsfield Water Department 31729801 9P31729801	0.43 (reg) 0.17 (per) 0.60 (total)*	0.43 (reg) 0.23 (per) 0.66 (total)*	0.51	0.53	0.51	0.53	0.46

* Indicates system-wide withdrawal, all sources not necessarily within this segment.

The WMA Modified Permit dated 19 May 2003 (currently under appeal) for the Topsfield Water Department included monitoring adjacent to the Topsfield wells under Special Condition # 5-Wetlands Monitoring. "The Town has completed ten years of wetlands monitoring of the wetlands adjacent to the North Street wellfield. Based upon the [MA DEP's] review of the monitoring reports it appears that the reported wetness index has remained the same or is moving towards a slightly wetter condition, therefore the operation of the North Street well has not resulted in measurable impact to the wetlands adjacent to the North Street well during the period of record. As a result the [MA DEP] no longer requires monitoring of this wetland by the Town as a condition of this Modified Permit" (O'Keefe 2004).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLES H2 AND H3)

Bodycote in Ipswich has a general permit (MAR05B925) that allows them to discharge stormwater to this subwatershed (Table H2). This general permit was issued by the EPA in October 2001 and will expire in October 2005.

Rowley and Topsfield are Phase II Stormwater communities. These communities were issued stormwater general permits from EPA and MA DEP in 2003/2004, and are authorized to discharge stormwater from the municipal drainage systems (MAR041218 and MAR041227, respectively). Over the five-year permit

term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from their storm sewer systems to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Although no current stream gaging data are available it should be noted that there is one WMA permittee within this subwatershed area – the Topsfield Water Department withdrawals from one of their two wells along the brook (Appendix H, Table H4). The withdrawal volume from the Topsfield Water Department between 1998 and 2002 averaged 0.51 MGD. The Town of Topsfield is currently on septic systems and has no long-term sewering plans (Felix 2002).

DFWELE sampled two reaches along Howlett Brook in July 1999 upstream and downstream from Ipswich Road, Topsfield (Armstrong *et al.* 2001). The channel type upstream of the road was a riffle and downstream was a glide with gravel and cobble substrates in the riffle and sand, gravel, and CPOM in the glide. Upland forest and shrub dominated the riparian zone on the upstream side of the road, while downstream from the road wetland shrub/emergent vegetation was present. The canopy cover was closed upstream of the road and was partially open on the downstream side. Large woody debris and other instream habitat types dominated the upstream sampling reach. The RBP habitat assessment scores were 158 and 165 (out of 200); the downstream station receiving the higher of the scores. Channel flow status and limited velocity/depth combinations affected habitat quality in the brook (Armstrong *et al.* 2001).

Biology

Fish community sampling was conducted by DFWELE in July 1999 (Armstrong et al. 2001). A total of 220 fish (13 species) were collected in Howlett Brook. Dominant fish species at the upstream sampling reach (near East Street) included: redfin pickerel and American eel while white sucker, banded sunfish, sea lamprey and swamp darter were also present (a total of 77 fish represented by 6 species). In the lower sampling reach (the riffle reach) upstream of Ipswich Road largemouth bass and American eel dominated the sample, while chain pickerel; redbreast sunfish; brown bullhead; pumpkinseed, redfin pickerel, sea lamprey, and an individual each of banded sunfish, brook trout, and brown trout were also present (a total of 101 fish represented by 11 species). In the wetland reach, sampled downstream from Ipswich Road, redfin pickerel, American eel, and largemouth bass dominated the collection, while sea lamprey and one individual swamp darter were also present (a total of 42 fish represented by 5 species). Ninety-eight percent of the fish collected in Howlett Brook are classified as macrohabitat generalists. Fluvial dependents and fluvial specialists comprised only 2% of the sample.

DFWELE also conducted fish community sampling in Howlett Brook just upstream of East Street in Topsfield in July 2002. A total of 54 fish (six species) were collected and the sample was dominated by redfin pickerel. American eel, creek chubsucker, white sucker, golden shiner and a swamp darter were also collected (Richards 2003).

In July 1995 DWM biologists conducted benthic macroinvertebrate sampling in Howlett Brook 5 m upstream of Ipswich Road (Appendix E).

Chemistry – water

In 1995 DWM conducted water quality sampling at two stations in Howlett Brook; near North Street, Topsfield, just off Route 1 (Station HB01) and near Ipswich Road, Topsfield, (Station HB02) (Appendix B, Tables B3 and B4).

Through the IRWA's RiverWatch Volunteer Monitoring Program (RiverWatch) water quality monitoring has also been conducted in Howlett Brook near Ipswich Road, Topsfield (Station HB) since 1997 (IRWA 2000a).

DO

None of the DOs documented by RiverWatch in the summers of 1999 and 2000 at their sampling location were below 5 mg/L (IRWA 2000b and 2001).

Temperature

No temperatures measured by RiverWatch were above 28.3°C (IRWA 2000b, 2001, and 2002). Two measurements taken in June and August 1999 (a "dry" year) were greater than 20°C. Summertime measurements in 2000 (a "normal" year) (July and August) were as high as 20°C.

The *Aquatic Life Use* is assessed as impaired for Howlett Brook based primarily on the fish community data fish community (heavily dominated by macrohabitat generalists) and best professional judgment. Although the cause(s) of impairment are largely unknown the presence of numerous impoundments in the subwatershed may contribute to the dominance of macrohabitat generalists.

PRIMARY AND SECONDARY CONTACT RECREATION

No recent quality assured bacteria data are available so the recreational uses are not assessed. DWM did conduct limited bacteria sampling in Howlett Brook in 1995 at near North Street, Topsfield (Station HB01) and near Ipswich Road, Topsfield, (Station HB02) (Appendix B, Table B4).

Howlett Brook (MA92-17) Use Summary Table

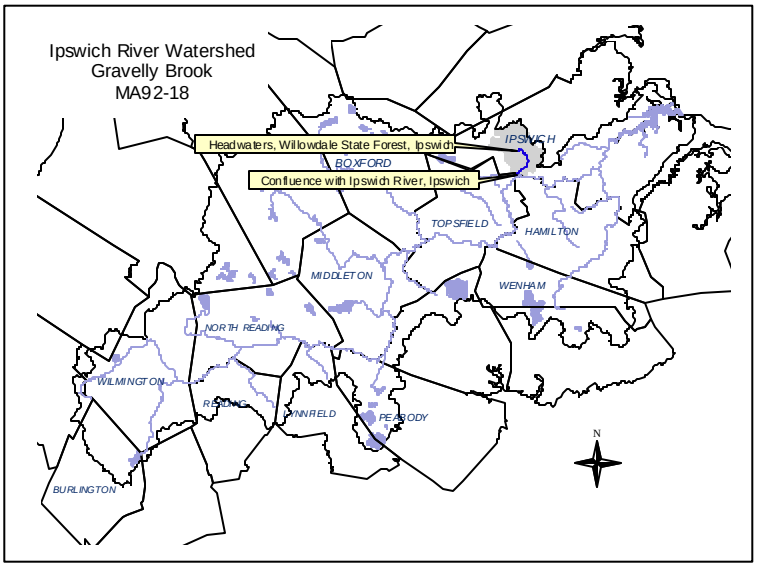
Designated Uses		Status
Aquatic Life		IMPAIRED Cause: Unknown, Fish bioassessment Source: Unknown (Suspected Source: Impacts from hydrostructure flow regulation/modification)
Fish Consumption		NOT ASSESSED
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		NOT ASSESSED

RECOMMENDATIONS HOWLETT BROOK (MA92-17)

- Although some data are available that show cold-water temperature criteria were occasionally exceeded, historic DFWELE records indicate the presence of reproducing brook trout. Therefore, DFWELE recommended that Howlett Brook be reclassified as a Cold Water Fishery during the next revision of the SWQS (Richards 2003).
- Continue to conduct biological (benthic macroinvertebrate and fish population) sampling, habitat quality (including documenting the frequency, duration, and extent of low/no flow conditions) and temperature monitoring in Howlett Brook to evaluate the status of the *Aquatic Life Use*.
- Evaluate the outlet control practices at Fourmile, Hood, Lowe, Lower Fourmile, Spoffard and Stevens ponds to determine if current operations are negatively impacting streamflow in Howlett Brook. To the extent possible, operate the outlet control structures to mimic natural flow regimes.
- Conduct *in-situ* monitoring for dissolved oxygen/saturation to determine the frequency and duration of low dissolved oxygen in the brook, determine to what extent low DO is related to natural conditions and/or reduced baseflow, and to assess the status of the *Aquatic Life Use*.
- Monitor bacteria levels to document the effectiveness of bacteria source reduction activities including treatment of stormwater discharges and the Phase II community stormwater management programs and to evaluate the status of the *Primary* and *Secondary Contact Recreational* uses.
- Additional sampling should be conducted in Howlett Brook to better evaluate the status of the *Aquatic Life Use*.
- Review Bodycote, Ipswich (MAR05B925) SWPPP. Evaluate the quality of their SWPPP, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from the facility.
- Continue to monitor Topsfield Water Department's compliance with WMA registration/permit limits and other special conditions of the permit.

GRAVELLY BROOK (SEGMENT MA92-18)

Location: Headwaters, Willowdale State Forest, Ipswich to confluence with Ipswich River, Ipswich.
Segment Length: 1.5 miles
Classification: Class B.



The drainage area of this segment is approximately 2.2 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 88%
Residential 6%
Agriculture..... 2%

Gravelly Brook flows in a generally southerly direction through a large wetland in the Willowdale State Forest to its confluence with the Ipswich River, Ipswich. A portion of the Turner Hill estate is currently being developed into the Turner Hill Golf Course in the Gravelly Brook subwatershed (Mackin 2003 and Pancoast 2003).

DFWELE has proposed that Gravelly Brook be reclassified in the SWQS as a cold water fishery (MassWildlife 2001).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLE H3)

Based on the available information there are no WMA regulated water withdrawals in this subwatershed.

Ipswich is a Phase II Stormwater community. Ipswich was issued a stormwater general permit from EPA and MA DEP in 2003 and is authorized to discharge stormwater from its municipal drainage system (MAR041199). Over the five-year permit term the community will develop, implement and enforce a stormwater management program to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Gravelly Brook was sampled by DWM approximately 60m upstream from Topsfield Road, Ipswich (Station GB01) in July 2000. At the time of the survey the river was roughly 3 m wide with depths of 0.25 m in the riffles and runs. The substrates were comprised primarily of cobble with lesser amounts of pebble, gravel and boulder. Mosses also provided instream cover. Algal cover was estimated as <1%. The reach was approximately 80% shaded. The overall habitat score was 175 (Appendix D and MA DEP 2000a). Limited velocity/depth combinations reduced the habitat score.

Biology

Compared to the Fish Brook reference station (station FB00) the RBP III analysis conducted by DWM biologists indicated the benthic community was non-impacted in Gravelly Brook approximately 60m upstream from Topsfield Road, Ipswich (Station GB01) in July 2000 (Appendix D).

Fish community sampling (backpack electrofishing) was conducted by DFWELE in August 2000 (Richards 2003). A total of 42 fish (3 species) were collected in Gravelly Brook. The dominant fish species in the sampling reach (adjacent to Gravelly Brook Road near the mouth of the brook) was redfin pickerel. American eel and multiple age classes of brook trout were also present.

Chemistry – water

Limited water quality sampling was conducted in Gravelly Brook at Gravelly Brook Road, Ipswich (Station GB01) in 1995 (Appendix B, Tables B3 and B4).

The *Aquatic Life Use* is assessed as support for Gravelly Brook based primarily on the benthic macroinvertebrate community analysis and the presence of multiple age classes of brook trout.

PRIMARY AND SECONDARY CONTACT RECREATION

No recent quality assured bacteria data are available so the recreational uses are not assessed. DWM did conduct limited bacteria sampling in Gravelly Brook in 1995 at Gravelly Brook Road, Ipswich (Station GB01) in 1995 (Appendix B, Table B4).

AESTHETICS

No objectionable odors, deposits, or oils were noted by DWM biologists during their survey in Gravelly Brook in July 2000 (Appendix D and MA DEP 2000a). The water column was described as tea-stained.

The *Aesthetics Use* is assessed as support based on field observations by DWM biologists.

Gravelly Brook (MA92-18) Use Summary Table

Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
				
SUPPORT	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	SUPPORT

RECOMMENDATIONS GRAVELLY BROOK (MA92-18)

- In the next revision of the Massachusetts SWQS Gravelly Brook should be reclassified as a Cold Water Fishery.
- Monitor bacteria levels to document the effectiveness of bacteria source reduction activities including treatment of stormwater discharges and the Phase II community stormwater management programs and to evaluate the status of the *Primary* and *Secondary Contact Recreational* uses.
- Prior to developing a water quality monitoring plan for Gravelly Brook review any available instream monitoring data collected as part of the Turner Hill Golf Course "Project" under the Order of Conditions (OOC) required by the Ipswich Conservation Commission (DEP #36-728) and its usefulness in assessing the status of the designated uses.
- Continue to sample the benthic macroinvertebrate community in Gravelly Brook and assess the status of the *Aquatic Life Use*.
- Conduct *in-situ* monitoring for dissolved oxygen/saturation to determine the frequency and duration of low dissolved oxygen in the brook, determine to what extent low DO is related to natural conditions and/or reduced baseflow, and to better assess the status of the *Aquatic Life Use*.

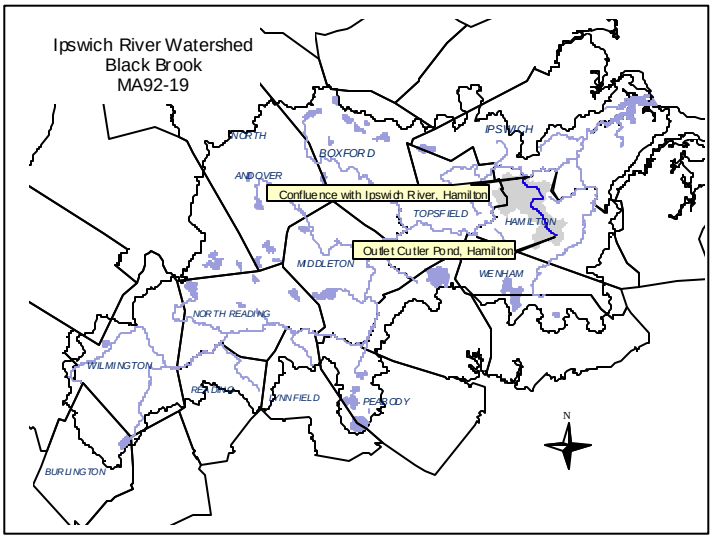
BLACK BROOK (SEGMENT MA92-19)

Location: Outlet Cutler Pond, Hamilton to confluence with Ipswich River, Hamilton.
Segment Length: 3.6 miles
Classification: Class B.

The drainage area of this segment is approximately 3.1 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 65%
Agriculture.....20%
Residential 8%

Black Brook flows from the outlet of Cutler Pond, Hamilton and meanders in a northerly direction to its confluence with the Ipswich River in Hamilton. Two small, unnamed streams feed this tributary to the Ipswich River.



WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLE H3)

Based on the available information there are no WMA regulated water withdrawals in this subwatershed.

Hamilton is a Phase II Stormwater community. Hamilton was issued a stormwater general permit from EPA and MA DEP in 2004 and is authorized to discharge stormwater from its municipal drainage system (MAR041196). Over the five-year permit term the community will develop, implement and enforce a stormwater management program to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

No recent water quality data are available so all uses for Black Brook are not assessed. Limited bacteria sampling was collected in 1995 by DWM in the brook off Winthrop Street, Hamilton (Station BB01) (Appendix B, Table B4).

Black Brook (MA92-19) Use Summary Table

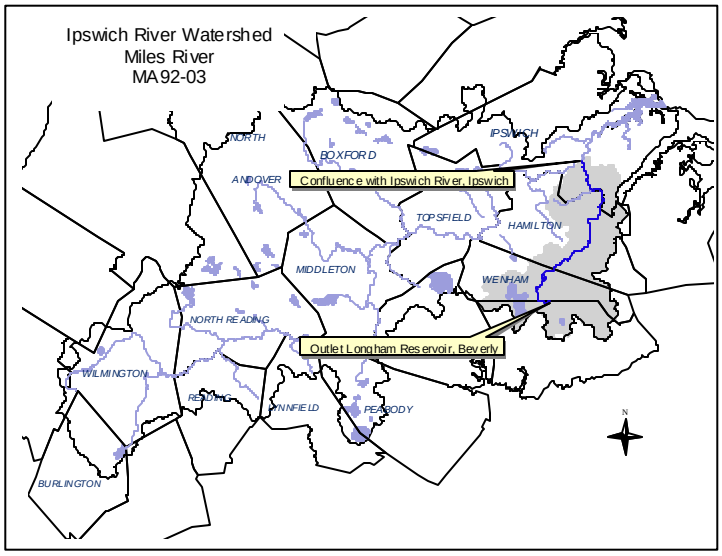
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
				
NOT ASSESSED				

RECOMMENDATIONS BLACK BROOK (MA92-19)

- Additional sampling in Black Brook (such as dissolved oxygen, pH, temperature, nutrients, flow) should be conducted to determine the status of the *Aquatic Life Use*.
- Field reconnaissance along Black Brook should be conducted to identify any potential nonpoint source(s) of pollution to the brook. Where appropriate, bacteria sampling should be conducted to bracket any land-use activities that may affect water quality, and to provide data to evaluate the status of the *Primary* and *Secondary Contact Recreational* and *Aesthetic* uses.

MILES RIVER (SEGMENT MA92-03)

Location: Outlet Longham Reservoir, Beverly to confluence with Ipswich River, Ipswich.
Segment Length: 8.9 miles
Classification: Class B.



The drainage area of this segment is approximately 17.1 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 40%
Residential 26%
Agriculture.....14%

The Miles River flows from the outlet of Longham Reservoir in Wenham/Beverly and meanders in a northerly direction to its confluence with the Ipswich River in Ipswich. The upper subwatershed flow is generally in a southwesterly direction into Longham Reservoir. The river flows through a wetland along much of its length and forms the boundary between Hamilton and Ipswich, where it is joined by Long Causeway Brook.

The use assessment for Beaver Pond (MA92002), Longham Reservoir (MA92030) and Wenham Lake (MA92073) are provided in the Lake Assessment section of this report.

This segment is on the 1998 303(d) List of Waters for organic enrichment/low DO and pathogens (Table 3).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX H, TABLE H4)

Facility Name Registration Permit	Authorized Withdrawal (MGD)	Reported Actual Use (MGD)				
		1998	1999	2000	2001	2002
Salem & Beverly Water Supply Board 31725801 9P31725801	9/1/1994 to 8/31/1999 10.17 (reg) 1.14 (per) 11.31 (total)* 9/1/1999 to 5/18/2003 10.17 (reg) 1.70 (per) 11.87 (total)*	10.05	10.3	10.19	10.66	10.6
Hamilton Water Department** 31711901 9P31711901	5/7/1997 to 8/31/1999 0.92 (reg) 0.11 (per) 1.03 (total)* 9/1/1999 to 5/18/2003 0.92 (reg) 0.19 (per) 1.11 (total)*	0.64	0.66	0.5	0.69	0.57
Ipswich Water Department 31714402 no permit	0.2*	0.39	0.39	0.2	0.24	0.27
Myopia Hunt Club 31711902 no permit	0.17	0.13	0.15	0.06	0.14	0.13

* Indicates system-wide withdrawal; all sources not necessarily within this segment.
**Note: Hamilton Water Department Bridge Street Well 01G, which is in this subwatershed, is inactive.

Under their permit, issued 5 February 1991, the Salem & Beverly Water Supply Board is allowed to withdraw water from the Ipswich River between 1 December and 31 May when streamflow at the USGS Ipswich Gauge Station #01102000 exceeds 28 MGD. However, the permit was modified on 19 May 2003

to reflect new streamflow limitations. Salem & Beverly is authorized under the modified permit to withdraw water from June 1 through October 30 when streamflow at the Ipswich gauge is >381 cfs (246 MGD) and from November 1 through May 31 when streamflow is >125 cfs (80 MGD). Since the modified permit was appealed the previous permit remains in effect pending a decision on the appeal.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLES H1 AND H3)
The Salem and Beverly Water Supply Board is permitted (MAG640059 effective January 2002) to discharge <1.0 MGD (average monthly flow) of wastewater from the Arlington Avenue Water Filtration Plant in Beverly, MA to Wenham Lake.

There are two general stormwater permittees in this subwatershed. The following general permits were issued by the EPA in October 2001 and will expire in October 2005:

- Town of Hamilton, Permit No. MAR05C595
- Wenham Highway Garage, Wenham, Permit No. MAR05C485

It should also be noted that Beverly, Hamilton, Ipswich and Wenham are NPDES Phase II communities. These communities were issued stormwater general permits from EPA and MA DEP in 2003/2004 and are authorized to discharge stormwater from the municipal drainage systems (MAR041181, MAR041196, MAR041199, and MAR041230, respectively). Over the five-year permit term the communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT
AQUATIC LIFE
Habitat and Flow

There are three municipal water suppliers and one golf course with WMA permits and/or registrations in the Miles River subwatershed. These are summarized from upstream to downstream in Table 9.

Table 9. WMA registered and/or permitted suppliers along the Miles River and the location of wastewater discharges.

Facility Name Registration Permit	Number of sources in Segment MA92-03	Average Use 1998 – 2002 (MGD)	% of town population sewered	Wastewater discharge location
Salem & Beverly Water Supply Board 31725801 9P31725801	2	10.4	Beverly - 100% (Salem is in the North Coastal Watershed area)	South Essex Sewage District and discharged to the North Coastal Watershed
Myopia Hunt Club 31711902 no permit	1	0.12	Not applicable	
Hamilton Water Department 31711901 9P31711901	1 active	0.61	0	On-site septic systems
Ipswich Water Department 31714402 no permit	2	0.3	33%*	Ipswich WWTP discharge to an unnamed tributary locally known as “Greenwood Creek”

*Note: Currently about 33% of the town population is sewered. Future plans are to expand sewers to an additional 20% of the population.

The Miles River was sampled by DWM approximately 370 m downstream from Route 1A, Ipswich, MA (Station MR01) in July 2000. At the time of the survey the river was roughly 5 m wide with depths of 0.75 m in the riffles and runs. The substrates were comprised primarily of cobble with lesser amounts of boulder, pebble, gravel, and sand. Mosses and rooted emergent macrophytes also provided instream cover. A thin film of algae was noted on the substrates, although cover was estimated as <5%. The reach was approximately 40% shaded. The overall habitat score was 179 (Appendix D and MA DEP 2000a). Riparian disruption and the suboptimal fish habitat (due to a lack of deep pools and variety of stable cover) negatively affected the evaluation score.

There is a dam on the Miles River near the Myopia Hunt Club (Mortimer Bridge). The dam and the flow of the river is controlled by the Hamilton Conservation Commission (Heroian 2003). The impounded water is used by the Myopia Hunt Club for irrigation of the golf course.

Biology

Compared to the Fish Brook reference station (station FB00) the RBP III analysis conducted by DWM biologists indicated the benthic community was moderately impacted in Miles River approximately 370m downstream from Route 1A, Ipswich, MA (Station MR01) in July 2000 (Appendix D).

Chemistry – water

In 1995 DWM conducted limited water quality monitoring in the Miles River near County Road and Lakeman Lane in Ipswich (Station MR01) (Appendix B, Tables B3 and B4).

Through the IRWA's RiverWatch Volunteer Monitoring Program (RiverWatch) water quality monitoring has also been conducted in the Miles River at Route 1A in Ipswich (Station MR-1A). Sampling has been conducted at this location since 1999 (IRWA 2000a).

DO

Low DOs were documented by RiverWatch in June and August of 1999, August 2000 and July through October 2001 (IRWA 2000b, 2001, and 2002). It should be noted that the river was stagnant on the June, July and August 1999 sampling dates.

Temperature

No temperatures measured by RiverWatch were above 28.3°C (IRWA 2000b, 2001 and 2002).

The *Aquatic Life Use* is assessed as impaired for the Miles River based primarily on the benthic macroinvertebrate community analysis (only 25% comparable to the reference condition). Water quality degradation (low dissolved oxygen), potential nonpoint sources of pollution directly adjacent to the river (e.g., horse stables, golf course), and flow manipulation associated with water withdrawals are suspected causes of impairment. Naturally occurring conditions associated with the wetland nature of the system may also exacerbate stress on the biota.

PRIMARY AND SECONDARY CONTACT RECREATION

No recent quality assured bacteria data are available so the recreational uses are not assessed. DWM did conduct limited bacteria sampling in the Miles River in 1995 near County Road and Lakeman Lane in Ipswich (Station MR01) (Appendix B, Table B4).

AESTHETICS

No objectionable odors, deposits, or oils were noted by DWM biologists during their survey in the Miles River in July 2000 or by the RiverWatch volunteers (Appendix D, MA DEP 2000a, and IRWA 2000b). The water column was described as tea-stained by both sampling groups and DWM biologists also noted slight turbidity.

The *Aesthetics Use* is assessed as support based on field observations by DWM biologists and the RiverWatch volunteers.

Miles River (MA92-03) Use Summary Table

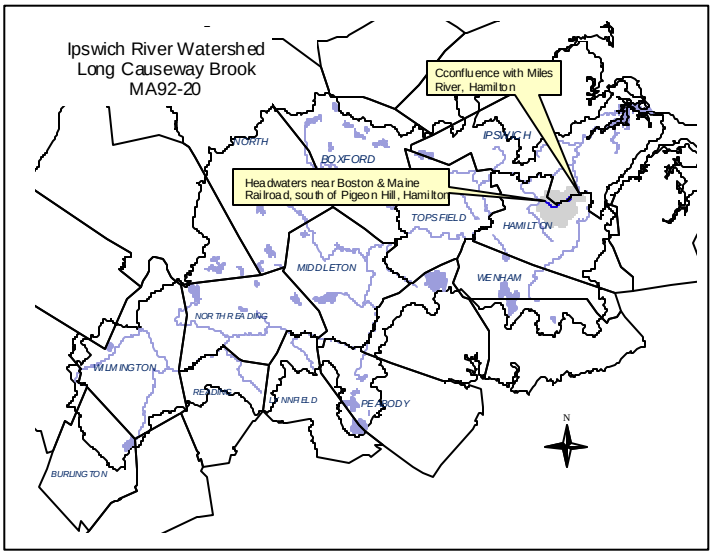
Designated Uses		Status
Aquatic Life		IMPAIRED Cause: Benthic macroinvertebrate bioassessment (Suspected Causes: DO, Nutrient enrichment, Low flow alterations) Source: Unknown (Suspected Sources: Flow alterations from water diversions, Golf courses, Grazing in riparian zone)
Fish Consumption		NOT ASSESSED
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		SUPPORT

RECOMMENDATIONS MILES RIVER (MA92-03)

- Additional *in-situ* monitoring for dissolved oxygen/saturation should be conducted to determine the frequency and duration of low dissolved oxygen in the brook, to determine to what extent lwo DO is related to natural conditions (wetland influence) and/or reduced baseflow resulting from water withdrawals or other nonpoint sources of pollution, and to better assess the status of the *Aquatic Life Use*. Additional sampling should include tributaries (especially Long Causeway Brook) to determine their effects.
- Monitor bacteria levels to document the effectiveness of bacteria source reduction activities including treatment of stormwater discharges, sewering, and the Phase II community stormwater management programs. Bacteria sampling should also bracket potential nonpoint sources including agricultural landuses. These data should be used to evaluate the status of the *Primary* and *Secondary Contact Recreational* uses
- Continue to conduct benthic macroinvertebrate sampling and analysis in the Miles River and assess the status of the *Aquatic Life Use*. .
- Evaluate potential nonpoint sources of pollution that may contribute to instream turbidity in the Miles River.
- The Myopia Hunt Club should use best management practices to minimize any potential impacts to the Miles River from their use of fertilizers, pesticides, and herbicides.
- The flow control structure on the Miles River near the Myopia Hunt Club should be operated so as to maintain a natural hydrograph.
- Nutrient and bacteria sampling along the Miles River should be conducted to help isolate sources (potentially from agricultural runoff) of nutrient/organic loads to the Miles River (Appendix D).
- Evaluate outlet control practices at Wenham Lake and Longham Reservoir and determine if current operations are negatively impacting streamflow in the Miles River. To the extent possible, releases at the dam should be optimized to mimic natural flow regimes.
- Continue to monitor compliance with WMA registration/permit limits and other special conditions of the permits.
- Review Town of Hamilton (MAR05C595) and Wenham Town Garage (MAR05C485) SWPPPs. Evaluate the quality of their SWPPPs, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from these facilities.

LONG CAUSEWAY BROOK (SEGMENT MA92-20)

Location: Headwaters near Boston & Maine Railroad, south of Pigeon Hill, Hamilton to confluence with Miles River, Hamilton/Ipswich.
Segment Length: 1.9 miles
Classification: Class B.



The drainage area of this segment is approximately 1.67square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 52%
Agriculture.....30%
Residential 13%

Long Causeway Brook begins in Hamilton west-northwest of Pigeon Hill and east of Black Brook. From its source it flows southeasterly for about a half mile before turning to the northeast, around Pigeon Hill, where it forms a portion of the boundary between Hamilton and Ipswich for a little over a mile before joining with the Miles River just east of Route 1A. This brook drains Appleton Farms.

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

Based on the available information, there are no WMA regulated water withdrawals in this subwatershed.

Hamilton and Ipswich are Phase II Stormwater communities (Appendix H, Table H3). These communities were issued stormwater general permits from EPA and MA DEP in 2003/2004 and are authorized to discharge stormwater from the municipal drainage systems (MAR041196 and MAR041199, respectively). Over the five-year permit term these communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from their storm sewer systems to protect water quality (Domizio 2004).

USE ASSESSMENT

No recent water quality data are available so all uses for Long Causeway Brook are not assessed. Limited water quality sampling was collected in 1995 by DWM in the brook near Route 1A, Main St, Hamilton/County Rd Hamilton (Station MR04) (Appendix B, Table B3). During a field reconnaissance survey in September 2003, the water was described as being reddish-brown in appearance and very turbid near the Route 1A crossing and, therefore, the *Aesthetics Use* is identified with an Alert Status.

Long Causeway Brook (MA92-20) Use Summary Table

Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics*
				
NOT ASSESSED				

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

RECOMMENDATIONS LONG CAUSEWAY BROOK (MA92-20)

- Additional sampling in Long Causeway Brook (such as dissolved oxygen, pH, temperature, nutrients, flow) should be conducted to determine the status of the *Aquatic Life Use*.
- Additional field reconnaissance/monitoring should be conducted to determine the source of coloration/turbidity in Long Causeway Brook and to assess the status of the *Aesthetics Use*.
- Monitor bacteria levels to document the effectiveness of bacteria source reduction activities including the Phase II community stormwater management program and best management practices associated with the agricultural landuse and to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

KIMBALL BROOK (SEGMENT MA92-21)

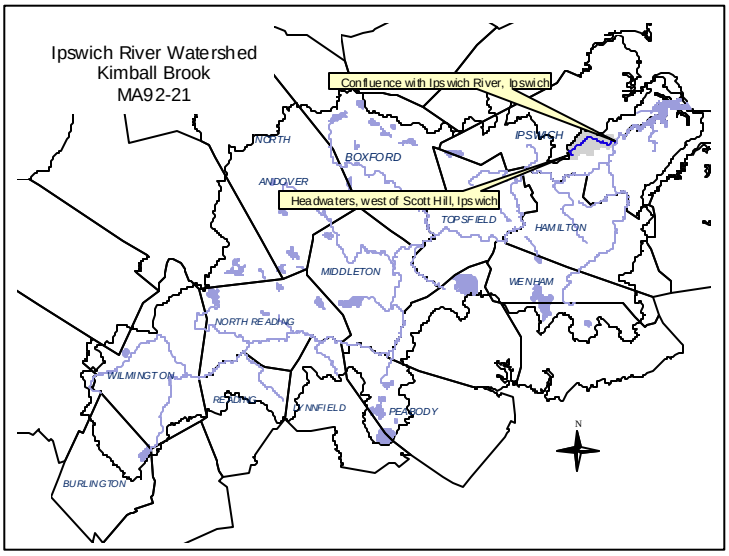
Location: Headwaters, west of Scott Hill, Ipswich to confluence with Ipswich River, Ipswich.
Segment Length: 2.2 miles.
Classification: Class B.

The drainage area of this segment is approximately 1.0 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 45%
Residential 32%
Agriculture.....17%

Kimball Brook drains in a generally easterly direction from its source west of Scott Hill in Ipswich to the confluence with the Ipswich River in Ipswich. This is the last tributary to the Ipswich River upstream of the Ipswich Dam.

This segment is on the 1998 303(d) List of Waters for organic enrichment/low DO and pathogens (Table 3).



WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

Based on the available information there are no WMA regulated water withdrawals in this subwatershed.

Ipswich is a Phase II Stormwater community (Appendix H, Table H3). Ipswich was issued a stormwater general permit from EPA and MA DEP in 2003 and is authorized to discharge stormwater from its municipal drainage system (MAR041199). Over the five-year permit term the community will develop, implement and enforce a stormwater management program to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

No recent water quality or bacteria data are available so all uses for Kimball Brook are not assessed. Limited water quality and bacteria sampling was collected by DWM in the brook near Kimball Street, Ipswich (Station KB01) (Appendix B, Tables B3 and B4). Bacteria samples were also collected from the brook at Heard Drive, Ipswich (Station KB02) (Appendix B, Table B4). The Ipswich Coastal Pollution Control Committee developed a plan of action to address the high levels of bacteria affecting the town's recreational and commercial shellfishery and published their recommendations in 1995. Their report included maps and an inventory of all storm drains discharging to Kimball Brook (Castonguay 2004). Because of the elevated bacteria levels previously documented in Kimball Brook the *Primary* and *Secondary Contact Recreational* uses are identified with an Alert Status.

Kimball Brook (MA92-21) Use Summary Table

Aquatic Life	Fish Consumption	Primary Contact*	Secondary Contact*	Aesthetics
NOT ASSESSED				

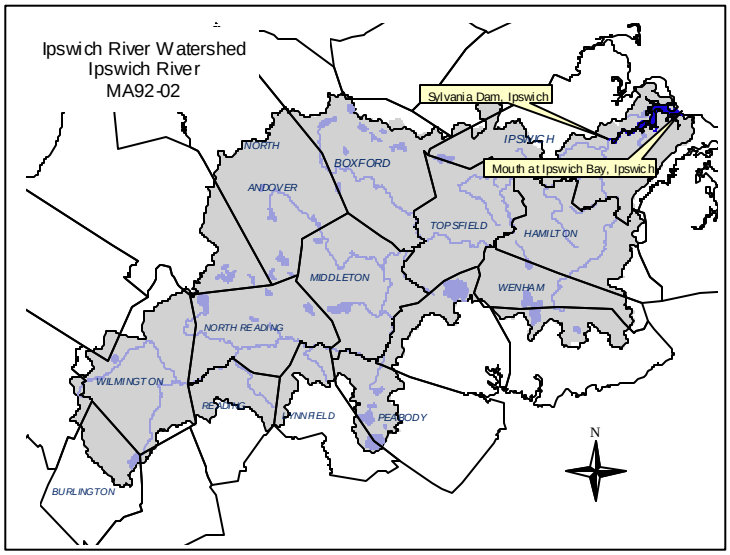
* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS KIMBALL BROOK (MA92-21)

- Monitor bacteria levels to document the effectiveness of bacteria source reduction activities including the Phase II community stormwater management program. Bacteria sampling should also bracket potential nonpoint sources including agricultural landuses and should be used to assess the status of the *Primary* and *Secondary Contact Recreational* uses.
- Additional sampling in Kimball Brook (such as dissolved oxygen, pH, temperature, nutrients, flow) should be conducted to determine the status of the *Aquatic Life Use.*
- Encourage the use of agricultural BMPs where appropriate.

IPSWICH RIVER (SEGMENT MA92-02)

Location: Ipswich Dam (formerly known as the Sylvania Dam), Ipswich to mouth at Ipswich Bay, Ipswich.
Segment Area: 0.411 square miles
Classification: Class SA.



The drainage area of this segment is approximately 155 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 49%
Residential 28%
Wetlands..... 6%

The Ipswich River estuary begins just downstream from the Ipswich Dam and then flows through extensive saltwater marshlands to its mouth at Ipswich Bay delineated between Little Neck and Crane Beach. There are several estuarine tributaries to this segment of the Ipswich River. There is access to the Ipswich River at East Street via a public concrete boat ramp (PAB 2002). This segment is part of the Parker River/Essex Bay ACEC (MA DEM 2001).

This segment is on the 1998 303(d) List of Waters for pathogens (Table 3).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

Based on the available information there are no WMA regulated water withdrawals in this subwatershed.

All 22 communities in the Ipswich River Watershed are Phase II Stormwater communities (Appendix H, Table H3). These communities were issued stormwater general permits from EPA and MA DEP in 2003/2004 and are authorized to discharge stormwater from the municipal drainage systems. Over the five-year permit term these communities will develop, implement and enforce stormwater management programs to reduce the discharge of pollutants from their storm sewer systems to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

The Ipswich Dam was reconstructed in 1995. Blueback herring from the Charles River have been stocked in the Ipswich River by DMF since 1990 in an effort to restore herring runs (Reback *et al*. in preparation).

Biology

DMF monitored and mapped rainbow smelt (*Osmerus mordax*) spawning habitat in the Ipswich River during 1990 and 1991. Smelt egg deposition was found over a river length of approximately 550 m and included over 10,000 squared meters of river substrate (Chase in preparation). The available spawning habitat for smelt is the largest on the north shore of Massachusetts. However, the amount of egg deposition observed was low relative to available habitat. Observations of smelt egg deposition during monitoring and more recently anecdotes from the Ipswich River smelt fishery indicate this population has declined substantially during the last 20 years. DMF has an ongoing project investigating the relationship between water quality and the degradation of smelt spawning habitat in the Ipswich River (Chase 2003b).

Chemistry – water

In 1995, DWM conducted limited water quality sampling at one station near County Road, Ipswich (Station IP17) on this segment of the Ipswich River (Appendix B, Tables B3 and B4).

Marine Biological Laboratory as part of the PIE-LTER study collected monthly surface water quality samples from one station near the Ipswich Dam in Ipswich (WAT-IP-Ipswich Dam) between 1997 and 2000. Analytes included temperature and ammonium (MBL 2003).

Through the IRWA's RiverWatch Volunteer Monitoring Program (RiverWatch) water quality monitoring has also been conducted at three stations in the upper reach of this segment of the Ipswich River; Ipswich Dam, near Route 1A (Station IP24), near the Green Street Bridge (IP25), and at the Town Wharf near Water Street (IP26). Sampling has been conducted at these locations since 1997 (IRWA 2000a).

DMF conducted weekly water chemistry measurements in the Ipswich River in the vicinity of the smelt spawning habitat below the Ipswich Dam during March-May 2002 and 2003 as part of an investigation on the influence of water quality on smelt spawning habitat. Basic water chemistry parameters were recorded using a YSI 6820 meter. Nutrient concentrations and periphyton growth were also measured. These data are currently being evaluated for quality assurance (Chase 2003b).

DO
DOs documented by RiverWatch were occasionally less than 6.0 mg/L in the summer and/or fall of 1999, 2000 and 2001 at stations IP24 and/or IP25. With one exception all DO's at Station IP26 were greater than 6.0 mg/L (IRWA 2000b, 2001 and 2002).

Temperature
Temperatures in the Ipswich River near the Ipswich Dam, recorded as part of the PIE-LTER study, ranged between –2.0 and 27°C. No temperature measured by RiverWatch was above 29.4°C (IRWA 2000b, 2001, and 2002).

Ammonium
Ammonium concentrations recoded by the PIE-LTER study ranged between 0.04 and 5.49 uM.

Too limited data are available so the *Aquatic Life Use* is not assessed for this segment of the Ipswich River.

SHELLFISH HARVESTING

The July 2000 DMF Shellfish Status Report indicates that shellfish growing areas N5.0, N5.2. N5.3, and N5.7 are prohibited. Since then the Town replaced the sewer interceptor in the town Wharf area, which resulted in improved conditions. The Division of Marine Fisheries reported that the Ipswich River was reopened for direct harvest of shellfish on 11 January 2001; the first time in over 70 years (MA DEP 2003). Currently, their growing area N5.7 (from the Ipswich Dam to the upstream/western side of the confluence with Labor in Vain Creek) is prohibited. Growing areas N5.0 (which now encompasses N5.2) and N5.3 are currently conditionally approved for direct harvest from October through April (Kennedy 2003a). Although major progress has been made in improving water quality through upgrades to the Ipswich WWTP and its associated conveyance system, problems still remain that are smaller and more difficult to pinpoint (Roach 2003). Septic system failures are still known to be problematic in the Little Neck and Great Neck areas near the mouth of the Ipswich River (Felix 2002 and Kennedy 2003a).

Based on the current status of the shellfish growing areas in this segment of the Ipswich River the *Shellfish Harvesting Use* is assessed as impaired.

PRIMARY AND SECONDARY CONTACT RECREATION

No recent quality assured bacteria data are available so the recreational uses are not assessed. DWM did conduct limited bacteria sampling in this segment of the Ipswich River in 1995 near County Road, Ipswich (Station IP17) (Appendix B, Table B4).

AESTHETICS

Although no objectionable odors or other conditions were noted by the RiverWatch volunteer samplers, too limited data are available so the *Aesthetics Use* is not assessed.

Ipswich River (MA92-02) Use Summary Table

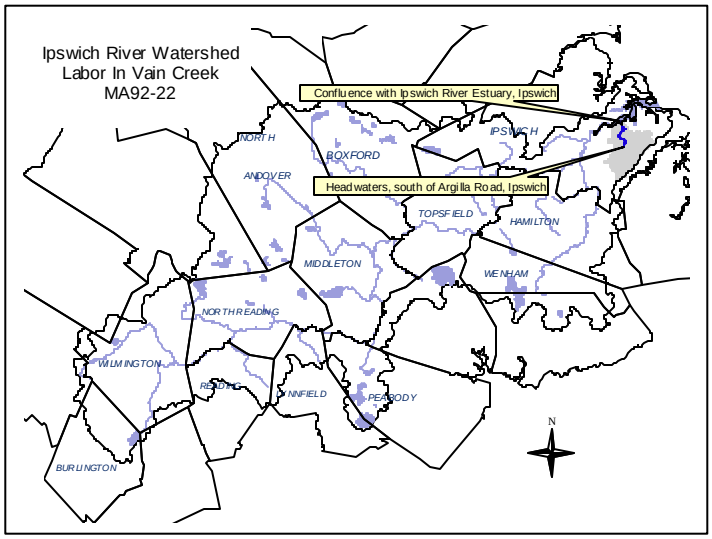
Designated Uses		Status
Aquatic Life		NOT ASSESSED
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Fecal coliform bacteria Source: On-site septic systems (Suspected Source: Municipal storm sewers - MS4)
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		NOT ASSESSED

RECOMMENDATIONS IPSWICH RIVER (MA92-02)

- Monitor bacteria levels to document the effectiveness of bacteria source reduction activities including the Phase II community stormwater management program, sewer collection system improvements, and Title V (septic system) improvements/upgrades and to assess the status of the *Primary* and *Secondary Contact Recreation* uses.
- Review and implement recommendations in the DMF shellfish sanitary survey reports and the triennials reviews for growing areas N5.0, N5.2, N5.3 and N5.7.
- Review and implement recommendations in the DMF anadromous fish assessment report for improving effectiveness of fish passage in this segment.
- Review and implement recommendations from the DMF *Rainbow Smelt (*Osmerus mordax*) spawning habitat on the Gulf of Maine Coast of Massachusetts* report, when available.

LABOR IN VAIN CREEK (SEGMENT MA92-22)

Location: Headwaters, south of Argilla Road, Ipswich to confluence with Ipswich River Estuary, Ipswich.
Segment Length: 0.03 square miles
Classification: Class SA.



The drainage area of this segment is approximately 5.0 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest 37%
Agriculture.....29%
Wetlands.....22%

This segment is part of the Parker River/Essex Bay ACEC (MA DEM 7 June 2001).

This segment is on the 1998 303(d) List of Waters for organic enrichment/low DO and pathogens (Table 3).

WMA WATER WITHDRAWAL SUMMARY AND NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLE H3)

Based on the available information there are no WMA regulated water withdrawals in this subwatershed.

Ipswich is a Phase II Stormwater community. Ipswich was issued a stormwater general permit from EPA and MA DEP in 2003 and is authorized to discharge stormwater from its municipal drainage system (MAR041199). Over the five-year permit term the community will develop, implement and enforce a stormwater management program to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

No recent data are available so the *Aquatic Life Use* is not assessed for Labor in Vain Creek. It should be noted, however, that in 1995 DWM conducted limited water quality monitoring at two locations in Labor In Vain Creek; Argilla Road, Ipswich (Station LV01) and at Labor in Vain Road, Ipswich (Station LV03) (Appendix B, Tables B3 and B4).

SHELLFISH HARVESTING

The July 2000 DMF Shellfish Status Report indicated that shellfish growing area N5.6, which encompasses this entire segment, was prohibited. However, the growing area N5.6 is now conditionally approved (DFWELE 2000 and Kennedy 2003a). The area has a 5-day rainfall closure after 0.25" of rain and is closed seasonally from May through September.

Based on the DMF shellfishing status information the *Shellfish Harvesting Use* is assessed as impaired for this entire segment.

PRIMARY AND SECONDARY CONTACT RECREATION

No recent quality assured bacteria data are available so the recreational uses are not assessed. DWM conducted limited bacteria sampling in the Labor in Vain Creek subwatershed in 1995 at three locations; the headwaters of Labor in Vain Creek near the dirt road just east of a creek on Argilla Road (Station LV02), Labor in Vain Creek at Argilla Road (Station LV01) and from Labor in Vain Creek at Labor in Vain Road (Station LV03) (Appendix B, Table B4).

Labor in Vain Creek (MA92-22) Use Summary Table

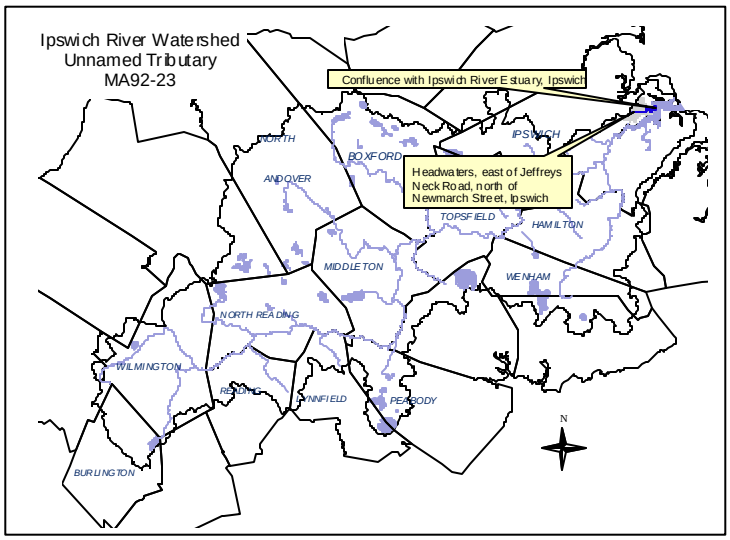
Designated Uses		Status
Aquatic Life		NOT ASSESSED
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Fecal coliform bacteria Source: Unknown (Suspected Source: Municipal storm sewers - MS4)
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		NOT ASSESSED

RECOMMENDATIONS LABOR IN VAIN CREEK (SEGMENT MA92-22)

- Monitor bacteria levels to document the effectiveness of bacteria source reduction activities including the Phase II community stormwater management program. Bacteria sampling should also bracket potential nonpoint sources including agricultural landuses (e.g., horses). These data can then be used to assess the status of the *Primary* and *Secondary Contact Recreation* uses.
- Encourage the use of agricultural BMPs, particularly for individual horse owners.
- Review and implement recommendations in the DMF shellfish sanitary survey reports and the triennials reviews for growing area N5.6.
- Determine the need to remediate two tidal restrictions identified in this subwatershed.

UNNAMED TRIBUTARY (SEGMENT MA92-23)

Location: Headwaters, east of Jeffreys Neck Road, north of Newmarch Street to confluence with Ipswich River Estuary, Ipswich. (Locally known as Greenwood Creek)
Segment Area: 0.03 square miles
Classification: Class SA.



The drainage area of this segment is approximately 0.44 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Wetlands.....43%
Residential 22%
Agriculture.....16%

This stream, known locally as "Greenwood Creek", flows from its headwaters, just east of Jeffreys Neck Road in Ipswich, in an easterly direction to its confluence with the Ipswich River estuary, Ipswich. This segment is part of the Parker River/Essex Bay ACEC (MA DEM 7 June 2001).

This segment is on the 1998 303(d) List of Waters for pathogens (Table 3).

WMA WATER WITHDRAWAL SUMMARY

Based on the available information there are no WMA regulated water withdrawals in this subwatershed.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX H, TABLES H1 AND H3)

The Town of Ipswich Sewer Department is permitted (MA0100609 issued February 2003) to discharge 1.8 MGD (average monthly flow) of treated sanitary wastewater from the Ipswich Wastewater Treatment Facility in Ipswich, MA to Greenwood Creek. In 1998 the facility's chlorination system was upgraded to an ultraviolet disinfection system. The upgrade also included replacing the mechanical aeration system with a fine bubble diffuser type system and incorporating cascade step aeration to the outfall. According to the permit DO in the effluent must be $\geq$ 6.0 mg/L at all times. The average monthly DO in the effluent has been greater than 6.0 mg/L between January 1998 and December 2002 with the exception of October 2000 (average monthly DO 5.3 mg/L) (PCS 2003). The whole effluent toxicity limits (monitoring frequency of 4 times per year) are $LC_{50} \geq 100\%$ and CNOEC $\geq 100\%$ using *Menidia beryllina* (inland silverside minnow), and *Arbacia punctulata* (sea urchin).

Ipswich is a Phase II Stormwater community. Ipswich was issued a stormwater general permit from EPA and MA DEP in 2003 and is authorized to discharge stormwater from its municipal drainage system (MAR041199). Over the five-year permit term the community will develop, implement and enforce a stormwater management program to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

USE ASSESSMENT

AQUATIC LIFE

Toxicity

Ambient

The Ipswich WWTP collects water from Greenwood Creek (approximately 20 yards upstream from their discharge on an outgoing tide) for use as dilution water in their whole effluent toxicity tests. Between March 1998 and October 2002 survival of *M. beryllina* exposed (7-day) to the river water was good ($\geq$ 80% in all 19 test events). Data from these reports (maintained in the TOXTD database) are summarized below.

Effluent

Nineteen modified acute and chronic whole effluent toxicity tests were conducted on the Ipswich WWTP discharge using *M. beryllina* between March 1998 and October 2002. Whole effluent LC_{50}'s were all ≥ 100% effluent and, with the exception of one test event, the CNOECs were all 100% effluent (in compliance with permit limits). The effluent was chronically toxic to *M. beryllina* during the April 2001 test event (CNOEC = 6.25% effluent).

Chemistry – water

Water from Greenwood Creek was collected for use as dilution water in the Ipswich WWTP whole effluent toxicity tests (approximately 20 yards upstream of the discharge on an outgoing tide) on 19 occasions between March 1998 and October 2002. Data from these reports (maintained in the TOXTD database) are summarized below.

Through the IRWA's RiverWatch Volunteer Monitoring Program (RiverWatch) water quality monitoring has also been conducted in Greenwood Creek "behind S. Hamilton's House" in Ipswich (Station GC-1). Sampling has been conducted at this location since 1997 (IRWA 2000a).

DO

Low DOs were documented by RiverWatch in June, August and September of 1999; May and June 2000; and June and August 2001 (IRWA 2000b, 2001, and 2002).

Temperature

No temperatures measured by RiverWatch were above 28.3°C (IRWA 2000b, 2001, and 2002).

pH

Instream pH ranged between 6.7 and 7.7 SU.

Suspended Solids

The maximum suspended solids concentration was 28 mg/L. Two of the 18 measurements (11%) exceeded 25 mg/L.

Ammonia-Nitrogen

The ammonia-nitrogen concentrations ranged between <0.05 and 3.99 mg/L. These data could not be compared to the chronic criteria continuous concentration (water quality criterion) due to the lack of temperature data.

Total Residual Chlorine

All of the 19 measurements were below the minimum quantification level of 0.05 mg/L.

No ambient or effluent toxicity problems were identified at the most upstream end of this segment, but there are too limited data available that are representative of the entire segment so the *Aquatic Life Use* is not assessed.

SHELLFISH HARVESTING

The entire 0.03 square miles of this unnamed tributary, locally known as "Greenwood Creek" (DMF Shellfish Growing Area N5.5) are prohibited (DFWELE 2000). However, the creek is also a "closed safety zone", which is required around a wastewater treatment plant outfall by the National Shellfish Sanitation Program (Kennedy 2003b).

The *Shellfish Harvesting Use* is impaired for "Greenwood Creek" because of the creek's prohibited classification (Growing Area N5.5).

PRIMARY AND SECONDARY CONTACT RECREATION

No recent quality assured bacteria data are available so the recreational uses are not assessed. In November 1995 DWM collected a bacteria sample from the outfall of the Ipswich WWTP (station IPS/WWTF) (Appendix B, Table B4).

AESTHETICS

Although no objectionable odors or other conditions were noted by the RiverWatch volunteer samplers, too limited data are available so the *Aesthetics Use* is not assessed.

"Greenwood Creek" (MA92-23) Use Summary Table

Designated Uses		Status
Aquatic Life		NOT ASSESSED
Fish Consumption		NOT ASSESSED
Shellfish Harvesting		IMPAIRED Cause: Fecal coliform bacteria Source: Unknown (Suspected Sources: On-site septic systems, Municipal point source discharge)
Primary Contact		NOT ASSESSED
Secondary Contact		NOT ASSESSED
Aesthetics		NOT ASSESSED

RECOMMENDATIONS "GREENWOOD CREEK" (MA92-23)

- Additional water quality monitoring of DO should be conducted to evaluate the status of the *Aquatic Life Use* in Greenwood Creek.
- Monitor bacteria levels to document the effectiveness of bacteria source reduction activities including upgrade of the Ipswich WWTP, additional sewering, the Phase II community stormwater management program, and to assess the status of the *Primary* and *Secondary Contact Recreation* uses.
- Review and implement recommendations in the DMF shellfish sanitary survey reports and the triennials reviews for growing area N5.5.

IPSWICH RIVER WATERSHED - LAKE ASSESSMENTS

A total of 72 lakes, ponds or impoundments (the term "lakes" will hereafter be used to include all) have been identified and assigned pond and lake identification system (PALIS) code numbers in the Ipswich River Watershed (Ackerman 1989 and MA DEP 2004). The total surface area of the Ipswich River Watershed lakes is 2,226 acres. They range in size from less than one acre to 283 acres. This report presents information on 44 of the Ipswich River Watershed lakes that are listed in the WBS database (Figure 10). The remaining 28 lakes, which total 270 acres, are unassessed and are not currently included as segments in the WBS/ADB database. Eleven of the lakes assessed in this report (25%) are designated for public water supply (i.e., Class A).

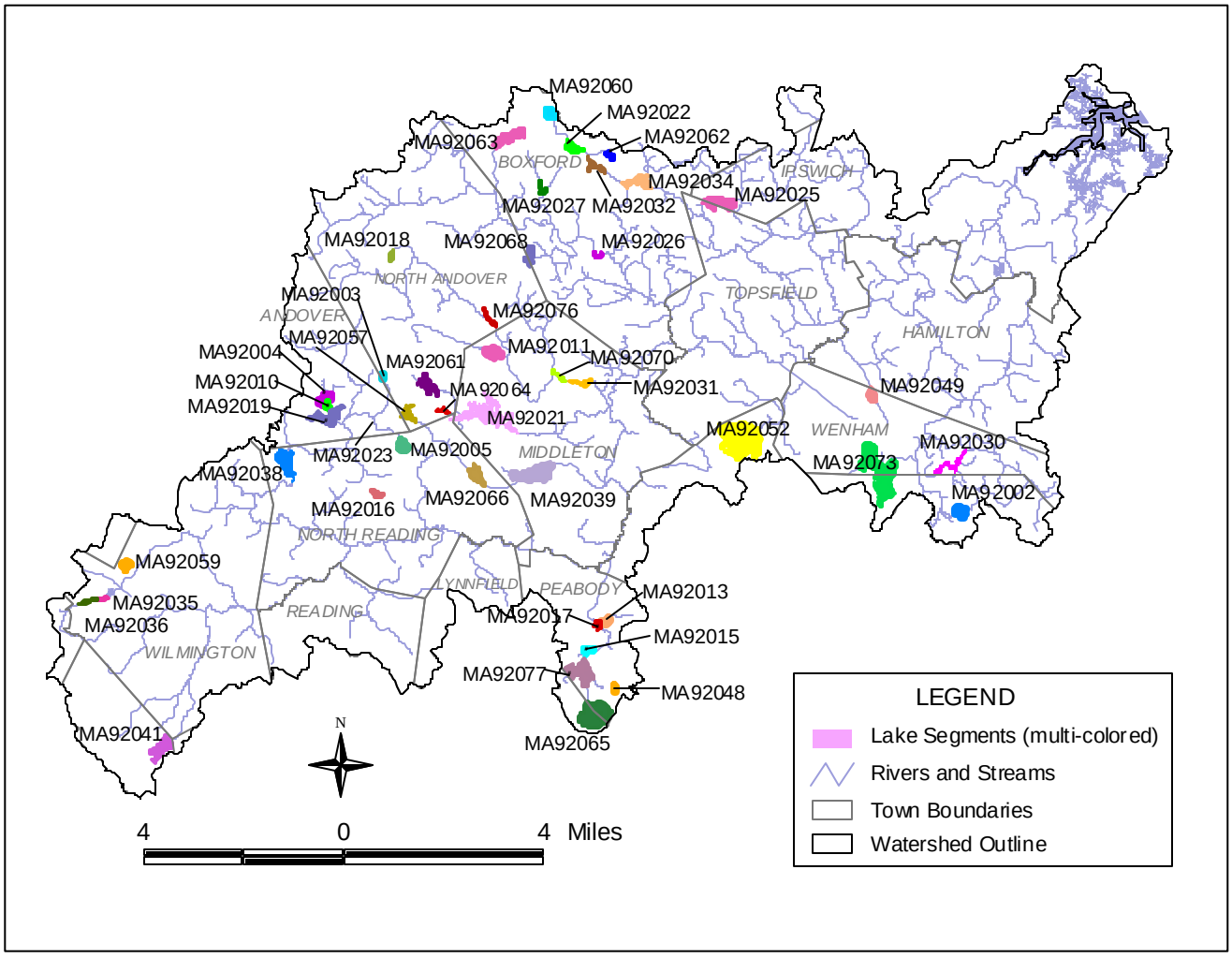


Figure 10. Lake Segments in the Ipswich River Watershed.

The designated use assessments for lakes are based on information gathered during DWM surveys (recent and historic) as well as pertinent information from other reliable sources (e.g., abutters, herbicide applicators, diagnostic/feasibility studies, MDPH, etc.). The 1995 DWM synoptic surveys focused on visual observations of water quality and quantity (e.g., water level, sedimentation, etc.), the presence of native and non-native aquatic plants (both distribution and areal cover) and presence/severity of algal blooms (Appendix C, Table C1). During 2000 more intensive in-lake sampling was conducted by DWM in two lakes in the Ipswich River Basin (Crystal Pond and Devils Dishfull Pond, both in Peabody) as part of the TMDL program. This sampling included: in-lake measurements of dissolved oxygen, pH, temperature, Secchi disk transparency, nutrients, and chlorophyll *a* as well as detailed macrophyte mapping (Appendix C, Tables C2 and C3). While these surveys provided additional information to assess the status of the

designated uses, fecal coliform bacteria data were not collected so the *Primary Contact Recreational* Use was usually not assessed. In the case of the *Fish Consumption Use* fish consumption advisory information was obtained from the MDPH (MDPH 2002c). Although the *Drinking Water Use* was not assessed in this water quality assessment report the Class A waters were identified. 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 Ipswich River Basin's public water suppliers.

Harold Parker State Forest, which lies in Andover, North Andover, North Reading and Middleton, comprises just over 3000 acres of Central Hardwood-Hemlock-White Pine forest. Recreational opportunities include hiking, mountain biking, fishing, hunting, horseback riding, swimming, camping and picnicking. Non-motorized boating is allowed on any of the 11 ponds within the forest. Berry Pond, the area's day use facility, is open to swimming between Memorial Day and Labor Day. In addition, the Annual Fishing Festival is held in mid-August at Sudden Pond and the Annual Fall Festival in September is held at Berry Pond. Additional information on Harold Parker State Forest is available online at the MA DCR website.

The use assessments and supporting information reported herein will be entered into either the EPA Water Body System or ADB database. Data on the presence of non-native plants were entered into a MA DEP DWM informal non-native plant tracking database.

WMA

Emerson Brook Reservoir (MA92021), Longham Reservoir (MA92030), Middleton Pond (MA92039), Mill Pond (MA92041), Putnamville Reservoir (MA92052), Suntaug Lake (MA92065), Swan Pond (MA92066), Wenham Lake (MA92073), and Winona Pond (MA92077) are Class A Public Water Supplies. Additional information is available in Table 10 and in Appendix H, Table H4).

NPDES

The City of Peabody Department of Public Services is permitted (MAG640028 effective September 1995) to discharge 0.12 MGD (average monthly) of wastewater from the Winona Pond Water Treatment Facility in Peabody, MA to Winona Pond (MA92077).

The Salem and Beverly Water Supply Board is permitted (MAG640059 effective January 2002) to discharge <1.0 MGD (average monthly flow) of wastewater from the Arlington Avenue Water Filtration Plant in Beverly, MA to Wenham Lake.

AQUATIC LIFE

Non-native macrophytes were observed in five of the 41 lakes surveyed by DWM in 1995 and/or 2000 (Appendix C, Table C1 and Mattson 2003). *Cabomba caroliniana* (fanwort) was observed in three lakes; Field Pond (Andover), Lowe Pond (Boxford), and Martins Pond (North Reading). The pepperwort, *Marsilea quadrifolia*, was observed in Stevens Pond, Boxford. *Myriophyllum spicatum* (Eurasian milfoil) was observed in Devils Dishfull Pond, Peabody. The *Aquatic Life Use* for these lakes is assessed as impaired. Figure 11 indicates where these non-native aquatic species were observed during the 1995 and/or 2000 surveys and the likely, or potential, avenues of downstream spreading.

Myriophyllum sp. (possibly the non-native variable water milfoil *M. heterophyllum)* was found in Pleasant Pond (Idelwood Lake), Wenham/Hamilton. At the time of the DWM surveys these plants had not matured sufficiently for positive identification. *M. heterophyllum* has a high potential for spreading and is likely to have established itself in downstream lake and river segments, which may not have been surveyed. Because *M. heterophyllum* is suspected the *Aquatic Life Use* is identified with an "Alert Status". Another unconfirmed non-native aquatic species, *Najas minor*, was reported by Merrimack College and Malcolm Pirnie Engineers (2003) to be in Martins Pond, North Reading.

Water quality sampling in Crystal Pond in the summer of 2000 found elevated levels of total phosphorus (0.064 to 0.15 mg/L) and chlorophyll *a* (4.6 to 45.7 mg/m^3) (Appendix C, Table C3). Dissolved oxygen concentrations ranged between 5.8 and 9.4 mg/L and saturation between 67 and 109%(qualified data excluded) (Appendix C, Table C2). Filamentous algal mats, duckweed and watermeal were abundant throughout the pond, particularly during the July 2000 sampling event. Based on these data the *Aquatic Life Use* is assessed as impaired. Suspected sources of nutrient inputs include runoff and waterfowl.

Significant oxygen depletion occurred in Devils Dishfull Pond throughout the summer of 2000 (Appendix C, Table C2). The phosphorus concentrations throughout the water column ranged from 0.014 to 0.086 mg/L and the chlorophyll a concentrations ranged from 12.0 to 31.7 mg/m^3 (Appendix C, Table C3). This pond was also infested with a non-native aquatic plant (Eurasian milfoil). Based on these data the *Aquatic Life Use* is assessed as impaired due to organic enrichment/low dissolved oxygen, somewhat elevated phosphorus concentrations, and the non-native aquatic macrophyte. Suspected sources of nutrient inputs include runoff.

The remaining 38 lakes in this watershed are not assessed for the *Aquatic Life Use* because of the cursory nature of the synoptic surveys and/or lack of dissolved oxygen data.

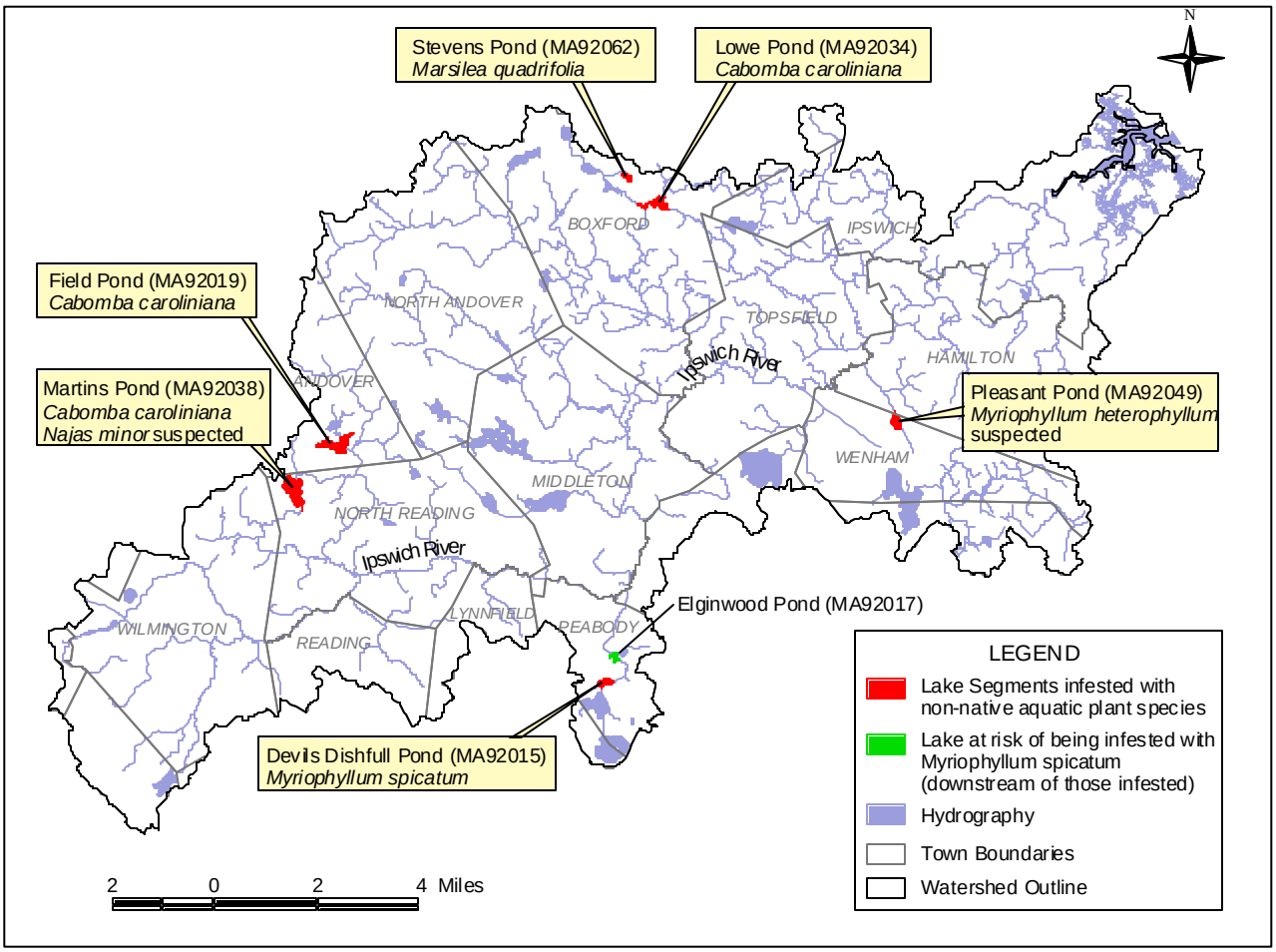


Figure 11. Presence of non-native aquatic vegetation documented in the Ipswich River Watershed and potential for downstream spreading.

The non-native wetland species *Lythrum salicaria* (purple loosestrife) was observed in 37 (90%) of the 41 lakes surveyed and *Phragmites australis* (common reed/reed grass) was observed in three (7%) of the 41 lakes (Appendix C, Table C1). Although the presence of these species is not generally a cause of impairment to lakes, their invasive growth habit can result in the impairment of wetland habitat associated with lakes.

FISH CONSUMPTION

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

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)."

MDPH's statewide advisory does not include fish stocked by the state Division of Fisheries and Wildlife or farm-raised fish sold commercially. The advisory encompasses all freshwaters in Massachusetts and, therefore, the *Fish Consumption Use* for lakes in the Ipswich River Basin cannot be assessed as support.

In September and October 1995 fish toxics monitoring was conducted by DWM in Martins Pond in North Reading and the mainstem Ipswich River in Middleton (near Bostik Company), respectively, at the request of the Ipswich River Watershed Team for human consumption considerations. PCB concentrations were below the MDPH action level of 2.0 ppm (Appendix G, Table 1). With the exception of a two fish composite sample of chain pickerel (Hg = 0.964 ppm), mercury concentrations were also below the MDPH action level of 0.5 ppm in Ipswich River fishes but were elevated in three species of fish from Martins Pond (Appendix G, Table 1). Because of elevated mercury concentrations MDPH issued a fish consumption advisory due to mercury contamination for Martins Pond in North Reading (MDPH 2002c). The advisory recommends the following.

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any largemouth bass, black crappie or yellow perch from this waterbody."
2. "The general public should limit consumption of largemouth bass, black crappie or yellow perch from this waterbody to two meals per month."

In May and August 2000 fish toxics monitoring was conducted by DWM in Hood Pond in Topsfield/Ipswich and the mainstem Ipswich River in North Reading (downstream from Central Street), respectively, at the request of the Ipswich River Watershed Team for human consumption considerations. PCB concentrations were below the MDPH action level of 2.0 ppm (Appendix G, Table 2). Mercury concentrations were also below the MDPH action level of 0.5 ppm in Ipswich River fishes but were elevated in four species of fish from Hood Pond (Appendix G, Table 2). Because of elevated mercury concentrations MDPH issued a fish consumption advisory due to mercury contamination for Hood Pond in Topsfield/Ipswich (MDPH 2002c). The advisory recommends the following.

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody."
2. "The general public should not eat any largemouth bass or yellow perch from this waterbody."
3. "The general public should limit consumption of non-affected fish from this waterbody to two meals per month."

A directed study of fish in lakes in northeastern Massachusetts was performed by the MA DEP Office of Research and Standards (ORS) during 1999 in order to examine possible spatial patterns in the occurrence of higher fish mercury concentrations and to compare the fish contamination situation in this localized geographic region to statewide and regional data (MA DEP 2000b). Two lakes in the Ipswich River Watershed included in this study were sampled by Normandeau and Associates (under contract to MA DEP ORS in 1999); Lowe Pond (Boxford) and Towne Pond (Boxford/North Andover). Because of elevated mercury concentrations MDPH issued a fish consumption advisory due to mercury contamination for Lowe Pond in Boxford (MDPH 2002c). The advisory recommends the following.

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody."
2. "The general public should not eat any largemouth bass from this waterbody."
3. "The general public should limit consumption of non-affected fish from this waterbody to two meals per month."

Four species of fish (eel, bluegill, rainbow trout, and largemouth bass) were collected by the Burlington Board of Health from Mill Pond in Burlington (Rose 2002). The samples were analyzed at the Wall Experiment Station. Because of elevated mercury concentrations MDPH issued a fish consumption advisory due to mercury contamination for Mill Pond in Burlington (MDPH 2002c). The advisory recommends the following.

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any largemouth bass from this waterbody."
2. "The general public should limit consumption of largemouth bass from this waterbody to two meals per month."

Four ponds - Martins Pond (North Reading), Hood Pond (Topsfield/Ipswich), Lowe Pond (Boxford), and Mill Pond (Burlington) - are impaired due to mercury contamination for the *Fish Consumption Use* (Table 10). The remaining lakes in the Ipswich River Basin are currently not assessed for the *Fish Consumption Use* due to the statewide fish consumption advisory. [NOTE: The MDPH fish consumption advisory list contains the status of each water body for which a site-specific 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. MDPH's most current Fish Consumption Advisory list is available online at: http://www.state.ma.us/dph/beha/fishlist.htm.]

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

In 1995 DWM conducted synoptic surveys of 41 lakes in the Ipswich River Watershed. These surveys included observations of water quality and quantity, the presence of native and non-native aquatic plants and presence/severity of algal blooms (Appendix C, Table C1). Additional data were collected in two of these lakes by DWM in 2000 for the purpose of TMDL development. These data, combined with the 1998 303(d) List of Waters, Beaches Bill monitoring, DEM bathing beach closures, MDPH bathing beach closures, and diagnostic/feasibility studies were used to assess the recreational and aesthetics uses.

In Crystal Pond two of three Secchi disk depth measurements violated the bathing beach guidance of four feet (Appendix C, Table C2). Because of the presence of algae and duckweed blooms the *Primary* and *Secondary Contact Recreational* and *Aesthetic* uses are assessed as impaired. Additionally, approximately 55% of the lake biovolume (the 3-dimensional space available for biological growth) has dense/very dense vegetation. Suspected sources of nutrient inputs that would support these conditions include runoff and waterfowl.

Approximately 76% of Devils Dishfull Pond biovolume has dense/very dense vegetation, including *Myriophyllum spicatum*. Because of this high percentage of biovolume of a non-native aquatic plant the *Primary* and *Secondary Contact Recreational* and *Aesthetic* uses are assessed as impaired. None of the Secchi disk depth measurements in Devils Dishfull Pond violated the bathing beach guidance of four feet (Appendix C, Table C2).

Two lakes in Harold Parker State Forest, Berry Pond and Frye Pond, were closed to swimming due to elevated levels of *Enterococci*. Berry Pond (MA92003) was closed to swimming between 2 August and 9 August 2001 and again between 3 July and 6 July 2002. Frye Pond (MA92023) was also closed to swimming between 2 August and 6 August 2001 (MA DEM 2002 and MDPH 2002b).

The Ipswich Board of Health has a beach at Hood Pond (MA92025) and sampled it weekly for bacteria. The beach was closed to swimming between 26 July and 1 August 2002 due to elevated levels of *Enterococci* (MDPH 2002b) but remained open for the rest of the swimming season (Hough 2003). The Topsfield Board of Health agents reported no postings of the beach at Hood Pond in Topsfield in 2002 or 2003 (Cormier 2004 and Decie 2004). The Boxford Board of Health has the beach at Stiles Pond sampled weekly for bacteria from Memorial Day weekend through Labor Day weekend. The beach has not been posted or closed during the 2001, 2002 or 2003 swimming seasons (Cody 2003).

In lakes that were unaffected by macrophyte growth or where macrophyte growth was likely to be naturally occurring (including many lakes that were noted to have dense/very dense plant growth during the 1995 synoptic surveys) the *Primary* and *Secondary Contact Recreational uses* were not assessed due to lack of current bacteria data.

Table 10. Ipswich River Watershed Lake Use Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Beaver Pond, Beverly.	MA92002	19	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Beaver Pond is on the 1998 303(d) List of Waters, needing confirmation, because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring.							
Berry Pond, North Andover	MA92003	4	NOT ASSESSED	NOT ASSESSED	SUPPORT	SUPPORT	NOT ASSESSED
Berry Pond is in the DEM Harold Parker State Forest in North Andover. The pond has a public bathing beach and is open Memorial Day to Labor Day. The pond was closed to swimming once for 7 days during the 2001 swimming season and once for 3 days during the 2002 swimming season because of elevated bacteria. Because the beach was open for the vast majority of the 2001 and 2002 bathing seasons the *Recreational* uses are assessed as support. The *Aesthetics Use* is not assessed.							
Brackett Pond, Andover.	MA92004	16	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Brackett Pond is on the 1998 303(d) List of Waters because of turbidity (Table 3). DWM conducted a synoptic survey of Brackett Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Bradford Pond, North Reading.	MA92005	14	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Bradford Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. DWM conducted a synoptic survey of Bradford Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Collins Pond, Andover.	MA92010	2	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Collins Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants and turbidity (Table 3). DWM conducted a synoptic survey of Collins Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Creighton Pond, Middleton.	MA92011	19	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
DWM conducted a synoptic survey of Creighton Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Crystal Pond, Peabody.	MA92013	8	IMPAIRED (Excess algal growth, chlorophyll *a* and total phosphorus)	NOT ASSESSED	IMPAIRED (Excess algal growth, Secchi disk transparency, and total phosphorus)	IMPAIRED (Excess algal growth, Secchi disk transparency, and total phosphorus)	IMPAIRED (Excess algal growth, Secchi disk transparency, and total phosphorus)
Crystal Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). DWM conducted a synoptic survey of Crystal Pond in 1995; the non-native wetland plants *Lythrum salicaria* and *Phragmites sp*. were identified (Appendix C, Table C1). During the DWM surveys conducted at the pond in the summer of 2000 the surface water was densely covered with algae, duckweed and watermeal. High total phosphorus concentrations and chlorophyll *a* measurements were also documented (Appendix C, Table B2). Based on these data the *Aquatic Life Use* was assessed as impaired. Additionally, the Secchi disk depth bathing beach guidance was violated on two of three sampling dates. Because of the Secchi disk measurements and the nuisance plant growth the *Recreational* and *Aesthetic* uses are impaired. The City of Peabody was awarded a DEM Lakes and Ponds Grant (1995) to develop a lake and watershed management plan to improve water quality and decrease sediment loading in Crystal Lake and Elginwood Pond. The City of Peabody was also awarded a DEM Lakes and Ponds Grant (2000) to develop a watershed management brochure for the residences and businesses in the watershed of Crystal Lake and Elginwood Pond.							

Table 10 cont. Ipswich River Watershed Lake Use Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Devils Dishfull Pond, Peabody.	MA92015	14	IMPAIRED (Non-native aquatic plants - *Myriophyllum spicatum* , low dissolved oxygen and saturation and total phosphorus)	NOT ASSESSED	IMPAIRED (Non-native aquatic plants – *Myriophyllum spicatum*)	IMPAIRED (Non-native aquatic plants – *Myriophyllum spicatum*)	IMPAIRED (Non-native aquatic plants – *Myriophyllum spicatum*)
Devils Dishfull Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants and turbidity (Table 3). Significant oxygen depletion, moderate total phosphorus concentrations, and elevated chlorophyll*a* measurements were documented by DWM during the summer of 2000 (Appendix C, Tables B1 and B2). The pond was also found to be infested with the non-native aquatic species, *Myriophyllum Spicatum* , in 2000. Based on these data the *Aquatic Life Use* is assessed as impaired. Because of the high percentage of biovolume occupied by aquatic macrophytes including a non-native aquatic plant in Devils Dishfull Pond, the *Primary* and *Secondary Contact Recreational* and *Aesthetic* uses are also assessed as impaired. It should also be noted that DWM also identified the presence of the non-native wetland plant L*ythrum salicaria* during both the synoptic survey in 1995 and the baseline lake surveys conducted in the summer of 2000 (Appendix C, Table C1 and Mattson *et al*. 2003).							
Eisenhaures Pond, North Reading.	MA92016	12	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Eisenhaures Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. The Town of North Reading and the Martin's Pond Association were awarded a Lakes and Ponds Grant (1994) to develop a town-wide watershed management plan and for educating the public on Martin's Pond, Eisenhower Pond, Swan Pond and Furbish Pond. DWM conducted a synoptic survey of Eisenhaures Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Elginwood Pond, Peabody.	MA92017	9	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Elginwood Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. The City of Peabody was awarded a DEM Lakes and Ponds Grant (1995) to develop a lake and watershed management plan to improve water quality and decrease sediment loading in Crystal Lake and Elginwood Pond. The City of Peabody was also awarded a DEM Lakes and Ponds Grant (2000) to develop a watershed management brochure for the residences and businesses in the watershed of Crystal Lake and Elginwood Pond. DWM conducted a synoptic survey of Elingwood Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Emerson Brook Reservoir (formerly known as Forest Street Pond), Middleton	MA92021	195	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Emerson Brook Reservoir is a Class A public water supply. The Danvers Water Department has a surface water intake from Emerson Brook Reservoir (WMA permit 31707101). Additional information is available in Appendix D.							
Farnum Street Pond, North Andover.	MA92018	9	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Farnum Street Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. DWM conducted a synoptic survey of Farnum Street Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							

Table 10 cont. Ipswich River Watershed Lake Use Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Field Pond, Andover.	MA92019	57	IMPAIRED (Non-native aquatic plants – *Cabomba caroliniana*)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Field Pond is infested with the non-native aquatic species *Cabomba caroliniana* (Appendix C, Table C1) so the *Aquatic Life Use* is assessed as impaired. DWM conducted a synoptic survey of Field Pond in 1995; the non-native wetland plant L*ythrum salicaria* was also identified (Appendix C, Table C1).							
Fourmile Pond, Boxford.	MA92022	29	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Fourmile Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. No non-native aquatic or wetland plants were observed during the 1995 synoptic survey (Appendix C, Table C1).							
Frye Pond, Andover.	MA92023	7	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED*	NOT ASSESSED*	NOT ASSESSED
Frye Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). In 1995 DWM conducted a synoptic survey of Frye Pond; no non-native aquatic or wetland plants were observed (Appendix C, Table C1). However, extensive duckweed and other aquatic plant cover indicated generally poor water quality. Frye Pond is located in the Harold Parker State Forest. The public beach at the pond was closed to swimming for a 4 day period during the 2001 swimming season. Although the beach was open for the vast majority of the 2001 and 2002 bathing seasons the *Recreational* and *Aesthetic* uses are not assessed. Because of the 1995 survey information, which indicated water quality problems, they are identified with an Alert Status.							
Hood Pond, Ipswich.	MA92025	67	NOT ASSESSED	IMPAIRED (Mercury)	SUPPORT	SUPPORT	NOT ASSESSED
Hood Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that these conditions in this pond were likely naturally occurring. DWM conducted a synoptic survey of Hood Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1). Fish contaminant monitoring was conducted by DWM in Hood Pond in 2000 (Appendix G, Table 2). Because of elevated mercury concentrations in largemouth bass and yellow perch MDPH issued a site-specific fish consumption advisory for Hood Pond so the *Fish Consumption Use* is assessed as impaired. Hood Pond has a public access site. The semipublic beach near the boat ramp at Hood Pond in Ipswich was closed to swimming for a 6-day period during the 2002 swimming season because of elevated bacteria. No postings were reported by the Topsfield Board of Health agents for the beach on the pond in Topsfield. Because the beach was open for the vast majority of the 2002 bathing season the *Recreational* uses are assessed as support. The *Aesthetics Use* is not assessed.							
Howes Pond, Boxford.	MA92026	7	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Howes Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that these conditions in this pond were likely naturally occurring. DWM conducted a synoptic survey of Howes Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Kimballs Pond, Boxford.	MA92027	7	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
In 1995 DWM conducted a synoptic survey of Kimballs Pond and no non-native aquatic or wetland plants were observed (Appendix C, Table C1).							

Table 10 cont. Ipswich River Watershed Lake Use Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Longham Reservoir, Wenham/Beverly.	MA92030	34	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Longham Reservoir is a Class A Public Water Supply. The Salem & Beverly Water Supply Board has a surface water intake from Longham Reservoir (WMA permit 31725801). Additional information is available in Appendix D. A USGS report which includes this reservoir is also available (Appendix E, 104(b) Project 97-07).							
Lowe Pond, Boxford.	MA92034	36	IMPAIRED (Non-native aquatic plants – *Cabomba caroliniana*)	IMPAIRED (Mercury)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Lowe Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that these conditions in this pond were likely naturally occurring. The pond, however, is infested with the non-native aquatic species *Cabomba caroliniana* (Appendix C, Table C1) so the *Aquatic Life Use* is assessed as impaired. The non-native wetland plant *Lythrum salicaria* was also identified. Fish contaminant monitoring was conducted by Normandeau and Associates in Lowe Pond in 1999 as part of the DEP ORS mercury study (Rose 2002). Because of elevated mercury concentrations in largemouth bass MDPH issued a site-specific fish consumption advisory for Lowe Pond so the *Fish Consumption Use* is assessed as impaired.							
Lower Boston Brook Pond, Middleton.	MA92031	9	NOT ASSESSED*	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
DWM conducted a synoptic survey of Lower Boston Brook Pond in 1995; the non-native wetland plant L*ythrum salicaria* covered >90% pond (Appendix C, Table C1). Although these data are too old to make an assessment the *Aquatic Life Use* is identified with an Alert Status.							
Lower Fourmile Pond, Boxford.	MA92032	18	NOT ASSESSED*	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Lower Fourmile Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). DWM conducted a synoptic survey of Lower Fourmile Pond in 1995; the non-native wetland plant L*ythrum salicaria* covered much of the pond (Appendix C, Table C1). Although these data are too old to make an assessment the *Aquatic Life Use* is identified with an Alert Status.							
Lubber Pond East, Wilmington.	MA92035	6	NOT ASSESSED*	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Lubber Pond East is on the 1998 303(d) List of Waters because of siltation and noxious aquatic plants (Table 3). Although these data are too old to make an assessment the *Aquatic Life Use* is identified with an Alert Status. DWM conducted a synoptic survey of Lubber Pond East in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Lubber Pond West, Wilmington.	MA92036	10	NOT ASSESSED*	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Lubber Pond West is on the 1998 303(d) List of Waters because of siltation and noxious aquatic plants (Table 3). Although these data are too old to make an assessment the *Aquatic Life Use* is identified with an Alert Status. DWM conducted a synoptic survey of Lubber Pond West in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							

Table 10 cont. Ipswich River Watershed Lake Use Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Martins Pond, North Reading.	MA92038	89	IMPAIRED (Non-native aquatic plants – *Cabomba caroliniana*)	IMPAIRED (Mercury)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Martins Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants and turbidity (Table 3). A diagnostic/feasibility study for the management of the Martins Pond is available (Anderson-Nichols & Co., Inc. and Lycott Environmental Research, Inc. 1985). The Town of North Reading and the Martin's Pond Association were awarded a Lakes and Ponds Grant (1994) to develop a town-wide watershed management plan and for educating the public on Martin's Pond, Eisenhaures Pond, Swan Pond and Furbish Pond. A DEM Lakes and Ponds Grant (1997) was awarded to the Town for the Turtle Trail Project. The purpose of the Turtle Trail project was to develop a small basin area next to the pond. An interpretive trail at the basin area will educate the public about the pond and watershed. A DEM Lakes and Ponds Grant (2002) was awarded to the Town of North Reading and the Martin's Pond Association to prepare a lake and watershed management plan to deal with ecological impacts of accelerated eutrophication primarily due to nutrients and aquatic nuisance vegetation. The pond is infested with the non-native aquatic species *Cabomba caroliniana* (Appendix C, Table C1) so the *Aquatic Life Use* is assessed as impaired. The non-native wetland plant *Lythrum salicaria* was also identified. This study also noted a low frequency occurrence of the non-native aquatic species *Najas minor* (Merrimack College and Malcolm Pirnie Engineers 2003). However, this occurrence needs to be verified. Fish contaminant monitoring was conducted by DWM in Martins Pond in 1995 (Appendix G, Table 1). Because of elevated mercury concentrations in largemouth bass, black crappie, and yellow perch MDPH issued a site-specific fish consumption advisory for Martins Pond so the *Fish Consumption Use* is assessed as impaired. It should also be noted that there is a long-term potential for river herring restoration to Martins Pond, which would first require improvement of fish passage at Willowdale Dam and construction of a fishway at Bostik Company Dam (Chase 2003b).							
Middleton Pond, Middleton.	MA92039	129	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Middleton Pond is a Class A Public Water Supply. Danvers Water Department has a surface water intake from Middleton Pond (WMA permit 31707101). MIddleton Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that these conditions in this pond were likely naturally occurring. Additional information is available in Appendix D. DWM conducted a synoptic survey of Middleton Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Mill Pond, Burlington. (Mill Pond Reservoir)	MA92041	59	NOT ASSESSED	IMPAIRED (Mercury)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Mill Pond is a Class A Public Water Supply. Water is withdrawn from the Shawsheen River (Burlington Public Water Supply) and stored in Mill Pond for later withdrawal (LeVangie 2003b). Fish contaminant monitoring was conducted by the Burlington Board of Health in Mill Pond in 2000 (Rose 2002). Because of elevated mercury concentrations in largemouth bass MDPH issued a site-specific fish consumption advisory for Mill Pond so the *Fish Consumption Use* is assessed as impaired. Fish population sampling was conducted by DFWELE in Mill Pond on 17 August 2000 using boat electroshocking equipment. Sixty-eight yellow perch, 23 bluegill, 18 chain pickerel, 15 largemouth bass, six American eel, and two rainbow trout were collected. DWM conducted a synoptic survey of Mill Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Pierces Pond, Peabody.	MA92048	3	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
DWM conducted a synoptic survey of Pierces Pond in 1995; the non-native wetland plants L*ythrum salicaria* and *Phragmites australis* were identified (Appendix C, Table C1).							

Table 10 cont. Ipswich River Watershed Lake Use Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Pleasant Pond (Idlewood Lake), Wenham/Hamilton.	MA92049	27	NOT ASSESSED*	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
DWM conducted a synoptic survey of Pleasant Pond in 1995; a species of *Myriophyllum* (suspected *M. heterophyllum)* and the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1). Because of the report of a potential non-native aquatic species (*Myriophyllum heterophyllum*), which needs confirmation, the *Aquatic Life Use* is identified with an Alert Status.							
Putnamville Reservoir, Danvers.	MA92052	283	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Putnamville Reservoir is a Class A Public Water Supply. The Salem & Beverly Water Supply Board has a surface water intake from Putnamville Reservoir (WMA permit 31725801). Additional information is available in Appendix D. DWM conducted a synoptic survey of Putnamville Reservoir in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1). A USGS report, which includes this reservoir, is also available (Appendix E, 104(b) Project 97-07).							
Salem Pond, North Andover.	MA92057	15	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Salem Pond is on the 1998 303(d) List of Waters because of turbidity (Table 3). In 1995 DWM conducted a synoptic survey of Salem Pond and no non-native plants were observed.							
Salem Street Pond (unnamed gravel pit pond), North Andover	MA92076	11	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
DWM conducted a synoptic survey of Salem Street Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Silver Lake, Wilmington.	MA92059	30	NOT ASSESSED	NOT ASSESSED	SUPPORT	SUPPORT	NOT ASSESSED
Note: A diagnostic/feasibility study for the management of Silver Lake is available (BEC, Inc. 1988). The Town of Wilmington was awarded a DEM Lakes and Ponds Grant (1998) to develop an education program and a management plan that included water quality sampling. The public "Town Beach" on Silver Lake was closed to swimming for a 6-day period during the 2002 swimming season because of elevated bacteria (Delgenio 2003). Because the beach was open for the vast majority of the 2002 bathing season the *Recreational* uses are assessed as support. The *Aesthetics Use* is not assessed. DWM conducted a synoptic survey of Silver Lake in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Spofford Pond, Boxford.	MA92060	28	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Spofford Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that these conditions in this pond were likely naturally occurring. DWM conducted a synoptic survey of Spofford Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Stearns Pond, North Andover.	MA92061	43	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Stearns Pond is a Class A Public Water Supply (tributary to Emerson Brook Reservoir). Stearns Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that these conditions in this pond were likely naturally occurring. DWM conducted a synoptic survey of Stearns Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							

Table 10 cont. Ipswich River Watershed Lake Use Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Stevens Pond, Boxford.	MA92062	11	IMPAIRED (Non-native aquatic plants – *Marsilea quadrifolia*)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
The pond is infested with the non-native aquatic species *Marsilea quadrifolia* (Appendix C, Table C1) so the *Aquatic Life Use* is assessed as impaired. The non-native wetland plant *Lythrum salicaria* was also observed during the 1995 synoptic survey.							
Stiles Pond, Boxford.	MA92063	59	NOT ASSESSED	NOT ASSESSED	SUPPORT	SUPPORT	NOT ASSESSED
DWM conducted a synoptic survey of Stiles Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1). The public beach at Stiles Pond has been open for the entire 2001, 2002 and 2003 bathing seasons (Cody 2003) so the *Recreational* uses are assessed as support. The *Aesthetics Use* is not assessed.							
Sudden Pond, North Andover.	MA92064	5	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Sudden Pond is a Class A Public Water Supply (tributary to Emerson Brook Reservoir). Sudden Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that these conditions in this pond were likely naturally occurring. DWM conducted a synoptic survey of Sudden Pond in 1995; the non-native wetland plant *Phragmites australis* was identified (Appendix C, Table C1).							
Suntaug Lake, Lynnfield/Peabody	MA92065	150	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Suntaug Lake is a Class A Public Water Supply. The Peabody Department of Public Works has a surface water Intake from Suntaug Lake (WMA permit 31722901). Additional information is available in Appendix D. DWM conducted a synoptic survey of Suntaug Lake in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1). A USGS report, which includes this lake, is also available (Appendix E, 104(b) Project 97-07).							
Swan Pond, North Reading.	MA92066	42	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Swan Pond is a Class A Public Water Supply. Danvers Water Department has a surface water intake from Swam Pond (WMA permit 31707101). Additional information is available in Appendix D. The Town of North Reading and the Martin's Pond Association was awarded a Lakes and Ponds Grant (1994) to develop a town-wide watershed management plan and for educating the public on Martin's Pond, Eisenhower Pond, Swan Pond and Furbish Pond. DWM conducted a synoptic survey of Swan Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Towne Pond, Boxford/North Andover.	MA92068	23	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Towne Pond is on the 1998 303(d) List of Waters because of siltation and noxious aquatic plants (Table 3). After reevaluating information it was determined that these conditions in this pond were likely naturally occurring. Fish contaminant monitoring was conducted by Normandeau and Associates in Towne Pond in 1999 as part of the MA DEP ORS mercury study (Appendix G). No site-specific fish consumption advisory for Towne Pond was issued so the *Fish Consumption Use* is not assessed (precluded by the statewide advisory). DWM conducted a synoptic survey of Towne Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							

Table 10 cont. Ipswich River Watershed Lake Use Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Upper Boston Brook Pond, Middleton.	MA92070	7	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Upper Boston Brook Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that these conditions in this pond were likely naturally occurring. DWM conducted a synoptic survey of Upper Boston Brook Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1).							
Wenham Lake, Wenham/Beverly.	MA92073	243	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Wenham Lake is a Class A Public Water Supply. The Salem & Beverly Water Supply Board has a surface water intake from Wenham Lake (WMA permit 31725801). Additional information is available in Appendix D. The Salem and Beverly Water Supply Board is permitted (MAG640059 effective January 2002) to discharge <1.0 MGD (average monthly flow) of wastewater from the Arlington Avenue Water Filtration Plant in Beverly, MA to Wenham Lake Reservoir. Fly ash from a nearby disposal area, the former Vitale gravel pit, has been deposited in the sediments of Airport Brook and in a cove where the brook discharges to Wenham Lake. Plans are being developed by National Grid, the owner of the power plant that generated the ash, to remove the ash from the brook and cove. A Technical Advisory Committee has been participating in the planning of the project. The Committee includes representatives of the Wenham Lake Watershed Association, the Town of Wenham, the cities of Salem and Beverly and MA DEP (Chalpin 2003). DWM conducted a synoptic survey of Wenham Lake in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1). A USGS report, which includes this lake, is also available (Appendix E, 104(b) Project 97-07).							
Winona Pond, Peabody	MA92077	91	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Winona Pond is a Class A Public Water Supply. The Peabody Department of Public Works has a surface water Intake from Winona Pond (WMA permit 31722901). Additional information is available in Appendix D. The City of Peabody Department of Public Services is permitted (MAG640028 effective September 1995) to discharge 0.12 MGD (average monthly) of wastewater from the Winona Pond Water Treatment Facility in Peabody, MA to Winona Pond. The City needs to reapply for a new permit since their permit has expired. DWM conducted a synoptic survey of Winona Pond in 1995; the non-native wetland plant L*ythrum salicaria* was identified (Appendix C, Table C1). A USGS report, which includes this pond, is also available (Appendix E, 104(b) Project 97-07).							

RECOMMENDATIONS – LAKES

- Confirm the presence of *Myriophyllum heterophyllum*, which is suspected to occur in Pleasant Pond (Idelwood Lake), Wenham/Hamilton and *Najas minor*, which is suspected to be in Martins Pond, North Reading.

- Coordinate with DCR and/or other groups conducting lake surveys to generate quality assured lake data. Conduct more intensive lake surveys to better determine the lake trophic and use support status and identify causes and sources of impairment. As sources are identified within lake watersheds they should be eliminated or, at least, minimized through the application of appropriate point or non-point source control techniques.

- Implement recommendations identified in lake diagnostic/feasibility studies, including lake watershed surveys to identify sources of impairment.

- Continue to review data from "Beaches Bill" required water quality testing (bacteria sampling at all formal bathing beaches) to assess the status of the recreational uses.

- Quick action is necessary to manage non-native aquatic or wetland plant species that are isolated in one or a few location(s) in order to alleviate the need for costly and potentially fruitless efforts to do so in the future. Two courses of action should be pursued concurrently. More extensive surveys need to be conducted, particularly downstream from these recorded locations to determine the extent of the infestation. And, "spot" treatments (refer to the Final Generic Environmental Impact Report for Eutrophication and Aquatic Plant Management in Massachusetts [Mattson et *al.* 2003] for advantages and disadvantages of each) should be undertaken to control populations at these sites. These treatments include careful hand-pulling of individual plants in small areas. In larger areas other techniques, such as selective herbicide application, may be necessary. In either case, the treatments should be undertaken prior to fruit formation and with a minimum of fragmentation of the individual plants. These actions will minimize the spreading of the populations. The aquatic plant management report (Mattson et *al*. 2003) should be consulted prior to the development of any lake management plan to control non-native aquatic or wetland plant species.

- Where non-native plant infestations are more widespread conduct additional monitoring to determine the extent of the problem. The Final Generic Environmental Impact Report for Eutrophication and Aquatic Plant Management in Massachusetts (Mattson et *al*. 2003) should be consulted prior to the development of any lake management plan to control non-native aquatic plant species. Plant control options can be selected from several techniques (e.g., bottom barriers, drawdown, herbicides, etc.) each of which has advantages and disadvantages that need to be addressed for the specific site. However, methods that result in fragmentation (such as cutting or raking) should not be used because of the propensity for some invasive species of these plants to reproduce and spread vegetatively (from cuttings).

- Prevent spreading of invasive aquatic plants. Once the extent of the problem is determined and control practices are exercised, vigilant monitoring needs to be practiced to guard against infestations in unaffected areas and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert lake-users to the problem and responsibility of spreading these species.

- Review the MA DEP Drinking Water Program SWAP evaluations when they are completed to develop and implement appropriate recommendations for the protection of Class A lakes in the Ipswich River Watershed including: Emerson Brook Reservoir, Longham Reservoir, Middleton Pond, Mill Pond, Putnamville Reservoir, Suntaug Lake, Swan Pond, Wenham Lake, and Winona Pond.

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Table 2. Summary of RBP III data analysis for macroinvertebrate communites sampled at four stream sites (FB01, HB01, MB02, IP06) in the Ipswich River watershed and one stream site (MR03) in the Parker River watershed. Seven biological metrics were calculated and scored (in parentheses) for taxa collected at each station. Scores were totaled and compared to the regional reference station. The percent comparability to the reference station yields a final impairment score for each study site.

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APPENDIX A

Technical Memorandum TM-92-5
IPSWICH RIVER WATERSHED
DWM YEAR 2000 WATER QUALITY MONITORING DATA

DWM Control Number: 088.1

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
ELLEN ROY HERZFELDER, SECRETARY
MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
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GLENN HAAS, DIRECTOR

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Sampling of the Ipswich River basin was conducted in 2000 to address DWM program objectives. Specific ones for the Ipswich River are outlined below. It began with biological assessment in June. This was followed by dissolved oxygen sampling (pre-dawn) in July and then water quality sampling i.e., nutrients, bacteria and other physico-chemical parameters, in August and September. The DWM sampling plan matrix for the Year Two monitoring is presented in Table 1. Sampling components at river stations included: *in-situ* Hydrolab™ measurements, physico-chemical and nutrient sampling, benthic macroinvertebrate and periphyton sampling. Surveys for the development of total maximum load (TMDL) were done at Devils Dishfull Pond, Peabody and Crystal Pond, Peabody. Each sampling component - except for the lakes - is described in the sections that follow.

Project Objectives
The primary water quality objectives of this sampling, as outlined in CN 44.0 Ipswich River Water Quality-Quality Assurance Project Plan, were to:

- Obtain sufficient data to help determine or confirm if certain segments and tributaries should be on the 303d list for low DO or for nutrients;
- Perform biological assessment of certain segments and tributaries to evaluate if they are impaired and to look for trends from previous sampling events;
- Obtain nutrient, physico-chemical and biological data for 305b assessment from one or two unassessed tributaries;
- Re-sample sites that were included in the 1995 survey for nutrients, DO and chemistry and biological sampling to help establish trends;
- Obtain fish toxics data from two waterbodies in the Ipswich River watershed;
- Another objective was to evaluate a method of identifying sources of fecal contamination in the Ipswich River using antibiotic resistance of the enterococci bacteria.
- ***Another objective was not accomplished during the 2000 sampling. It had been planned to try to assist Dr. Oscar Pancorbo (Wall Experiment Station, Lawrence) in the evaluation of sources of fecal contamination in the Ipswich River using antibiotic resistance of the Enterococci bacteria. However, validating methods at WES led to delays so that the Ipswich could not be included in this research.***

This technical memorandum presents the water quality sampling component of the survey. Results of the other monitoring efforts such as biological assessment and the lake Total Maximum Daily Load are described in separate memoranda or reports.

Methods
Water quality samples were collected at the Ipswich River basin on the dates and for the parameters as shown in Table 1. See Fig. 1 for station locations. The parameters included in the sampling were: *in-situ* Hydrolab ™ measurements (dissolved oxygen, percent saturation, pH, conductivity, temperature and total dissolved solids), physico-chemical and nutrient sampling. The water quality sampling procedures are included in the publication: *Grab Collection Techniques for DWM Water Quality Sampling, Standard Operating Procedure* (MA DEP 1999). SOP (2001) CN 4.0 outlines the standard operating procedures for the Hydrolab ™. Samples for total suspended solids, nutrients (nitrate-N, ammonia-N, total phosphorus) total alkalinity, total hardness, chlorides and conductivity were analyzed at the Wall Experiment Station (WES), the Department's analytical laboratory in Lawrence, Massachusetts.

The quality control and assurance plan is included in CN 44.0 *Ipswich River Water Quality Quality Assurance Project Plan* and *2000 Benthic Macroinvertebrate Biomonitoring Quality Assurance Project Plan.* **One additional water quality station was sampled LB03-Lubbers Brook, Glen Rd., Wilmington (see Fig. 1).**

Field sheets, raw data files, chain of custody forms, lab reports, and other metadata used in this report are managed and maintained by DEP DWM in the *Water Quality Access Database* in Worcester, MA. Several people were involved in the validation of the water quality data. This work included data entry into DWM databases, data entry quality control checks, analysis for outliers, blank contamination, duplicates, precision and holding time violations and project level review. Following this is project level review. The project coordinator, as identified in the QAPP for the Ipswich River, reviews the data for reasonableness, completeness and acceptability, see CN 83.0 for more detail regarding DWM data validation of 2000 Ipswich data.

Table 1: Ipswich River Basin Sampling Summary For Water Quality - 2000 Location, Parameters, Segment Numbers								
Location and segment numbers	**Sta No.**	**Aug 1**	**Aug 8**	**Aug 9**	**Aug 24**	**Aug 31**	**Sept 1**	**Sept 7**
Ipswich River, Mill St., North Reading/Reading, upstream of Station IP02 (segment 92-06)	IP1.5	C, N, TSS	DO	DO-am	DO, C, N, TSS	DO	DO-am	DO
Ipswich River, Route 28, North Reading/Reading, downstream (segment 92-06)	IP02	C, N, TSS	DO	DO-am	DO, C, N, TSS	DO	DO-am	DO
Maple Meadow Brook, Federal St., Wilmington (segment 92-04)	MM01	C, N, TSS	DO	DO-am	DO, C, N, TSS	DO	DO-am	DO
Lubbers Brook, Concord St, Wilmington (segment 92-05)	LB02	C, N, TSS	DO	DO-am	DO, C, N, TSS	DO	DO-am	DO
Lubbers Brook-Glen Rd., Wilmington (segment 92-05)	LB03							DO
Martins Brook, downstream/east at Park St., North Reading (segment 92-08)	MB02B	C, N, TSS	DO	DO-am	DO, C, N, TSS	DO	DO-am	DO
Martins Brook, Burroughs Rd., N. Reading (outlet Martins Pond) (segment 92-08)	MB01	C, N, TSS	DO	DO-am	DO, C, N, TSS	DO	DO-am	DO
Martins Brook-downstream/south at Salem St., Wilmington (segment 92-08)	MB03							DO
DO-dissolved oxygen, DO-am, early morning DO C-total alkalinity, total hardness, chlorides N-nitrates, ammonia, total phosphorus (low level) TSS-total suspended solids								

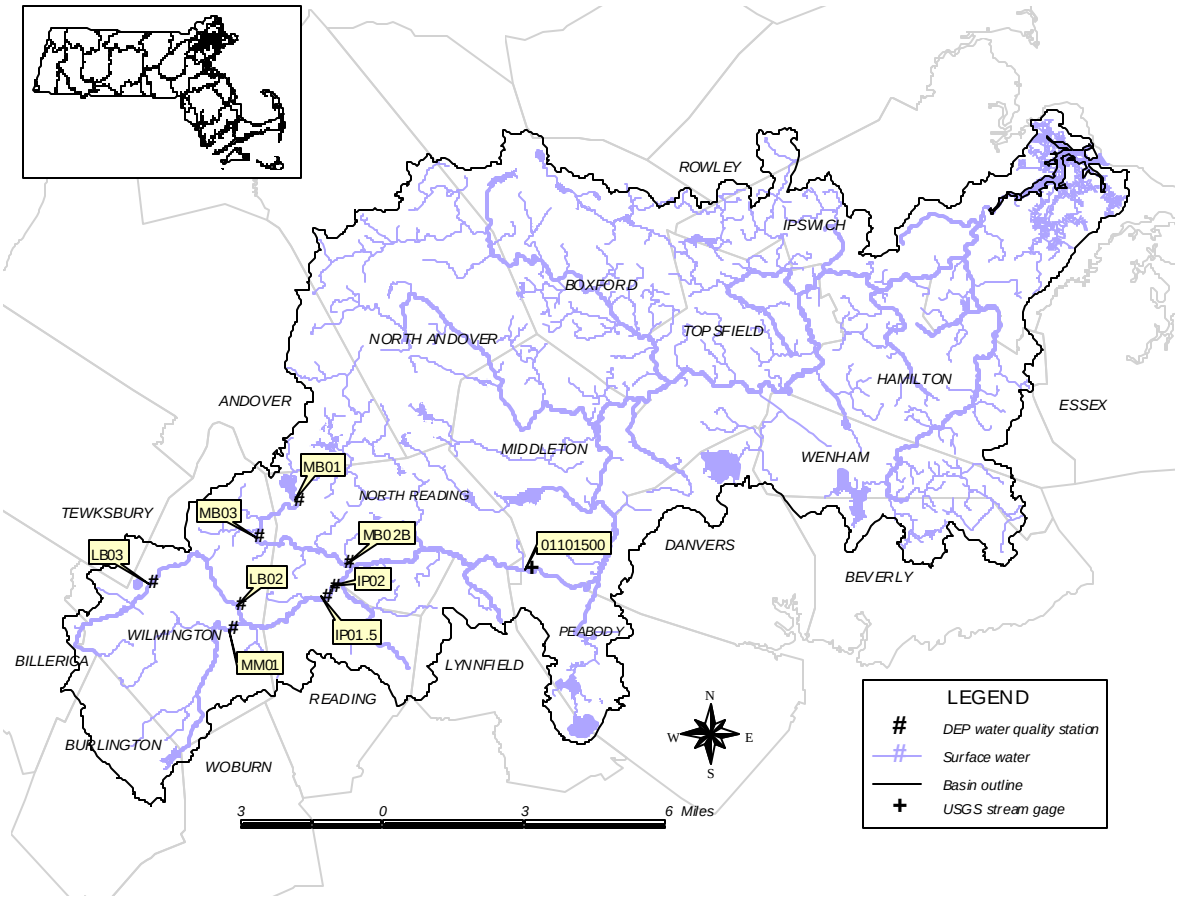

Figure 1: Ipswich River Basin Water Quality Sampling Stations - 2000

Survey Conditions

Table 2 (precipitation) and Table 3 (stream discharge) contain information on the survey conditions during each sampling event. The stream discharge data are used to estimate hydrological conditions during water quality sampling and whether the bacterial sampling conditions should be described as wet or dry weather events. Wet weather is defined as precipitation within a five day antecedent period that leads to more than a slight increase in stream discharge (flow). During "dry weather", trace amounts of precipitation may fall, but no measurable change in stream flow occurs. Because the sources of bacterial contamination differ in wet and dry conditions, it is important to determine if the fecal coliform bacteria data were representative of "wet" or dry weather". The discharge values were also examined in relation to the 7-day, 10-year (7Q10) low flow.

The USGS stream gage at the Ipswich River, South Middleton No. 01101500 was used for streamflow (discharge) statistics (Socolow *et al*. 2000). It is located just outside the area included in the sampling area. Appendix A has figures of the flow data and precipitation data combined for the days prior to the sampling dates. The determination of 7Q10 was from the USGS *Gazetter of Hydrologic Characteristics of Streams in Massachusetts-Coastal River Basins of the North Shore and Massachusetts Bay* (Wandle and Fontaine, 1984).

The antecedent weather conditions for five days prior to sampling was determined by reviewing the National Oceanographic and Atmospheric Administration's data from their website (tgsv5.nws.noaa.gov/cgi-bin/box). The data from Beverly, Massachusetts were used as the closest town.

August 1, 2000-This survey was conducted during a relatively wet period, according to comments on weather conditions recorded by the DWM field crew, a light rain was falling during the survey period. There was a large storm event on July 27-at the beginning of the antecedent period- of 1.46 inches, a storm which dropped 0.69 inches of rain on July 31 and rain on August 1, the survey date, of 0.20 inches (Table 2). The heavy rain on July 27 led to an increase in the daily mean discharge which went from 16 cubic feet per second (cfs) on July 26 to 40 cfs on July 27 (Table 3). Peak mean discharge during the antecedent sampling period (July 27-July 31) occurred on July 28. The mean discharge declined after this peak to 49 cfs, but then increased to 62 cfs just before sampling on August 1 (Table 3, Appendix A, Figure A1). The mean discharge on Aug. 1 was approximately five times the mean monthly data for August for the water years 1938 to 2000. That mean discharge was 12.7 cfs. This is considered a wet weather survey.

August 8/ 9, 2000- According to comments on weather conditions recorded by the field crew, the sky was clear during the August 8 survey with air temperatures in the 90's F. The predawn survey (August 9) also had clear conditions as annotated in the field sheets. No significant amounts of precipitation occurred during the antecedent period, which extended from August 3 to August 7, prior to sampling. On August 3, 0.07 inches fell which was the most during this antecedent period (Table 2). Stream-flow declined daily during this time period from a high of 61 cfs on August 3 to a low of 36 cfs on August 7 (Table 3, Appendix A, Figure A1). Data collected on this survey are interpreted as being representative of dry weather conditions.

August 24, 2000- According to comments on weather conditions recorded by the field crew, the survey was conducted under clear skies and air temperatures 75-80 F. The day prior to sampling there was a rain event of 0.26 inches (Table 2) that contributed to an increase of 0.8 cfs (Table 3) on the sample date. The beginning part of the cycle began with a storm of 0.05 inches, following that flow declined each day (Appendix A, Figure A1) until the rain event described. This would be considered a wet weather survey.

August 31, 2000— According to comments on weather conditions recorded by the field crew, the skies were partially cloudy during the August 31 survey. Following the storm on August 24, no significant amount of precipitation occurred during the antecedent period which proceeded sampling on August 31. Only 0.01 inches of rain fell from the start of the antecedent period on August 26 until August 30 (Table 2, Appendix A, Figure A1). The mean daily discharge declined over this period from 6.9 cfs on August 26 to 3.9 cfs on August 30 (Table 3). Data collected on this survey were interpreted as being representative of dry weather conditions.

September 1, 2000- According to comments on weather conditions recorded by the field crew, the sky was clear during this sampling event. Even with two small precipitation events of 0.01 inches on August 29 and 31 (Table 2), the stream-flow continued to decline over the antecedent August values from a mean daily discharge of 5.8 cfs on August 27 to a low 3.4 cfs on August 31 (Table 2, Appendix A, Figure A1). On sampling day the streamflow mean was 3.1 cfs which was greater than the 7Q10 of 0.41 cfs (Wandle and Fontaine.1984). Data collected on this survey are interpreted as being representative of dry weather conditions.

September 7, 2000- According to comments on weather conditions recorded by the field crew, the sky was clear during the survey, and air temperatures relatively cool approximately 60-70 F. A storm event occurred at the beginning of the antecedent period of 0.37 inches (Table 2) that led to an increase in flow of 0.7 cfs (Appendix A, Figure A1). Flow declined though following this event and on the sample day it was 2.3 cfs, almost three times below the monthly mean, but still above the 7Q10 of 0.41 cfs. Data collected from this survey are interpreted as being representative of dry weather conditions.

Table 2: Ipswich River Basin Precipitation Data Summary (reported in inches of rain)

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Sample Date
National Weather Service at Beverly, MA (unofficial NWS data at http//tgsv5.nws.noaa.gov/er/box/clstns.htm)						
1 Aug	1.46	0.02	0.01	0.02	0.69	0.20
8 Aug	0.07	0.01	0.00	0.04	0.01	MFR
9 Aug	0.01	0.00	0.04	0.01	MFR	0.00
24 Aug	0.05	0.00	0.00	0.00	0.26	0.00
31 Aug	0.00	0.00	0.00	0.01	0.00	0.01
1 Sep	0.00	0.00	0.01	0.00	0.01	T
7 Sep	0.37	0.00	0.03	0.00	0.00	0.00
MFR-Missing from record, T= trace amounts						

Table 3: Ipswich River at South Middleton, MA-USGS Flow Data Summary Discharge in Cubic Feet per Second (cfs) Gage # 01101500

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Sample Date	Monthly Mean	POR* Mean
1 Aug	40	69	54	49	62	73	23.5	12.7
8 Aug	61	55	48	41	36	32	23.5	12.7
9 Aug	55	48	41	36	32	27	23.5	12.7
24 Aug	18	15	13	10	8.6	9.4	23.5	12.7
31 Aug	6.9	5.8	4.4	4.4	3.9	3.4	23.5	12.7
1 Sep	5.8	4.4	4.4	3.9	3.4	3.1	6.04	14.6
7 Sep	3.8	4.5	4.1	3.4	2.9	2.3	6.04	14.6
7Q10 @ USGS, So. Middleton, 0.41 cfs, Ipswich River POR*-Period of Record								

Water Quality Data

Water quality data are included for Hydrolab ™ parameters (dissolved oxygen, percent saturation, pH, temperature, dissolved solids and conductivity) (Appendix B), as well as for nutrients (total phosphorus, nitrate-N, ammonia-N), and physical chemistry (alkalinity, hardness, chloride, total suspended solids) (Appendix C).

Quality control sample data are also provided in Appendix C. Based on acceptable RPD's for field duplicates and the lack of contamination (i.e. <MDL) for ambient field duplicates, there was no censoring or qualification decisions made for 2000 Ipswich water quality for rivers (except for minor Hydrolab data qualifications, i.e. unstable readings-see Appendix B).

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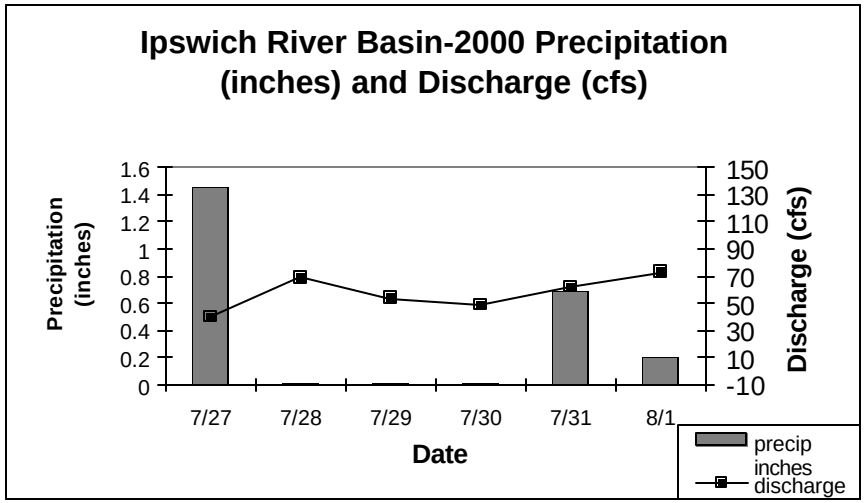
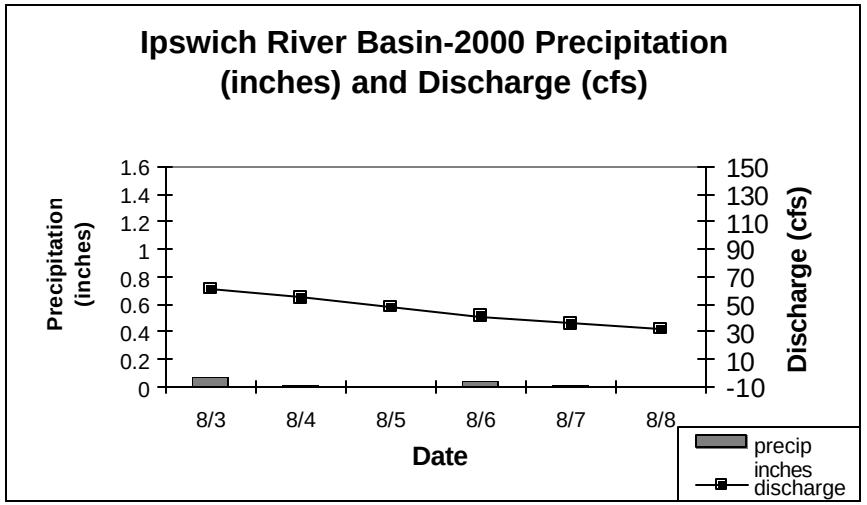
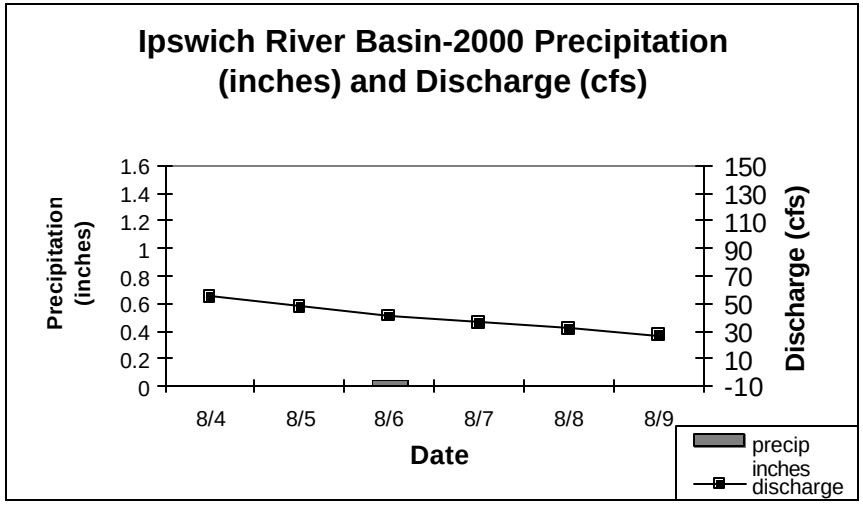
Appendix A: Graphs of Precipitation and Discharge Data

Figure A1: Ipswich River Basin 2000 Precipitation (inches) Measured at Beverly, Massachusetts and Discharge (cfs) Measured at the USGS gage (No. 01101500) South Middleton, Massachusetts - July 27, 2000 - September 7, 2000







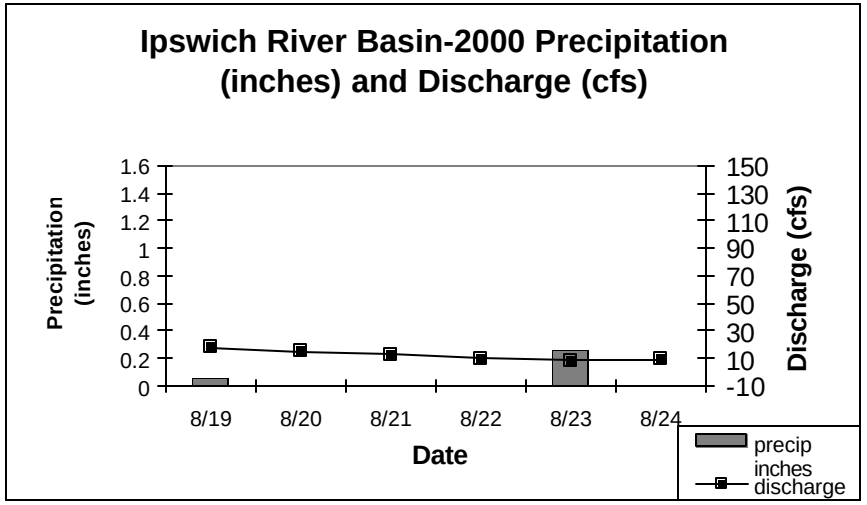
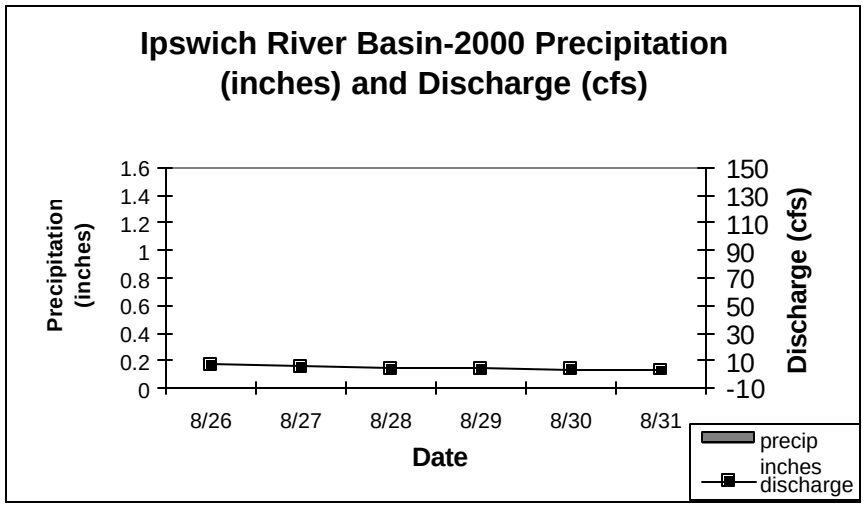
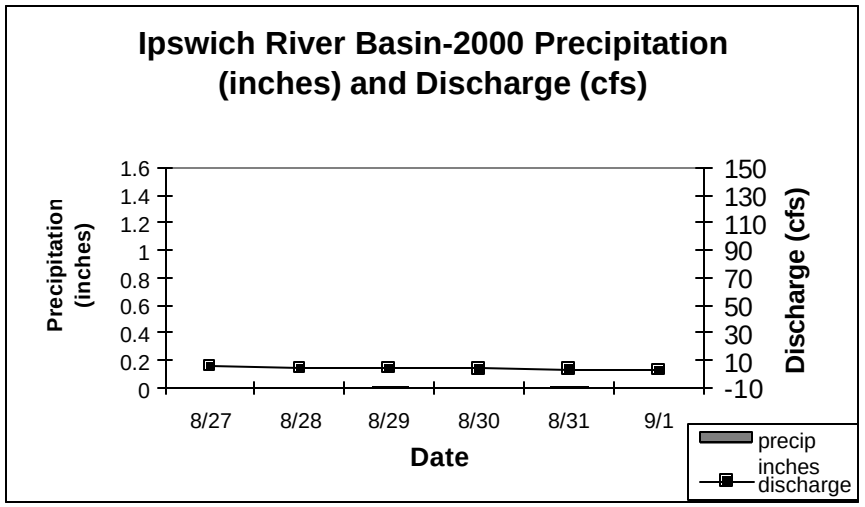
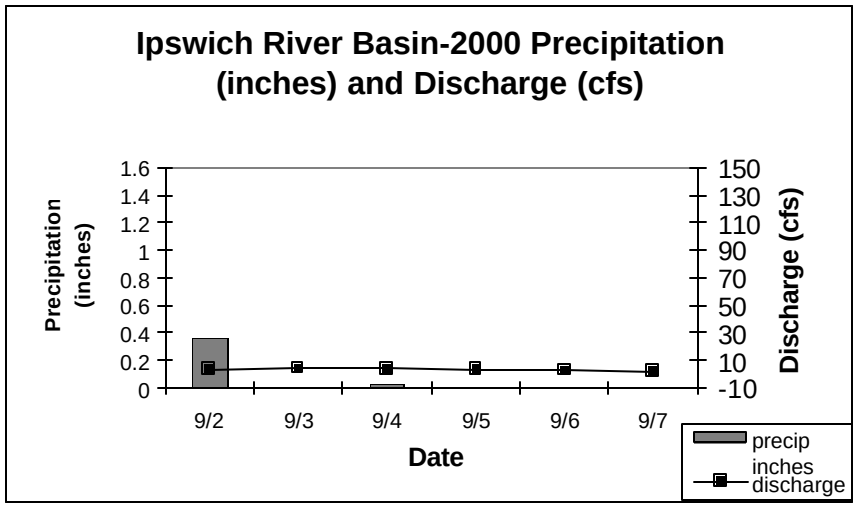


Figure A1 continued: Ipswich River Basin 2000 Precipitation (inches) Measured at Beverly, Massachusetts and Discharge (cfs) Measured at the USGS gage (No. 01101500) South Middleton, Massachusetts - July 27, 2000 - September 7, 2000







Appendix B: Ipswich River Basin Survey 2000 Hydrolab Data
Temperature, pH, Conductivity, Total Dissolved Solids, Dissolved Oxygen, % Saturation

IPSWICH RIVER (Saris: 9253500)
Station: IP01.5, Mile Point: 34.3, Unique ID: W0113
Description: at Mill Street, North Reading/Reading

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
8/8/2000	92-2221	14:04	0.3	23.1	6.4	308	197	2.2	25
8/9/2000	92-2228	03:08	0.4	22.1	6.4	308	197	1.8	21
8/24/2000	92-2235	12:48	0.2	19.0	6.3	323	207	3.1	33
8/31/2000	92-2250	12:59	0.6	21.0	6.3	341	218	3.3	36
9/1/2000	92-2259	03:08	0.5	21.8	6.4	342	219	3.3	36
9/7/2000	92-2270	14:06	0.6	16.5	6.3	341	218	4.1	41

IPSWICH RIVER (Saris: 9253500)
Station: IP02, Mile Point: 34, Unique ID: W0114
Description: at Route 28, North Reading/Reading

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
8/8/2000	92-2222	13:30	0.4	22.8	6.4	303	194	3.0	34
8/9/2000	92-2229	02:47	0.4	22.2	6.5	308	197	2.8	32
8/24/2000	92-2237	12:19	0.4	18.6	6.4	323	206	4.5	48
8/31/2000	92-2251	12:32	0.6	20.7	6.4	340	218	4.8	52
9/1/2000	92-2260	02:46	0.6	21.7	6.5	341	218	4.5	50
9/7/2000	92-2271	13:40	0.7	16.3	6.4	340	217	5.8	57

MARTINS BROOK (Saris: 9254000)
Station: MB01, Mile Point: 4.8, Unique ID: W0137
Description: Burroughs Road, North Reading - outlet of Martins Pond

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
8/8/2000	92-2227	14:34	0.6	28.1	6.8	215	138	7.4u	93u
8/9/2000	92-2234	03:32	0.7	25.3	6.6	212	136	5.7	68
8/24/2000	92-2244	13:19	0.3	24.7u	7.0	218	140	8.0	95
8/31/2000	92-2258	13:29	0.7	27.6u	6.9	223	142	7.8	96
9/1/2000	92-2267	03:38	0.7	24.6	6.8	222	142	6.9	81
9/7/2000	92-2278	13:00	0.7	23.1	6.8	224	143	8.3	93

U=unstable readings

MARTINS BROOK (Saris: 9254000)
Station: MB03, Mile Point: 2.8, Unique ID: W0753
Description: downstream/south at Salem Street, Wilmington

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
9/7/2000	92-2276	10:48	0.7	16.8	6.1	260	166	1.8	18

MARTINS BROOK (Saris: 9254000)
Station: MB02B, Mile Point: 0.1, Unique ID: W0755
Description: downstream/east at Park Street, North Reading near intersection with Winter Street (Route 62)

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
8/8/2000	92-2226	12:55	0.4	22.2	6.4	266	170	2.5	29
8/9/2000	92-2233	02:24	0.4	22.0	6.4	269	172	2.5	28
8/24/2000	92-2243	11:54	0.2	17.9	6.3	279	179	3.9	40
8/31/2000	92-2257	12:05	0.5	19.3	6.3	343	219	3.4	36
9/1/2000	92-2266	02:20	0.6	20.2	6.4	342	219	3.6	38
9/7/2000	92-2277	14:35	0.6	15.2	6.5	363	232	4.6	44

LUBBERS BROOK (Saris: 9254075)
Station: LB03, Mile Point: 3.4, Unique ID: W0141
Description: at Glen Road, Wilmington

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
9/7/2000	92-2274	11:31	0.7	13.3	6.7	292	187	5.7	52

LUBBERS BROOK (Saris: 9254075)
Station: LB02, Mile Point: 0.5, Unique ID: W0139
Description: at Concord Street, Wilmington

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
8/8/2000	92-2225	15:18	0.7	22.5	6.7	359	230	<0.2	<2
8/9/2000	92-2232	04:01	0.7	20.5	6.8	371	237	<0.2	<2
8/24/2000	92-2241	13:56	0.5	18.6	6.2	294	188	1.9	20
8/31/2000	92-2255	14:00	0.7	20.3	6.1	314	201	1.0	11
9/1/2000	92-2264	04:10	0.7	19.8	6.2	326	209	0.3	3
9/7/2000	92-2275	11:59	0.9	13.7	6.0	324	208	0.9	8

MAPLE MEADOW BROOK (Saris: 9254100)
Station: MM01, Mile Point: 0.4, Unique ID: W0143
Description: at Federal Street, Wilmington

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
8/8/2000	92-2224	15:38	0.3	22.2	6.4	313	200	1.1u	12u
8/9/2000	92-2231	04:26	0.4	20.5	6.5	327	209	0.5	5
8/24/2000	92-2239	14:22	0.1i	18.5u	6.3	339	217	2.1	22
8/31/2000	92-2253	14:24	0.5	21.0u	6.3	399	255	1.3	14
9/1/2000	92-2262	04:35	0.4	20.3	6.3	403	258	0.4	4
9/7/2000	92-2273	12:27	0.6	14.6u	6.2	388	248	1.5	14

U= unstable readings

Appendix C: Ipswich River Basin Survey 2000 Water Quality Data - Alkalinity, Hardness, Chloride, Suspended Solids, Ammonia Nitrogen, Nitrate-Nitrite Nitrogen, and Total Phosphorus

Field Blank Sample/Field Blank Sample (Palis: 00000)
Station: BLANK
Description: QAQC: Field Blank Sample

Date	OWMID	QAQC	Time	Depth	Alkalinity	Hardness	Chloride	TSS	NH3-N	NO3-NO2-N	TPhos
			24hr	(m)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
8/1/2000	92-2220	BLANK	12:25	--	<2	<0.66	<1.0	<1.0	<0.02	<0.02	<0.010
8/24/2000	92-2245	BLANK	13:52	--	<2	<0.66	<2.0	<1.0	<0.02	<0.02	<0.010

IPSWICH RIVER (Saris: 9253500)
Station: IP01.5, Mile Point: 34.3, Unique ID: W0113
Description: at Mill Street, North Reading/Reading

Date	OWMID	QAQC	Time	Depth	Alkalinity	Hardness	Chloride	TSS	NH3-N	NO3-NO2-N	TPhos
			24hr	(m)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
8/1/2000	92-2110		10:46	--	19	41	55	1.7	0.11	0.04	0.059
8/24/2000	92-2235		12:48	--	28	49	71	2.8	<0.02	0.11	0.049

IPSWICH RIVER (Saris: 9253500)
Station: IP02, Mile Point: 34, Unique ID: W0114
Description: at Route 28, North Reading/Reading

Date	OWMID	QAQC	Time	Depth	Alkalinity	Hardness	Chloride	TSS	NH3-N	NO3-NO2-N	TPhos
			24hr	(m)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
8/1/2000	92-2120	92-2130	10:17	--	20	40	55	1.6	<0.02	0.05	0.062
8/1/2000	92-2130	92-2120	10:17	--	20	41	55	1.6	<0.02	0.05	0.063
8/24/2000	92-2236	92-2237	12:19	--	28	49	70	1.3	<0.02	0.14	0.047
8/24/2000	92-2237	92-2236	12:19	--	28	50	72	1.4	<0.02	0.14	0.045

MARTINS BROOK (Saris: 9254000)
Station: MB01, Mile Point: 4.8, Unique ID: W0137
Description: Burroughs Road, North Reading – outlet of Martins Pond

Date	OWMID	QAQC	Time	Depth	Alkalinity	Hardness	Chloride	TSS	NH3-N	NO3-NO2-N	TPhos
			24hr	(m)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
8/1/2000	92-2190		11:33	--	14	27	45	1.5	0.04	0.09	0.042
8/24/2000	92-2244		13:19	--	14	28	48	2.6	<0.02	0.02	0.038

MARTINS BROOK (Saris: 9254000)
Station: MB02B, Mile Point: 0.1, Unique ID: W0755
Description: downstream/east at Park Street, North Reading near intersection with Winter Street (Route 62)

Date	OWMID	QAQC	Time	Depth	Alkalinity	Hardness	Chloride	TSS	NH3-N	NO3-NO2-N	TPhos
			24hr	(m)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
8/1/2000	92-2180		11:06	--	21	35	46	2.8	<0.02	0.10	0.061
8/24/2000	92-2243		11:53	--	28	43	59	2.5	<0.02	0.17	0.070

LUBBERS BROOK (Saris: 9254075)
Station: LB02, Mile Point: 0.5, Unique ID: W0139
Description: at Concord Street, Wilmington

Date	OWMID	QAQC	Time	Depth	Alkalinity	Hardness	Chloride	TSS	NH3-N	NO3-NO2-N	TPhos
			24hr	(m)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
8/1/2000	92-2170		12:01	--	24	39	52	1.5	<0.02	<0.02	0.051
8/24/2000	92-2241		13:56	--	30	43	65	1.9	<0.02	<0.02	0.046

MAPLE MEADOW BROOK (Saris: 9254100)
Station: MM01, Mile Point: 0.4, Unique ID: W0143
Description: at Federal Street, Wilmington

Date	OWMID	QAQC	Time	Depth	Alkalinity	Hardness	Chloride	TSS	NH3-N	NO3-NO2-N	TPhos
			24hr	(m)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
8/1/2000	92-2160		12:20	--	23	39	50	1.8	<0.02	0.05	0.077
8/24/2000	92-2239		14:30	--	32	50	73	2.8	<0.02	0.06	0.078

Ipswich River Survey 2000 Quality Control Sample Analysis
IPSWICH RIVER (Saris: 9253500)
Station: IP02, Mile Point: 34, Unique ID: W0114
Description: at Route 28, North Reading/Reading

Date	OWMID	QAQC	Time	Depth	Alkalinity	Hardness	Chloride	TSS	NH3-N	NO3-NO2-N	TPhos
			(24hr)	(m)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
8/1/2000	92-2120	92-2130	10:17	--	20	40	55	1.6	<0.02	0.05	0.062
8/1/2000	92-2130	92-2120	10:17	--	20	41	55	1.6	<0.02	0.05	0.063
Relative Percent Difference					*0.0%*	*2.5%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*1.6%*
8/24/2000	92-2236	92-2237	12:19	--	28	49	70	1.3	<0.02	0.14	0.047
8/24/2000	92-2237	92-2236	12:19	--	28	50	72	1.4	<0.02	0.14	0.045
Relative Percent Difference					*0.0%*	*2.0%*	*2.8%*	*7.4%*	*0.0%*	*0.0%*	*4.3%*

APPENDIX B
OWM/DWM WATER QUALITY MONITORING DATA IPSWICH RIVER WATERSHED 1995/1996

Synoptic water quality surveys were conducted by DEP DWM in the Ipswich River Watershed in the summer of 1995 to 1) define areas impacted by pollution, 2) determine whether impacts are caused by point or non-point sources, 3) determine the need for WMA and NPDES permit reissuance and/or modifications, and 4) determine the need for Best Management Practices (BMPs) to minimize non-point source pollution.

Conditions prior to each synoptic survey were characterized by analyzing precipitation and streamflow data. Two weather stations, MA DEM's Burlington Station 700 and Ipswich Station, were used to determine precipitation and weather conditions prior to the sampling dates: data for these stations was provided by the MA DEM Office of Water Resources. Discharge (hereinafter referred to as streamflow) was obtained from the continuous USGS stream gages: station 01101500 located on the Ipswich River at South Middleton, MA (near Bostik) and station 01102000 located on the Ipswich River near Ipswich, MA. In operation since 1938 and 1939, respectively, the data from these gages was used to calculate streamflow characteristics for the period of record. These statistical analyses can be found in *Water Resources Data Massachusetts and Rhode Island, Water Year 1995* (Socolow *et al*. 1996).

River station sampling during the synoptic surveys conducted during the summer of 1995 included *in situ* measurements of pH, temperature, dissolved oxygen, specific conductance using a Hydrolab® meter, physico-chemical and nutrient sampling including alkalinity, hardness, chloride, suspended solids, total solids, turbidity, total phosphorus, ammonia, nitrate-nitrogen, and total Kjeldahl nitrogen, streamflow and fecal coliform bacteria sampling. Additionally, two stations along the Ipswich River were monitored on a monthly basis for total phosphorus, total-Kjeldahl nitrogen, nitrate-nitrogen, ammonia-nitrogen, temperature, pH and dissolved oxygen from May 1995 to April 1996. These data, along with river flows from the two USGS gaging stations, can be used to calculate loadings to the bay from the Ipswich River. The water quality sampling matrix is summarized in Table B1.

MATERIALS AND METHODS

Procedures followed in 1995 are detailed in *BASINS PROGRAM Standard Operating Procedures River and Stream Monitoring* (MA DEP 1990). The Wall Experiment Station (WES), the Department's analytical laboratory, supplied all sample bottles and field preservatives, which were prepared according to the WES *Laboratory Quality Assurance Plan and Standard Operating Procedures* (MA DEP 1995). Samples were preserved in the field as necessary, transported on ice to WES, and analyzed according to WES standard operating procedures. Quality control samples included field blanks and field replicates.

RESULTS

In situ Hydrolab® data from the 1995 Ipswich River Watershed Monitoring surveys are presented in Table B3. Water quality data are presented in Table B4. Flow data are presented in Table B5.

Quality Assurance And Quality Control

In general, monitoring surveys in the Ipswich River Watershed in 1995 were performed with attention to maintaining quality assurance and control of field samples and field-generated data. For the majority of water quality surveys, quality control samples (field blanks and sample splits) were taken at a minimum of one each per crew per survey. Typically, field monitoring activities followed accepted DWM standard operating procedures. Where strict procedures were not in place or necessary, it is assumed that DWM field staff exercised best professional judgment.

All Hydrolab® multi-probe data were validated using multi-staff review. Data symbols (e.g., ** for censored/missing data) were applied to Hydrolab® data as necessary. All turbidity measurements were qualified with an "i" due to the likely potential for systematic inaccuracies in field measurements. In general, all water quality sample data were validated by reviewing QC sample results, analytical holding time compliance, QC sample frequency and related ancillary data/documentation (at a minimum). Data validation for the 1995 surveys is available in a Memorandum - *1994, 95 & 96 QA/QC Assessment Report* (MA DEP 2000). Specific notes pertaining to the Ipswich River Watershed were excerpted and appear in Table B2.

Table B1. Sampling Matrix for 1995 DWM Ipswich River Watershed Water Quality Surveys.

Station	1995 May	1995 June	1995 July	1995 August	1995 September	1995 October	1995 November	1996 January	1996 February	1996 March	1996 April
MM03							B				
MM01			B,H,N,W	No Flow			B				
LB01			No Flow								
LB03							B				
LB04							B				
LB02			B,H,N, W				B				
IP01				F	B		B				
IP01.5					No Flow		B,W				
IP02			B,H,N,W,F	B, No Flow	B,H,N,W,F	H,W,F	B,W				
IP02SD					B						
IP04.5			B,H,N,W,F								
IP06	N,W	B,H,N,W	B,H,N,W	B,H,N,W	B,H,N,W	B,H,N,W	H,N,W	B,H,N,W	H,N,W	B,H,N,W	H,N,W
IP09		B,H	B,H,W								
BM01			No Flow	No Flow	No Flow		B				
MB01			B,H,N,W	B,H,N,F	F		B				
MB02		B,H,F	B,H,N,W		B,H,N,W	B,H,W	B,W				
EP01				No Flow			B				
WB01		B,H	B,H,N,W								
NB02				B,H	B		B				
NB03				B,H,N,W	B		B				
NB04					B						
NB01		B,H	B,H,N,W	B,H,N,W	B,H,N,W		B				
NBSD01					B						
NBRP01					B						
KS01		B	B,N,W	B	B	B,W					
BO01		B,H,F				B,H,N,W					
FB03						B,W					
FB02				B,H,N,W							
FB01		B,H,F	B,H,N,W	B,H,N,W,F		B,H,W					
IP15.5		B,H,N,W	B,H,N,W	B,H,N,W	B,H,N,W	B,H,N,W	H,N,W		H,N,W	B,H,N,W	H,N,W
IP16	H,N,W				B,H,N,W			B,H,N			
MLB01							B				
HB01	H		B,H,N,F		B,N,W						
HB02		B,H,F	B,H,N,W	B,H		B,H,W					
GB01		B,H	B,N,W		B	B,W					
BB01		B	B,N,W				B				
MR04			B,H,N,W			B,W					
MR01		B,H,F	B,N,W	B,H,N,W,F	B,H,N,W	B,H,N,W,F					
KB02						B,W	B				
KB01				B,H	B,N,W,F	B,H,N,W	B				
IP17						B,H,N,W	B				
LV02						No Flow	B				
LV01		B,H	B,N,W			B,H	B				
LV03						B,H,N,W	B				
BLANK	N,W	N	N	N	N	N	N	N		N	N
DUPL.	N	N	N		N,W	N	B,N	N	N,W	N	N

B= Fecal coliform bacteria; H= Hydrolab® meter (pH, temperature, dissolved oxygen, specific conductance); N= Nutrients (total phosphorus, ammonia nitrogen, nitrate-nitrite nitrogen, total Kjeldahl nitrogen); W= Water quality (alkalinity, hardness, chloride, total suspended solids, turbidity); F= Flow measurement; M= Macroinvertebrate sampling and habitat analysis.; FC= Fish community sampling.

Table B2. 1995/1996 DWM data qualifications for Ipswich River Watershed data (excerpted from MA DEP 2000).

OWMID	Qualifier
92-0254-257	TKN had been analyzed outside of the established holding time of 28 days. Samples were collected on 3/26/96 and analyzed on 5/1/96.
92-0242-245	Hardness had been analyzed outside of the established holding time of 14 days. Samples were collected on 11/30/95 and analyzed on 12/22/95.
92-0065 92-0063 92-0060-061 92-0050-055	Fecal Coliform had been analyzed outside of the established holding time of 6 hrs. Samples were collected on 7/18/95 and analyzed on 7/19/95.
92-0151-152 92-0154-155	No field blank had been collected for the 9/26/95 sampling survey and Alkalinity and Chloride replicate samples exceeded the data quality objective of 20% RPD. Therefore, ***censor Alkalinity and Chloride results.***
92-0250-253	No field blank had been collected for the 2/21/96 fecal coliform sampling survey (see condition "a").
92-0230-241 92-0211-222 92-0199 92-0180-188	No field blank or field replicate samples had been collected during the 11/01/95 and 10/31/95 Fecal Coliform sampling surveys (see condition "a").
92-0116-120 92-0080-081	No field blank or field replicate samples had been collected during the 8/15/95 and 7/19/95 fecal coliform sampling surveys.
92-0070-076	No field replicate had been collected for the 7/19/95 fecal coliform sampling survey (see condition "a").
92-0050-055 92-0030-038	No field blank or field replicate samples had been collected during the 7/18/95 and 6/18/95 fecal coliform sampling surveys
92-0151/52	The Field Replicate and Quality Control Frequency data quality objectives were violated for this 9/26/95 survey data. ***All associated Alkalinity data by the sampling crew on that day is to be censored*** (92-0151-152 and 92-0154-155).
92-0151/52	The Field Replicate and Quality Control Frequency data quality objectives were violated for this 9/26/95 survey data. ***All associated Chloride data by the sampling crew on that day is to be censored*** (92-0151-152 and 92-0154-155).
92-0151/152	Although the Field Replicate and Quality Control Frequency data quality objectives were violated for this 9/26/95 survey data, the replicate concentrations were reported close to the established laboratory MDL. In addition, most of the 9/26/95 Suspended Solids sample results were reported at <MDL, indicating no contamination was present during the collection of these samples.
92-0250/251	Although the Field Replicate and Quality Control Frequency data quality objectives were violated for this 2/21/96 TKN survey data, the replicate concentrations were reported close to the established laboratory MDL (see condition "d").
92-0262/263 92-0246/247	The replicate concentrations were reported close to the established laboratory MDL (see condition "d"). No problems or aberrant trends were noted on the chain of custody or the OWM field sheet. There was not enough evidence to censor these replicate results.
92-0250/251	Although the Field Replicate and Quality Control Frequency data quality objectives were violated for this 2/21/96 Ammonia survey data, the replicate concentrations were reported close to the established laboratory MDL (see condition "d").
92-0063/064 92-0006/008	Most of these ammonia replicate concentrations were reported close to the established laboratory MDL (see condition "d"). No problems or aberrant trends were noted on the chain of custody or the OWM field sheet. There was not enough evidence to censor these replicate results.
92-0006/008 92-0001/003	These Nitrate replicate samples fell outside of the stated quality objective of 30% RPD. No problems or aberrant trends were noted on the chain of custody or the OWM field sheet. There was not enough evidence to censor these replicate results.
92-0262/263 92-0207/208:	Most of these Total Phosphorus replicate concentrations were reported close to the established laboratory MDL (see condition "d"). No problems or aberrant trends were noted on the chain of custody or the OWM field sheet. There was not enough evidence to censor these replicate results.

Note: *Condition "a"* - The DWM QA Program was not fully established during the 1994, 95 and 96 sampling surveys. In addition, DWM relied on WES to supply the reagent water for field blanks. DWM staff members were not always supplied with contaminant-free reagent water. If the field blank objective was violated the associated survey data is not necessarily suspect unless a trend is found or there is documented evidence that aberrant collection, handling or analysis procedures were used. If, however, two or more data quality objectives were violated than all associated data by that sampling crew on that day are to be censored.

Condition "d" - Statistically, slight differences between replicate values at or near a low MDL will result in an increase in relative percent difference (%RPD) values. This increase can create a false impression that replicate data are not meeting their set quality control limits. For replicate values at or near method detection limits (≤1 mg/L), a 30% RPD data quality objective was applied to help counter this statistical effect. Replicate values > 1mg/L were reviewed independently against other quality control factors (i.e. field blank data, documentation) and a decision made on their validity.

Table B3. 1995 Ipswich River Watershed *in-situ* Hydrolab® data.

OWMID[1]	Date	Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Conductivity (µS/cm)	TDS (mg/L)	DO (mg/L)	Saturation (%)	Turbidity (NTU)
UNNAMED AND/OR UNDEFINED SARIS										
Station: NB02, Description: Norris Drive, inlet to Elginwood Pond. Unique ID[2]: W0133										
92-0108	08/16/95	10:34	0.3	24.0	6.9	423	271	2.7	31	20i
UNNAMED AND/OR UNDEFINED SARIS										
Station: NB03, Description: At Lowell Street, Peabody - inlet to Crystal Pond. Unique ID: W0134										
92-0109	08/16/95	11:04	0.4	27.8	7.1	490	314	3.2	40	3i
IPSWICH RIVER										
Station: IP02, Description: At Route 28, North Reading/Reading. Unique ID: W0114										
92-0061	07/18/95	12:00	0.3	18.3	6.3	369	236	1.1	12	--
92-0151	09/26/95	10:24	0.4	13.9	6.3	52	34.0	8.6	83	--
92-0200	10/31/95	09:32	0.3	7.5	5.7	308	197	8.1	67	3i
IPSWICH RIVER										
Station: IP04.5, Description: Central Street, North Reading, sandy site, dirt bike area. Unique ID: W0112										
92-0053	07/18/95	14:03	0.1i	18.2	6.5	366	234	4.1	44	24i
IPSWICH RIVER										
Station: IP06, Description: At South Middleton USGS Gauge Station downstream from Bostik Company, Boston Street, Peabody/Middleton. Unique ID: W0111										
92-0006	05/25/95	15:13	0.5	19.6	7.0	267	171	8.3	90	--
92-0012	06/21/95	12:21	0.1i	22.6	7.0	259	166	7.4	85	2i
92-0065	07/18/95	14:34	0.5	21.6	6.7	341	218	6.3	72	--
92-0119	08/15/95	13:01	0.8	25.0	6.7	322	206	6.3	76	--
92-0130	09/13/95	09:51	0.3	14.6	6.3	422	270	4.7	46	8i
92-0140	09/26/95	10:40	0.3	15.3	6.7	318	203	8.4	83	7i
92-0202	10/31/95	10:51	0.7	9.2	6.3	297	190	10.2	87	7i
92-0244	11/30/95	11:24	0.5	1.9	6.3	239	153	12.7	92	5i
92-0248	01/17/96	14:04	0.2	0.5	5.9	329	211	10.8	74	5i
92-0252	02/21/96	15:23	0.2	0.5	6.0	311	199	10.7	73	--
92-0256	03/26/96	14:00	0.9	9.7	6.5	247	158	11.2	98	--
92-0260	04/17/96	10:58	0.2	7.1	6.2	194	124	10.8	90	5i
IPSWICH RIVER										
Station: IP09, Description: Peabody Street, Middleton. Unique ID: W0110										
92-0036	06/22/95	13:44	0.1i	23.0	7.0	257	165	6.7	77	14i
92-0071	07/19/95	11:08	0.3	21.8	7.3	372	238	6.6	75	8i
IPSWICH RIVER										
Station: IP15.5, Description: Off Topsfield Road, Ipswich - upstream of gauge station/wooden bridge across street from Gravelly Brook and Willowdale State Forest. Unique ID: W0107										
92-0010	06/21/95	11:04	0.3	23.5	6.9	254	163	5.3	62	18i
92-0063	07/18/95	13:33	1.6	21.3	6.9	275	176	3.7	42	--
92-0116	08/15/95	10:11	1.5	23.6	6.9	283	181	3.7	43	--
92-0132	09/13/95	11:20	0.4	18.4	7.4	328	210	7.9	83	6i
92-0145	09/26/95	12:19	0.8	14.9	7.0	342	219	6.9	68	6i
92-0207	10/31/95	13:26	0.9	9.0	6.5	303	194	8.6	73	6i
92-0242	11/30/95	10:27	1.3	1.0	6.2	208	133	10.1	71	35i
92-0250	02/21/96	14:20	1.0	0.16	6.0	251	161	5.9	40	--
92-0254	03/26/96	12:42	1.0	8.9	6.5	216	138	10.9	93	--
92-0262	04/17/96	11:55	**i	7.6	6.5	212	136	9.5	80	7i

[1] OWMID = sample tracking number, [2] Unique ID = unique station identification number, ** = censored data, -- = no data, i = inaccurate readings from Hydrolab® multiprobe likely

Table B3 (Continued). 1995 Ipswich River Watershed *in-situ* Hydrolab® data.

OWMID[1]	Date	Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Conductivity (µS/cm)	TDS (mg/L)	DO (mg/L)	Saturation (%)	Turbidity (NTU)
IPSWICH RIVER										
Station: IP16, Description: Downstream of Willowdale Dam, Topsfield Road, Ipswich, USGS Gage. Unique ID[2]: W0108										
92-0001	05/25/95	11:10	0.4	19.2	6.9	236	151	7.5	81	--
92-0147	09/26/95	12:53	0.3	14.8	7.2	312	200	9.1	89	5i
92-0246	01/17/96	12:53	0.4	-0.10	6.0	281	180	7.1	48	15i
IPSWICH RIVER										
Station: IP17, Description: At County Street, Ipswich. Unique ID[2]: W0109										
92-0181	10/31/95	09:48	0.7	9.3	6.8	320	205	10.6	91	--
LABOR IN VAIN CREEK										
Station: LV01, Description: Argilla Road, Ipswich. Unique ID[2]: W0117										
92-0031	06/22/95	11:06	0.1i	21.3	6.8	**	**c	**	**	--
92-0182	10/31/95	10:36	0.5	8.0	6.7	**	**	**	**	--
LABOR IN VAIN CREEK										
Station: LV03, Description: At Labor in Vain Road, Ipswich. Unique ID[2]: W0116										
92-0180	10/31/95	09:04	0.5	9.0	7.2	**	**c	**	**	--
KIMBALL BROOK										
Station: KB01, Description: On Kimball Street, Ipswich Estes Street turns into Kimball Street. Unique ID[2]: W0119										
92-0101	08/15/95	11:30	0.4	20.9	7.0	250	160	2.9	32	17i
92-0185	10/31/95	12:26	0.5	7.8	6.6	234	150	9.8	81	--
MILES RIVER										
Station: MR01, Description: County Road (Route 1A) across from intersection with Lakeman Lane, site is down long driveway of #187 County Road. Unique ID[2]: W0121										
92-0030	06/22/95	10:24	0.1i	19.6	6.6	232	148	4.1	45	19i
92-0074	07/19/95	12:18	0.2	22.2	7.1	260	166	5.1	59	4i
92-0100	08/15/95	10:43	0.4	22.8	7.1	272	174	5.3	61	4i
92-0149	09/26/95	14:16	**i	13.4	7.0	316	203	7.8	74	5i
92-0184	10/31/95	11:49	0.6	8.1	6.5	265	169	7.5	63	--
LONG CAUSEWAY BROOK										
Station: MR04, Description: At Route 1A, Main St. Hamilton/County Rd. Ipswich line. Unique ID[2]: W0122										
92-0102	08/15/95	12:24	0.4	20.0	6.9	406	260	1.4	15	23i
GRAVELLY BROOK										
Station: GB01, Description: Gravelly Brook Road, Ipswich, entrance to Willowdale State Forest, off Topsfield Road. Unique ID[2]: W0124										
92-0033	06/22/95	11:56	0.1i	16.4	6.8	113	72.0	7.2	73	--
HOWLETT BROOK										
Station: HB01, Description: On North Street, Topsfield, just off of Route 1. Unique ID[2]: W0126										
92-0005	05/25/95	13:49	0.6	18.3	7.1	231	148	7.6	81	--
92-0104	08/15/95	13:53	0.5	21.0	7.3	341	218	5.5	62	35i
HOWLETT BROOK										
Station: HB02, Description: On Ipswich Road, Topsfield near split of Ipswich Road, and Perkins Row, also near Willow Dale Road. Unique ID[2]: W0125										
92-0034	06/22/95	12:26	0.1i	20.3	7.1	253	162	7.2	78	--
92-0081	07/19/95	13:51	0.2	24.3	7.5	332	213	7.7	93	--
92-0103	08/15/95	13:24	0.4	23.8	7.3	315	202	6.5	76	16i
92-0210	10/31/95	14:16	0.2	7.8	6.8	268	172	9.7	80	2i

[1] OWMID = sample tracking number, [2] Unique ID = unique station identification number, ** = censored data, -- = no data,
i = inaccurate readings from Hydrolab® multiprobe likely

Table B3 (Continued). 1995 Ipswich River Watershed *in-situ* Hydrolab® data.

OWMID[1]	Date	Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Conductivity (µS/cm)	TDS (mg/L)	DO (mg/L)	Saturation (%)	Turbidity (NTU)
FISH BROOK										
Station: FB01, Description: Washington and Endicot Streets, Topsfield/Boxford, just east of Route 95. Unique ID[2]: W0128										
92-0035	06/22/95	13:20	0.2	18.4	7.0	248	158	8.0	84	--
92-0080	07/19/95	11:08	0.2	18.3	7.0	273	175	7.8	83	--
92-0117	08/15/95	10:48	0.4	19.9	7.0	281	180	7.1	78	--
92-0206	10/31/95	12:20	0.5	7.8	6.5	209	133	10.5	87	7i
FISH BROOK										
Station: FB02, Description: Lockwood Lane, Boxford. Unique ID[2]: W0129										
92-0118	08/15/95	11:25	0.4	24.0	7.0	164	105	6.4	76	--
BOSTON BROOK										
Station: BO01, Description: Liberty Street, Middleton near conservation area. Unique ID[2]: W0130										
92-0038	06/22/95	14:29	**i	19.0	6.9	239	153	7.0	74	7i
92-0187	10/31/95	13:45	0.7	6.8	6.0	259	166	10.1	82	--
NORRIS BROOK										
Station: NB01, Description: Russell Street, Peabody. Unique ID[2]: W0131										
92-0014	06/21/95	13:20	0.1i	22.7	7.1	407	260	2.9	33	3i
92-0055	07/18/95	15:17	0.1i	19.9	7.0	428	274	3.5	39	35i
92-0107	08/16/95	10:02	0.4	23.1	7.0	436	279	3.4	39	3i
92-0155	09/26/95	13:08	0.4	13.8	6.7	409	262	5.2	50	--
WILLS BROOK										
Station: WB01, Description: Access via Elm Street (Route 62), Lynnfield; location is on old RR bed near Lynn Water & Sewer Pump Station, dirt path near house #114 Elm Street. Unique ID[2]: W0135										
92-0016	06/21/95	14:13	0.1i	18.8	6.9	**	**	6.5	69	5i
92-0054	07/18/95	14:44	0.2	17.2	6.7	203	130	1.8	19	10i
MARTINS BROOK										
Station: MB01, Description: Burroughs Road, North Reading - outflow of Martins Pond. Unique ID[2]: W0137										
92-0052	07/18/95	12:08	0.2	22.9	7.1	238	152	6.7	77	54i
92-0110	08/16/95	11:52	0.3	23.5	7.0	475	304	5.6	65	4i
MARTINS BROOK										
Station: MB02, Description: Park Street in North Reading near intersection with Winter Street (Route 62). Unique ID[2]: W0136										
92-0018	06/21/95	14:58	0.1i	23.2	6.8	283	181	5.0	58	--
92-0060	07/18/95	10:29	0.3	19.0	6.8	470	301	3.7	40	--
92-0154	09/26/95	11:19	0.4	13.1	6.5	523	335	6.6	62	--
92-0201	10/31/95	10:01	0.1i	7.3	6.2	307	196	7.0	57	4i
LUBBERS BROOK										
Station: LB02, Description: At Concord Street, Wilmington. Unique ID[2]: W0139										
92-0050	07/18/95	10:27	0.1i	19.1	6.6	345	221	<1.0	6	10i
MAPLE MEADOW BROOK										
Station: MM01, Description: At Federal Street, Wilmington. Unique ID[2]: W0143										
92-0051	07/18/95	11:24	0.1i	19.0	6.6	352	226	1.1	12	5i

[1] OWMID = sample tracking number, [2] Unique ID = unique station identification number, ** = censored data, -- = no data,
i = inaccurate readings from Hydrolab® multiprobe likely

Table B4. 1995 Ipswich River Watershed Water Quality Data. Units are mg/L unless otherwise expressed.

OWMID[1]	QA/QC	Date	Time (24hr)	Alkalinity	Hardness	Specific Conductance (µS/cm)	Chloride	Suspended Solids	TKN	Ammonia	NO3-NO2	Total Phosphorus	Fecal Coliform Bacteria (colonies/100mL)
Pipe/Discharge to Unnamed and/or Undefined SARIS Station: NBSD01, Description: Stormdrain into Norris Brook at Lake Street and Lowell Street, Peabody (enters from west side, north of Lowell St.). Unique ID[2]: W0106													
92-0160		09/26/95	**	--	--	--	--	--	--	--	--	--	5,700
Unnamed and/or Undefined SARIS Station: KS01, Description: Unnamed tributary at King Street, Middleton near Middleton center, near old cemetery. Unique ID[2]: W0105													
92-0037		06/22/95	14:05	--	--	--	--	--	--	--	--	--	1,240
92-0070		07/19/95	10:35	54	40	--	91	11	0.24	<0.02	0.92	<0.05	480
92-0120		08/15/95	**	--	--	--	--	--	--	--	--	--	1,100
92-0143		09/26/95	**	--	--	--	--	--	--	--	--	--	1,700
92-0204		10/31/95	11:20	--	--	--	--	--	--	--	--	--	60
92-0188		10/31/95	14:40	53	--	--	116	<2.5	--	--	--	--	300
Unnamed and/or Undefined SARIS Station: FB03, Description: Tributary to Fish Brook at Middleton Road, Boxford. Unique ID[2]: W0101													
92-0205		10/31/95	11:50	37	--	--	19	<2.5	--	--	--	--	60
Unnamed and/or Undefined SARIS Station: LV02, Description: Dirt road just east of creek on Argilla Road, Ipswich. Unique ID[2]: W0118													
92-0233		11/01/95	9:45	--	--	--	--	--	--	--	--	--	20
Unnamed and/or Undefined SARIS Station: EP01, Description: Unnamed brook downstream of Eisenhaures Pond, near intersection of Elm Street and Willow Street, North Reading. Unique ID[2]: W0100													
92-0211		11/01/95	9:00	--	--	--	--	--	--	--	--	--	120
Unnamed and/or Undefined SARIS Station: NB02, Description: Norris Drive, inlet to Elginwood Pond. Unique ID[2]: W0133													
92-0108		08/16/95	10:30	--	--	--	--	--	--	--	--	--	<10
92-0157		09/26/95	14:05	--	--	--	--	--	--	--	--	--	60
92-0240		11/01/95	13:00	--	--	--	--	--	--	--	--	--	80
Unnamed and/or Undefined SARIS Station: NB03, Description: At Lowell Street, Peabody - inlet to Crystal Pond. Unique ID[2]: W0134													
92-0109		08/16/95	11:00	--	--	496	85	45	0.75	<0.02	<0.02	0.05	<10
92-0156		09/26/95	13:50	--	--	--	--	--	--	--	--	--	620
92-0239		11/01/95	12:45	--	--	--	--	--	--	--	--	--	200
Pipe/Discharge to Unnamed and/or Undefined SARIS Station: NBRP01, Description: Mall retention pond outlet, drains to an unnamed tributary to Norris Brook, Goodale Street, Peabody, around intersection of Goodale and Lowell Streets. Unique ID[2]: W0102													
92-0158		09/26/95	14:28	--	--	--	--	--	--	--	--	--	700

[1] OWMID = sample tracking number, [2] Unique ID = unique station identification number, * = interference, ** = missing/censored data, -- = no data

Table B4 (Continued). 1995 Ipswich River Watershed Water Quality Data. Units are mg/L unless otherwise expressed.

OWMID[1]	QA/QC	Date	Time (24hr)	Alkalinity	Hardness	Specific Conductance (µS/cm)	Chloride	Suspended Solids	TKN	Ammonia	NO3-NO2	Total Phosphorus	Fecal Coliform Bacteria (colonies/100mL)
Pipe/Discharge to Unnamed and/or Undefined SARIS Station: IPS/WWTF, Description: Sample taken at outfall in marsh. Unique ID[2]: W0104													
92-0236		11/01/95	**	124	304	--	500	<2.5	1.0	0.06	5.5	5.0	120
IPSWICH RIVER Station: IP01, Description: At Woburn Street, Wilmington. Unique ID: W0115													
92-0150		09/26/95	**	--	--	--	--	--	--	--	--	--	280
92-0218		11/01/95	10:40	--	--	--	--	--	--	--	--	--	20
IPSWICH RIVER Station: IP01.5, Description: At Mill Street, North Reading/Reading. Unique ID: W0113													
92-0219		11/01/95	11:00	6.0	--	--	47	<2.5	--	--	--	--	<20
IPSWICH RIVER Station: IP02, Description: At Route 28, North Reading/Reading. Unique ID: W0114													
92-0061	92-0062	07/18/95	11:56	43	45	--	78	14	2.1	0.91	4.5	0.10	**
92-0062	92-0061	07/18/95	11:56	--	42	--	--	--	2.3	0.89	9.4	0.12	--
92-0112		08/16/95	**	--	--	--	--	--	--	--	--	--	<20
92-0151	92-0152	09/26/95	10:20	**	--	--	**	3.0	0.33	0.04	0.31	0.08	7,900
92-0152	92-0151	09/26/95	10:20	**	--	--	**	4.0	0.44	0.05	0.33	0.08	--
92-0200		10/31/95	9:30	5.0	--	--	47	<2.5	--	--	--	--	--
92-0199		11/01/95	9:25	--	--	--	--	--	--	--	--	--	60
92-0220		11/01/95	11:15	6.0	--	--	47	<2.5	--	--	--	--	<20
Pipe/Discharge to Unnamed and/or Undefined SARIS Station: IP02SD, Description: Stormdrain located downstream of Route 28 on north side of river, North Reading/Reading. Unique ID: W0103													
92-0153		09/26/95	**	--	--	--	--	--	--	--	--	--	4,900
IPSWICH RIVER Station: IP04.5, Description: Central Street, North Reading, sandy site, dirt bike area. Unique ID: W0112													
92-0053		07/18/95	14:03	38	40	--	70	<2.5	0.54	0.03	0.60	<0.05	**

[1] OWMID = sample tracking number, [2] Unique ID = unique station identification number, * = interference, ** = missing/censored data, -- = no data

Table B4 (Continued). 1995 Ipswich River Watershed Water Quality Data. Units are mg/L unless otherwise expressed.

OWMID[1]	QA/QC	Date	Time (24hr)	Alkalinity	Hardness	Specific Conductance (µS/cm)	Chloride	Suspended Solids	TKN	Ammonia	NO3-NO2	Total Phosphorus	Fecal Coliform Bacteria (colonies/100mL)
IPSWICH RIVER Station: IP06, Description: At South Middleton USGS Gauge Station downstream from Bostik Company, Boston St, Peabody/Middleton. Unique ID[2]:W0111													
92-0006	92-0008	05/25/95	15:10	--	--	--	--	<2.5	--	0.05	0.08	<0.05	--
92-0008	92-0006	05/25/95	15:10	--	--	--	--	<2.5	--	0.07	0.12	<0.05	--
92-0011	92-0013	06/21/95	**	--	--	--	--	--	0.66	0.04	0.24	0.06	--
92-0013	92-0011	06/21/95	**	--	--	--	--	--	0.65	0.04	0.24	0.05	--
92-0012		06/21/95	12:14	--	--	--	--	**	0.65	0.04	0.23	<0.05	10
92-0065		07/18/95	14:29	41	39	--	65	<2.5	0.39	0.05	0.39	0.04	**
92-0119		08/15/95	13:00	--	--	308	56	<2.5	0.33	<0.02	0.20	0.02	<20
92-0130		09/13/95	9:51	--	--	--	--	--	0.23	<0.02	0.48	0.01	280
92-0141		09/26/95	**	--	--	--	--	--	0.31	0.02	0.23	0.03	--
92-0140		09/26/95	10:41	28	--	--	49	<2.5	0.22	0.02	0.23	0.03	1,200
92-0202		10/31/95	10:50	12	148	--	42	<2.5	0.61	<0.02	0.15	0.03	100
92-0244		11/30/95	11:24	--	**	--	--	--	0.28	<0.02	0.23	0.03	--
92-0248		01/17/96	13:50	--	--	--	--	--	0.36	0.13	0.34	0.03	20
92-0252	92-0253	02/21/96	15:16	15	59	--	67	<2.5	0.12	0.05	0.58	0.03	--
92-0253	92-0252	02/21/96	15:16	14	58	--	68	<2.5	<0.10	0.06	0.58	0.02	--
92-0256		03/26/96	13:58	16	--	--	55	<2.5	**	<0.02	0.27	0.02	20
92-0260		04/17/96	10:50	--	--	--	41	<2.5	0.22	0.02	0.25	0.03	--
IPSWICH RIVER Station: IP09, Description: Peabody Street, Middleton. Unique ID: W0110													
92-0036		06/22/95	13:45	--	--	--	--	--	--	--	--	--	30
92-0071		07/19/95	10:55	49	52	--	69	<2.5	0.42	<0.02	0.38	<0.05	20
IPSWICH RIVER Station: IP15.5, Description: Off Topsfield Road, Ipswich - upstream of gauge station/wooden bridge across street from Gravelly Brook and Willowdale State Forest. Unique ID: W0107													
92-0010		06/21/95	10:50	--	--	--	--	2.5	0.72	0.04	0.25	<0.05	60
92-0063	92-0064	07/18/95	13:30	52	45	--	55	4.0	0.52	0.08	0.05	0.04	**
92-0064	92-0063	07/18/95	13:30	--	45	--	--	--	0.52	0.04	0.05	0.04	--
92-0116		08/15/95	10:09	--	--	305	52	<2.5	0.78	<0.02	<0.02	0.02	<20
92-0132	92-0133	09/13/95	11:20	--	--	--	--	--	0.45	<0.02	<0.02	0.03	100
92-0133	92-0132	09/13/95	11:20	--	--	--	--	--	0.46	<0.02	<0.02	0.03	--
92-0145	92-0146	09/26/95	12:20	43	--	--	55	<2.5	0.31	0.02	0.11	0.02	20
92-0146	92-0145	09/26/95	12:20	--	--	--	--	--	0.31	<0.02	0.12	0.02	--
92-0207	92-0208	10/31/95	13:27	21	161	--	45	<2.5	0.55	<0.02	0.08	0.02	20
92-0208	92-0207	10/31/95	13:27	--	159	--	--	--	0.51	<0.02	0.08	0.03	--
92-0242	92-0243	11/30/95	10:10	--	**	--	--	--	0.31	<0.02	0.19	0.02	--
92-0243	92-0242	11/30/95	10:10	--	45	--	--	--	0.38	<0.02	0.21	0.02	--
92-0250	92-0251	02/21/96	14:12	16	60	--	52	<2.5	<0.10	0.03	0.49	0.01	--
92-0251	92-0250	02/21/96	14:12	18	60	--	52	<2.5	0.20	0.02	0.48	0.01	--
92-0254	92-0255	03/26/96	12:43	14	--	--	44	<2.5	**	<0.02	0.21	0.02	--
92-0255	92-0254	03/26/96	12:43	--	--	--	--	--	**	<0.02	0.21	0.02	<20
92-0262	92-0263	04/17/96	11:53	--	--	--	44	<2.5	0.28	<0.02	0.11	0.04	--
92-0263	92-0262	04/17/96	11:53	--	--	--	--	--	0.10	0.02	<0.02	0.02	--

[1] OWMID = sample tracking number, [2] Unique ID = unique station identification number, * = interference, ** = missing/censored data, -- = no data

Table B4 (Continued). 1995 Ipswich River Watershed Water Quality Data. Units are mg/L unless otherwise expressed.

OWMID[1]	QA/QC	Date	Time (24hr)	Alkalinity	Hardness	Specific Conductance (µS/cm)	Chloride	Suspended Solids	TKN	Ammonia	NO3-NO2	Total Phosphorus	Fecal Coliform Bacteria (colonies/100mL)
IPSWICH RIVER Station: IP16, Description: Downstream of Willowdale Dam, Topsfield Road, Ipswich, USGS Gaging station. Unique ID[2]: W0108													
92-0001	92-0003	05/25/95	11:20	--	--	--	--	<2.5	--	0.10	0.21	<0.05	--
92-0003	92-0001	05/25/95	11:20	--	--	--	--	<2.5	--	0.12	<0.02	<0.05	--
92-0147		09/26/95	12:53	39	--	--	51	3.0	0.47	0.02	0.10	0.02	20
92-0246	92-0247	01/17/96	12:30	--	--	--	--	--	0.32	0.07	0.38	0.02	40
92-0247	92-0246	01/17/96	12:30	--	--	--	--	--	0.13	0.07	0.37	0.02	--
IPSWICH RIVER Station: IP17, Description: At County Street, Ipswich. Unique ID: W0109													
92-0181		10/31/95	9:44	23	162	--	48	<2.5	0.52	<0.02	0.17	0.03	100
92-0231		11/01/95	9:55	--	--	--	--	--	--	--	--	--	20
LABOR IN VAIN CREEK Station: LV01, Description: Argilla Road, Ipswich. Unique ID: W0117													
92-0031		06/22/95	11:10	--	--	--	--	--	--	--	--	--	240
92-0072		07/19/95	12:40	80	3,560	--	14,400	4.0	1.4	0.19	<0.02	0.07	100
92-0182		10/31/95	10:30	52	906	--	5,000	6.0	1.3	0.04	<0.02	0.10	380
92-0232		11/01/95	9:30	--	--	--	--	--	--	--	--	--	140
LABOR IN VAIN CREEK Station: LV03, Description: At Labor in Vain Road, Ipswich. Unique ID: W0116													
92-0180		10/31/95	9:00	76	3,000	--	10,400	3.0	0.56	0.03	--	<0.05	20
92-0230		11/01/95	9:15	--	--	--	--	--	--	--	--	--	20
KIMBALL BROOK Station: KB02, Description: At Heard Drive, Ipswich. Unique ID: W0120													
92-0186		10/31/95	12:50	28	--	--	24	5.0	--	--	--	--	60
92-0235		11/01/95	10:25	--	--	--	--	--	--	--	--	--	100
KIMBALL BROOK Station: KB01, Description: On Kimball Street, Ipswich Estes Street turns into Kimball Street. Unique ID: W0119													
92-0101		08/15/95	11:22	--	--	--	--	--	--	--	--	--	2,000
92-0148		09/26/95	13:30	23	--	--	15	<2.5	0.42	0.02	0.30	0.02	2,300
92-0185		10/31/95	12:20	30	139	--	30	<2.5	0.39	<0.02	0.26	0.04	100
92-0234		11/01/95	10:15	--	--	--	--	--	--	--	--	--	100
MILES RIVER Station: MR01, Description: County Road (Route 1A) across from intersection with Lakeman Lane, site is down long driveway of #187 County Road. Unique ID: W0121													
92-0030		06/22/95	10:23	--	--	--	--	--	--	--	--	--	430
92-0074		07/19/95	12:14	66	44	--	39	<2.5	0.70	0.04	0.08	<0.05	740
92-0100		08/15/95	10:36	--	--	260	40	<2.5	0.56	<0.02	0.17	0.04	20
92-0149		09/26/95	14:16	53	--	--	46	<2.5	0.38	0.02	0.14	0.03	500
92-0184		10/31/95	11:57	34	131	--	39	<2.5	0.71	<0.02	0.10	<0.05	80

[1] OWMID = sample tracking number, [2] Unique ID = unique station identification number, * = interference, ** = missing/censored data, -- = no data

Table B4 (Continued). 1995 Ipswich River Watershed Water Quality Data. Units are mg/L unless otherwise expressed.

OWMID[1]	QA/QC	Date	Time (24hr)	Alkalinity	Hardness	Specific Conductance (µS/cm)	Chloride	Suspended Solids	TKN	Ammonia	NO3-NO2	Total Phosphorus	Fecal Coliform Bacteria (colonies/100mL)
BLACK BROOK Station: BB01, Description: Off Winthrop Street, Hamilton Dirt Road, Private Avenue. Unique ID[2]: W0123													
92-0032		06/22/95	11:30	--	--	--	--	--	--	--	--	--	90
92-0073		07/19/95	11:40	43	41	--	18	<2.5	0.48	0.05	3.1	<0.05	160
92-0237		11/01/95	12:15	--	--	--	--	--	--	--	--	--	100
GRAVELLY BROOK Station: GB01, Description: Gravelly Brook Road, Ipswich, entrance to Willowdale State Forest, off Topsfield Road. Unique ID[2]: W0124													
92-0033		06/22/95	11:55	--	--	--	--	--	--	--	--	--	40
92-0076		07/19/95	13:50	35	27	--	6.0	<2.5	0.18	<0.02	0.39	<0.05	20
92-0144		09/26/95	11:45	--	--	--	--	--	--	--	--	--	240
92-0209		10/31/95	13:40	14	--	--	11	<2.5	--	--	--	--	40
HOWLETT BROOK Station: HB01, Description: On North Street, Topsfield, just off of Route 1. Unique ID[2]: W0126													
92-0005		05/25/95	13:50	--	--	--	--	--	--	--	--	--	--
92-0104	92-0105	08/15/95	13:48	--	--	--	--	--	--	--	--	--	300
92-0105	92-0104	08/15/95	13:48	--	--	--	--	--	0.21	<0.02	0.56	0.03	--
92-0161		09/26/95	14:50	54	--	--	55	3.0	0.35	0.03	0.24	0.02	240
HOWLETT BROOK Station: HB02, Description: On Ipswich Road, Topsfield near split of Ipswich Road, and Perkins Row, also near Willow Dale Road. **UNIQUE ID[2]**: W0125													
92-0034		06/22/95	12:30	--	--	--	--	--	--	--	--	--	60
92-0081		07/19/95	13:46	70	56	--	51	4.0	0.40	<0.02	0.39	<0.05	<20
92-0103		08/15/95	13:20	--	--	--	--	--	--	--	--	--	420
92-0210		10/31/95	14:12	29	--	--	40	<2.5	--	--	--	--	220
MILE BROOK Station: MLB01, Description: At Brookside Street, Topsfield. Unique ID[2]: W0127													
92-0238		11/01/95	12:30	--	--	--	--	--	--	--	--	--	40
FISH BROOK Station: FB02, Description: Lockwood Lane, Boxford. Unique ID[2]: W0129													
92-0118		08/15/95	11:23	--	--	160	24	<2.5	0.35	<0.02	0.08	0.02	<20
FISH BROOK Station: FB01, Description: Washington and Endicot Streets, Topsfield/Boxford, just east of Route 95. Unique ID[2]: W0128													
92-0035		06/22/95	13:20	--	--	--	--	--	--	--	--	--	310
92-0080		07/19/95	11:05	35	37	--	50	<2.5	0.30	<0.02	0.40	<0.05	360
92-0117		08/15/95	10:45	--	--	275	49	<2.5	0.27	<0.02	0.41	0.04	120
92-0206		10/31/95	12:20	16	--	--	29	<2.5	--	--	--	--	40

[1] OWMID = sample tracking number, [2] Unique ID = unique station identification number, * = interference, ** = missing/censored data, -- = no data

Table B4 (Continued). 1995 Ipswich River Watershed Water Quality Data. Units are mg/L unless otherwise expressed.

OWMID[1]	QA/QC	Date	Time (24hr)	Alkalinity	Hardness	Specific Conductance (µS/cm)	Chloride	Suspended Solids	TKN	Ammonia	NO3-NO2	Total Phosphorus	Fecal Coliform Bacteria (colonies/100mL)
BOSTON BROOK Station: BO01, Description: Liberty Street, Middleton near conservation area. Unique ID[2]: W0130													
92-0038		06/22/95	14:21	--	--	--	--	--	--	--	--	--	40
92-0187		10/31/95	13:39	5.0	122	--	43	<2.5	0.49	<0.02	<0.02	<0.05	60
NORRIS BROOK Station: NB04, Description: At Lake Street and Lowell Street Peabody. Unique ID[2]: W0132													
92-0159		09/26/95	14:40	--	--	--	--	--	--	--	--	--	100
NORRIS BROOK Station: NB01, Description: Russell Street, Peabody. Unique ID[2]: W0131													
92-0014		06/21/95	13:23	--	--	--	--	--	--	--	--	--	100
92-0055		07/18/95	15:17	72	72	--	77	<2.5	0.46	0.07	0.22	0.06	**
92-0107		08/16/95	9:56	--	--	435	78	3.0	0.46	0.04	0.16	0.08	300
92-0155		09/26/95	13:03	**	--	--	**	<2.5	0.29	0.02	0.07	0.04	320
92-0241		11/01/95	13:10	--	--	--	--	--	--	--	--	--	40
WILLS BROOK Station: WB01, Description: Access via Elm Street (Route 62), Lynnfield, location is on old RR bed near Lynn Water & Sewer Pump Station, dirt path near house #114 Elm Street. Unique ID[2]: W0135													
92-0016		06/21/95	14:30	--	--	--	--	--	--	--	--	--	420
92-0054		07/18/95	14:44	37	29	--	32	<2.5	0.70	0.19	0.30	<0.05	**
MARTINS BROOK Station: MB01, Description: Burroughs Road, North Reading - outflow of Martins Pond. Unique ID[2]: W0137													
92-0052		07/18/95	12:17	19	22	--	52	7.0	1	<0.02	<0.02	<0.05	**
92-0110	92-0111	08/16/95	11:47	--	--	--	--	--	--	--	--	--	450
92-0111	92-0110	08/16/95	11:47	--	--	--	--	--	0.29	<0.02	0.23	0.04	--
92-0212		11/01/95	9:15	--	--	--	--	--	--	--	--	--	20
MARTINS BROOK Station: MB02, Description: Park Street in North Reading near intersection with Winter Street (Route 62). Unique ID[2]: W0136													
92-0018		06/21/95	15:00	--	--	--	--	--	--	--	--	--	90
92-0060		07/18/95	10:25	49	43	--	99	6.0	0.66	0.02	0.56	0.05	**
92-0154		09/26/95	11:10	**	--	--	**	<2.5	0.28	0.04	<0.02	0.04	160
92-0201		10/31/95	10:00	23	--	--	51	<2.5	--	--	--	--	<20
92-0221		11/01/95	11:25	21	--	--	52	<2.5	--	--	--	--	20
BEAR MEADOW BROOK Station: BM01, Description: Haverhill Street, near town line and conservation area in Reading. Unique ID[2]: W0138													
92-0222		11/01/95	11:35	--	--	--	--	--	--	--	--	--	40
LUBBERS BROOK Station: LB03, Description: At Glen Road, Wilmington. Unique ID[2]: W0141													
92-0214		11/01/95	9:40	--	--	--	--	--	--	--	--	--	40

[1] OWMID = sample tracking number, [2] Unique ID = unique station identification number, * = interference, ** = missing/censored data, -- = no data

Table B4 (Continued). 1995 Ipswich River Watershed Water Quality Data. Units are mg/L unless otherwise expressed.

OWMID[1]	QA/QC	Date	Time (24hr)	Alkalinity	Hardness	Specific Conductance (µS/cm)	Chloride	Suspended Solids	TKN	Ammonia	NO3-NO2	Total Phosphorus	Fecal Coliform Bacteria (colonies/100mL)
LUBBERS BROOK Station: LB04, Description: At Middlesex Avenue (Route 62), Wilmington, downstream side of bridge. Unique ID[2]: W0140													
92-0213		11/01/95	9:30	--	--	--	--	--	--	--	--	--	100
LUBBERS BROOK Station: LB02, Description: At Concord Street, Wilmington. Unique ID[2]: W0139													
92-0050		07/18/95	10:27	49	40	--	67	4.0	0.76	0.22	<0.02	0.05	**
92-0217		11/01/95	10:30	--	--	--	--	--	--	--	--	--	20
MAPLE MEADOW BROOK Station: MM03, Description: At Lowell Street, Wilmington, upstream side of bridge. Unique ID[2]: W0144													
92-0215		11/01/95	10:00	--	--	--	--	--	--	--	--	--	80
MAPLE MEADOW BROOK Station: MM01, Description: At Federal Street, Wilmington. Unique ID[2]: W0143													
92-0051		07/18/95	11:00	53	42	--	65	4.0	0.61	0.09	0.04	<0.05	**
92-0216		11/01/95	10:15	--	--	--	--	--	--	--	--	--	40

[1] OWMID = sample tracking number, [2] Unique ID = unique station identification number, * = interference, ** = missing/censored data, -- = no data

Table B5. 1995 DWM Ipswich River Watershed stream discharge measurements.

	Approximate Time (24hr)	Sampling Equipment	Average Velocity (fps)	Total Discharge (cfs)
Miles River				
Station: MR01				
Description: County Rd. (Rt. 1A) across from intersection with Lakeman lane. Site is down long driveway of #`87 County Rd.				
06/22/95	10:45	Swoffer	0.13	3.1
08/15/95	10:40	Swoffer	0.20	0.4
10/03/95	13:50	Swoffer	1.15	9.7
Howlett Brook				
Station: HB02				
Description: on Ipswich Rd., Topsfield near split of Ipswich Rd. and Perkins Row, also near Willowdale Rd.				
06/22/95	12:02		0.83	3.8
07/19/95	14:04	Swoffer	0.19	0.7
08/15/95	11:45	Swoffer	0.24	0.5
Fish Brook				
Station: FB01				
Description: Washington St., Topsfield just east of Rte. 95 and Masconomet H.S.				
06/22/95	14:10	Swoffer	0.44	3.9
07/19/95	11:50	Swoffer	0.17	1.7
08/15/95	14:00	Swoffer	0.12	1.4
Boston Brook				
Station: BO01				
Description: Liberty St., Middleton references site, near conservation area				
06/22/95	15:20		0.16	1.0
Martins Brook				
Station: MB02				
Description: Park St, North Reading near intersection with Winter St (Rte. 62)				
06/21/95 (MB01)	11:14		0.25	3.8
07/18/95 (MB02)	10:40	Swoffer	0.99	0.3
08/16/95 (MB01)	10:10	Swoffer	0.37	0.1
09/26/95 (MB01)	12:15	Swoffer	0.77	1.2
10-31/95 (MB02)	11:50	Swoffer	0.76	7.6
Ipswich River				
Station: IP02				
Description: Rte. 28, North Reading				
06/21/95	10:10		0.15	4.1
09/26/95	10:55	Swoffer	0.10	<0.1
10/31/95	10:30	Swoffer	0.30	10.2
Ipswich River				
Station: IP04.5				
Description: Central St., North Reading				
06/21/95	13:20		1.0	12.7
Lubbers Brook				
Station: LB02				
Description: at Concord St., Wilmington				
06/21/95	13:55		Two culverts; little (or no) flow	
Ipswich River				
Station: IP06				
Description: at S. Middleton USGS Gauge Sta. Downstream from Bostix Co., Boston St.				
7/18/95	14:35	Swoffer	0.82	0.7
Ipswich River				
Station: IP01				
Description: at Woburn St., Wilmington				
08/16/95	11:45	Swoffer	0.10	0.3
Kimball Brook				
Station: KB01				
Description: on Kimball St., Ipswich, Estes Street turns into Kimball St.				
09/26/95	14:40	Swoffer	0.06	0.2

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APPENDIX C
DWM 1995 AND 2000 LAKE SURVEY DATA IN THE IPSWICH RIVER WATERSHED

1995

In the Ipswich River Watershed, DWM conducted synoptic surveys at 42 lakes during the 1995 field season. Observations, from at least one access point on each lake (multiple access points on larger lakes) were recorded on standardized field sheets. An attempt was made to observe the entire surface area of each lake to determine the extent of aerial macrophyte cover. At each sampling location general water quality conditions, identification and abundance of aquatic and wetland macrophyte plant species, and estimates of total percent aerial coverage were recorded. Macrophyte visual observations were augmented at each station by identifying plant specimens collected from the lake bottom. Specimens were retrieved using a "rake" (a short handled, double-sided garden rake on a 50 foot line) thrown to its maximum extension in multiple directions at each station. Macrophytes collected in the "rake" were identified (in-situ or in the laboratory) and recorded on the field sheets. Transparency was measured where possible using a standard 20-centimeter diameter Secchi disk. Where Secchi disk measurements were not feasible, transparency was estimated as being above or below 1.2 meter (the MDPH bathing beach standard). Trophic status was estimated primarily using visual observations of macrophyte cover and phytoplankton populations. A more definitive assessment of trophic status would require more extensive collection of water quality and biological data.

Table C1. 1995 Ipswich River Watershed lake observations and trophic status estimates.

Lake Name (local name), Location	Waterbody Identification Code (WBID)	Size (Acres)	Trophic Status Estimate	SURVEY OBSERVATIONS (Objectionable Conditions)
Brackett Pond, Andover	MA92004	17	E	Turbid, slight tea stain, algal growth evident, Secchi depth probably <4 feet, *Lythrum salicaria* present, sparse vegetation, patches of submerged plants along shoreline, dam and outlet control in disrepair, non-native present (Ls)
Bradford Pond, North Reading	MA92005	17	E	Good water clarity, shallow depth, 100% of pond covered by floating leaf plants, islands of wetland plants present, non-native present (Ls)
Brook Street Pond, North Andover	MA92075	-	-	No pond evident, grass hussochs and swamp red maple predominate, dense cattail stand present, at north end of former pond, non-native present (Ls)
Collins Pond, Andover	MA92010	7	E	Turbid water, algal bloom evident, Secchi depth probably <4 feet, 35% of pond covered by floating leaf plants, pond bottom largely covered with aquatic plants, dam and outlet in disrepair, erosion very common, non-native present (Ls)
Creighton Pond, Middleton	MA92011	22	U	Clear, tea stain, patches of floating leaf plants, 50-75% submergent plant coverage at outlet, non-native present (Ls)

Table C1 (continued). 1995 Ipswich River Watershed lake observations and trophic status estimates.

Crystal Pond, Peabody	MA92013	11	E	Viewed from a distance, watermeal mass piled up on west side of pond, emergent encroaching patches of floating leaf plants, 50% open water, non-native present (Ls, Pa)
Devils Dishfulll Pond, Peabody	MA92015	26	E	Turbid and brown colored water, Secchi probably <4 feet, dense mats of benthic blue greens, plants covered with organic matter, center and west basins 100% covered with floating leaf plants, east basin 25% covered, and south basin 50% covered, non-native present (Ls)
Eisenhaures Pond, North Reading	MA92016	10	E	Clear, tea stain, 95-100% of pond covered with floating leaf and submergent plants, non-native present (Ls)
Elginwood Pond, Peabody	MA92017	11	E	Cloudy and grey colored water, about 65% of pond covered by surface and emergent plants, dense stands of cattails on eastern shoreline, south shoreline 100% covered by emergents, non-native present (Ls)
Farnum Street Pond, North Andover	MA92018	8	E	100% coverage of pond by floating leaf and emergent plants, no open water, non-native present (Ls)
Field Pond, Andover	MA92019	59	M	Good water clarity, surface water almost 100% open, 75-100% of pond bottom covered with low-growing submergents, non-native present (Cc, Ls)
Fourmile Pond, Boxford	MA92022	25	U	Great water clarity, 20% of pond covered by floating leaf plants
Frye Pond, Andover	MA92023	6	E	Variable water clarity, slight tea stain, 100% of pond covered by floating leaf and submergent plants except beach
Hood Pond, Ipswich	MA92025	67	U	Good water clarity, slight tea stain, surface water 80% open, southwest cove has emergent and floating-leaf plants covering 25% of the surface, adjacent to the extensive sandy beach, non-native present (Ls)
Howes Pond, Boxford	MA92026	7	E	Slightly turbid to turbid (possibly algal based), submerged plants covered with organic debris, west basin most covered with emergent and floating leaf plants about 60% of entire pond affected, entire pond 50-75% covered by emergent and floating leaf plants, lots of waterfowl present, non-native present (Ls)
Kimballs Pond, Boxford	MA92027	7	U	Slightly turbid, tea stain, sparse submerged vegetation

Table C1 (continued). 1995 Ipswich River Watershed lake observations and trophic status estimates.

Lower Boston Brook Pond, Middleton	MA92031	15	E	Only stream bed remains, >90% pond covered by emergent macrophytes, mostly non-native (Ls)
Lower Fourmile Pond, Boxford	MA92032	21	E	Very little water remains, 100% of pond covered by plants, non-native present (Ls)
Lowe Pond, Boxford	MA92034	32	E	Good water clarity, 100% of pond covered by submerged and floating leaf plants, non-native present (Cc, Ls)
Lubber Pond East, Wilmington	MA92035	7	E	No water to observe, almost 100% of pond basin covered by emergent plants, non-native present (Ls)
Lubber Pond West, Wilmington	MA92036	9	E	No water to observe, almost 100% of pond basin covered by emergent plants, non-native present (Ls)
Martins Pond, North Reading	MA92038	92	E	Very turbid, brown water, algal bloom likely in progress, Secchi depth estimated <4 feet, mostly open water except marginal community of floating leaf vegetation, non-native present (Cc, Ls)
Middleton Pond, Middleton*	MA92039	135	U	Good water clarity, tea stained, main body and east end 100% open water, large cove on west end 100% covered by floating leaf and emergent vegetation, non-native present (Ls)
Mill Pond, Burlington*	MA92041	65	U	Very good water clarity, low water level, 100% open water, sparse plant growth, non-native present (Ls)
Pierces Pond, Peabody	MA92048	5	U	Somewhat turbid (grey-green), about 90% open water, non-native present (Ls, Pa)
Pleasant Pond (Idlewood Lake), Wenham/Hamilton	MA92049	43	U	Slightly turbid (grey-green), water level low, open surface water except at extreme south and north ends where cover was very dense, non-native present (Ls) and possible non-native (M.sp.) present
Putnamville Reservoir, Danvers*	MA92052	270	U	Somewhat turbid and moderately tea stain, water level low, essentially 100% open water, non-native present (Ls)
Salem Pond, North Andover	MA92057	17	E	Very turbid, brown colored, algal bloom likely, Secchi depth estimated <4 feet, sparse aquatic plant cover
Salem Street Pond (unnamed gravel pit pond), North Andover	MA92076	10	U	Very good clarity, pond surface 90% open, pond bottom mostly covered with low growing submergents, green algal mats present, non-native present (Ls)
Silver Lake, Wilmington	MA92059	28.5	U	Very good water clarity, water level low, many Canada geese, sparse aquatic plant cover, sandy bottom to lake, >90% open water, non-native present (Ls)
Spofford Pond, Boxford	MA92060	27	E	Slightly turbid, tea stain, about 60% open water, encroaching plant community on east, north, and west shores, south coast is 100% covered with emergent plants, non-native present (Ls)

Table C1 (continued). 1995 Ipswich River Watershed lake observations and trophic status estimates.

Stearns Pond, North Andover*	MA92061	41	E	Slightly turbid, tea stain, very shallow, >75% of pond covered with emergent and floating leaf plants, open water inundated with submerged plants, non-native present (Ls)
Stevens Pond, Boxford.	MA92062	12	U	Good water clarity, tea stain, 90% open water, vegetation along margins of pond, non-native present (Ls, Mq)
Stiles Pond, Boxford.	MA92063	60	U	Clear to slightly turbid water, 90-100% open water, small aquatic plants are scarce, non-native present (Ls)
Sudden Pond, North Andover	MA92064	6	U	Dark tea stain, good water clarity, main portion of pond 50-75% aquatic plant cover, other sections sparse to moderate aquatic plant cover, non-native present (Pa)
Suntaug Pond, Lynnfield/Peabody*	MA92065	153	U	Very good water clarity, 100% open water, non-native present (Ls)
Swan Pond, North Reading*	MA92066	46	U	Slightly turbid, tea stain, mostly open water, southeast community encroaching, non-native present (Ls)
Towne Pond, Boxford/North Andover	MA92068	23	E	Good water clarity, slightly tea stain, water level very low, 100% of pond covered with emergent and floating leaf plants, non-native present (Ls)
Towne Street Pond, North Andover	MA92069	24	U	No open water habitat, 100% aquatic plant cover, non-native present (Ls)
Upper Boston Brook Pond, Middleton	MA92070	7	E	Slightly turbid, tea stain, 50-75% of pond surface covered by floating leaf aquatic plants, non-native present (Ls)
Wenham Lake, Beverly*	MA92073	225	U	Turbid and slight tea stain, Canada geese prevalent, 95-100% open water, marginal plants sparse, non-native present (Ls)
Winona Pond, Peabody*	MA92077	26	U	Slightly turbid and slight tea stain, 100% open water, non-native present (Ls)

***** Indicates Class A (water supply) waterbody; all others are Class B.
WBID – Waterbody Identification code.
Trophic State: E= Eutrophic, M= Mesotrophic, U= Undetermined.
Non-native Plants: Ls = *Lythrum salicaria*, Pa = *Phragmites australis*, Cc = *Cabomba caroliniana*, Mq = *Marsilea quadrifolia*
Note: M. sp. – Possible *Myriophyllum heterophyllum*, requires further confirmation when flowering heads are evident.

2000

In the Ipswich River Watershed, baseline lake surveys were conducted in July, August, and September 2000 to coincide with maximum growth of aquatic vegetation, highest recreational use, and highest lake productivity. Two ponds, Crystal Pond and Devils Dishfull Pond were sampled three times each (generally at monthly intervals). A technical memorandum by Dr. Mark Mattson entitled *Baseline Lakes 2000 Technical Memo* provides details of sample collection methods, results, data, and weed maps for the lakes surveyed in the Deerfield, Millers, Shawsheen, Ipswich, Islands, and Buzzards Bay watersheds in 2000 (Mattson .

In situ measurements using the Hydrolab® (measures dissolved oxygen, water temperature, pH, conductivity, and depth and calculates total dissolved solids and % oxygen saturation) were recorded. At deep hole stations measurements were recorded at various depths creating profiles. In-lake samples were also collected and analyzed for alkalinity, total phosphorus, apparent color, and chlorophyll *a* (an integrated sample). Procedures used for water sampling and sample handling are described in the *Grab Collection*

Techniques for DWM Water Quality Sampling Standard Operating Procedure and the *Hydrolab® Series 3 Multiprobe Standard Operating Procedure* (MA DEP 1999a and MA DEP 1999b). The Wall Experiment Station (WES), the Department's analytical laboratory, supplied all sample bottles and field preservatives, which were prepared according to the WES *Laboratory Quality Assurance Plan and Standard Operating Procedures* (MA DEP 1995). Samples were preserved in the field as necessary, transported on ice to WES, and analyzed according to the WES Standard Operating Procedure (SOP). Both quality control samples (field blanks, trip blanks, and split samples) and raw water quality samples were transported on ice to WES on each sampling date; they were subsequently analyzed according to the WES SOP. Information about data quality objectives (accuracy, precision, detection limits, holding times, representativeness and comparability) is also presented in Appendix A. Apparent color and chlorophyll *a* were measured according to standard procedures at the MA DEP DWM office in Worcester (MA DEP 1999c and MA DEP 1999d). An aquatic macrophyte survey was conducted at each lake. The aquatic plant cover (native and non-native) and species distribution was mapped and recorded. Details on procedures used can be found in the *Baseline Lake Survey Quality Assurance Project Plan* (MA DEP 1999e). Data was excerpted from the *Baseline Lake Survey 2000 Technical Memo* and presented in tables C2 and C3.

Table C2. 2000 DEP DWM Ipswich River Watershed Baseline Lakes *in-situ* Hydrolab® data

Crystal Pond (Palis: 92013) Unique_ID: 803 Station: A
Description: deep hole in northeast quadrant of pond, Peabody

Date	OWMID	Time	Depth	Temp	pH	Cond@ 25C	TDS	DO	SAT
		(24hr)	(m)	(C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
7/12/2000									
	LB-0618	10:44	0.5	23.5u	7.1c	466	298	10.2u	118u
	LB-0619	11:08	0.5	23.2	7.0	470	301	9.4	109
8/17/2000									
	LB-0712	10:45	0.5	**u	6.9	420	269	8.9	97
	LB-0978	10:53	0.5	20.3u	6.9	420	269	9.2u	100u
9/13/2000									
	LB-0805	10:14	0.5	23.0	6.8	494	316	5.8	67

Devils Dishfulll Pond (Palis: 92015) Unique_ID: 802 Station: A
Description: deep hole north of island, Peabody. (pond dredging is not reflected on 1987 Reading USGS quad - point is accurate overlaid on 1995 ortho photo)

Date	OWMID	Time	Depth	Temp	pH	Cond@ 25C	TDS	DO	SAT
		(24hr)	(m)	(C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
7/12/2000									
	LB-0627	14:05	0.5	23.9	6.7	293	188	5.4	62
		14:15	1.5	20.7	6.4	288	185	0.8	8
		14:21	2.5	15.0	6.5	245	157	<0.2	<2
		14:28	3.5	11.8	6.5	226	144	<0.2	<2
		14:34	4.5	9.6	6.8	265	169	<0.2	<2
		15:03	2.0	17.7u	6.5	254	163	0.3	3
8/17/2000									
	LB-0716	13:04	0.6	21.2	6.6	264	169	3.2	36
		13:11	1.5	20.0	6.4	266	170	0.8	9
		13:16	2.5	17.0	6.5	247	158	2.4u	24u
		13:22	3.5	13.0	6.6	247	158	<0.2	<2
		13:26	4.5	10.1u	7.1cu	322u	206u	<0.2	<2
9/13/2000									
	LB-0809	11:42	0.5	21.8	6.7	295	189	5.1	58
		11:50	1.5	20.3	6.4	300	192	1.3	15
		11:58	2.5	17.8	6.4	282	180	0.2	2
		12:05	3.5	14.2u	6.7	250	160	<0.2u	<2u
		12:14	4.5	10.7	7.0	350	224	<0.2	<2

" ** " = Censored or missing data (i.e., data that should have been reported)
" u " = unstable readings, due to lack of sufficient equilibration time prior to final readings, non-representative location, highly-variable water quality conditions, etc

Table C3. 2000 DEP DWM Ipswich River Watershed Baseline Lakes *physico-chemical* data.

Crystal Pond (Palis: 92013) Unique_ID: 803 Station: A
Description: deep hole in northeast quadrant of pond, Peabody

Date	Secchi	Secchi Time	Station Depth	OWMID	QAQC	Time	Sample Depth	Alkalinity	TP	Apparent Color	Chl a
	(m)	24hr	(m)			24hr	(m)	(mg/L)	(mg/L)	PCU	(mg/m3)
7/12/2000	0.9	11:33	1.3								
				LB-0613		**	0.5	62	0.091	65	--
				LB-0614	LB-0615	**	0.5	62	0.070	65	--
				LB-0615	LB-0614	**	0.5	64	0.071	65	--
				LB-0616	BLANK	**	--	<2	<0.005	<15	--
				LB-0617		**	0 - 1.0	--	--	--	23.1
8/17/2000	0.9	11:00	1.2								
				LB-0706	LB-0707	**	0.5	55	0.15 b	80	--
				LB-0707	LB-0706	**	0.5	56	0.15 b	--	--
				LB-0708	DUP	**	0.5	55	0.14 b	--	--
				LB-0710	BLANK	**	--	<2	0.006b	--	--
				LB-0711		**	0 - 0.7	--	--	--	45.7
9/13/2000	1.2	10:02	1.4								
				LB-0799	LB-0800	**	0.5	66	0.066	65d	--
				LB-0800	LB-0799	**	0.5	68	0.064	55d	--
				LB-0801	DUP	**	0.5	67	0.067	26d	--
				LB-0802	BLANK	**	--	<2	<0.005	<15	--
				LB-0803		**	**m	** m	** m	** m	--
				LB-0804		**	0 - ** m	--	--	--	4.6 m

Devils Dishfulll Pond (Palis: 92015) Unique_ID: 802 Station: A
Description: deep hole north of island, Peabody. (pond dredging is not reflected on 1987 Reading USGS quad - point is accurate overlaid on 1995 ortho photo)

Date	Secchi	Secchi Time	Station Depth	OWMID	QAQC	Time	Sample Depth	Alkalinity	TP	Apparent Color	Chl a
	(m)	24hr	(m)			24hr	(m)	(mg/L)	(mg/L)	PCU	(mg/m3)
7/12/2000	1.6	15:45	4.8								
				LB-0624		15:25	0.5	53	0.026	80	--
				LB-0625		15:40	4.5	52	0.036	75	--
				LB-0626		15:45	0 - 4.5	--	--	--	12.0
8/17/2000	2.0	13:05	5.5								
				LB-0713		**	0.5	48	0.024	65	--
				LB-0714		**	5.0	68	0.064	340	--
				LB-0715		**	0 - 5.0	--	--	--	31.7
9/13/2000	3.6	11:34	5.2								
				LB-0807		**	4.7	91	0.086	400	--
				LB-0808		**	0 - 4.7	--	--	--	15.8 h
				LB-0810		**	0.5	55	0.014	40	--

" ** " = Censored or missing data (i.e., data that should have been reported)
" -- " = No data (i.e., data not taken/not required)
" h " = holding time violation (usually indicating possible bias low)
" m " = method not followed; one or more protocols contained in the DWM Multi-probe SOP not followed, i.e. operator error (e.g. less than 3 readings per station (rivers) or per depth (lakes), or instrument failure not allowing method to be implemented.
" b " = blank Contamination in lab reagent blanks and/or field blank samples (indicating possible bias high and false positives).
" d " = precision of field duplicates (as RPD) did not meet project data quality objectives identified for program or in QAPP; batch samples may also be affected

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APPENDIX D

***Technical Memorandum* TM-92-2**

IPSWICH RIVER WATERSHED 2000 BIOLOGICAL ASSESSMENT

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5 June 2003

CONTENTS

Tables and Figures

INTRODUCTION

Biological monitoring is a useful means of detecting anthropogenic impacts to the aquatic community. Resident biota (e.g., benthic macroinvertebrates, fish, periphyton) in a water body are natural monitors of environmental quality and can reveal the effects of episodic and cumulative pollution and habitat alteration (Barbour et al. 1999, Barbour et al. 1995). Biological surveys and assessments are the primary approaches to biomonitoring.

As part of the Massachusetts Department of Environmental Protection/ Division of Watershed Management's (MA DEP/DWM) 2000/2001 Ipswich River watershed assessments, aquatic benthic macroinvertebrate biomonitoring was conducted to evaluate the biological health of various streams within the watershed. A total of eight biomonitoring stations were sampled to investigate the effects of various nonpoint and point source stressors—both historical and current—on the aquatic communities of the watershed. Some stations sampled during the 2000 biomonitoring survey were previously "unassessed" by DEP, while historical DEP biomonitoring stations—most recently assessed in 1995 (Fiorentino 1997)—were reevaluated to determine if water quality and habitat conditions have improved or worsened over time. Sampling locations, along with station identification numbers and sampling dates, are noted in Table 1. Sampling locations are also shown in Figure 1.

To provide additional information necessary for making basin-wide aquatic life use-support determinations required by Section 305(b) of the Clean Water Act, all Ipswich River watershed macroinvertebrate biomonitoring stations were compared to a regional reference station most representative of the "best attainable" conditions in the watershed. Use of a regional reference station is particularly useful in assessing nonpoint source pollution and nutrient/BOD loadings originating from multiple and/or unknown sources in a watershed, as well as nonpoint source pollution impacts (e.g., physical habitat degradation) at upstream control sites and downstream sites suspected as chemically-impacted from known point source stressors (Hughes 1989). The regional reference station was established in Fish Brook. The station was situated upstream from all known point sources of water pollution, and was also assumed (based on topographic map examinations and field reconnaissance) to be relatively unimpacted by nonpoint sources.

During "year 1" of its "5-year basin cycle", problem areas within the Ipswich River watershed were better defined through such processes as coordination with appropriate groups (EOEA Ipswich River Watershed Team, local watershed associations, DEP/DWM, DEP/NERO), assessing existing data, conducting site visits, and reviewing NPDES and water withdrawal permits. Following these activities, the 2000 biomonitoring plan was more closely focused and the study objectives better defined. Table 2 includes a summary of the perceived problems/issues addressed during the 2000 Ipswich River watershed biomonitoring survey.

The main objectives of biomonitoring in the Ipswich River watershed were: (a) to determine the biological health of streams within the watershed by conducting assessments based on aquatic macroinvertebrate and fish communities; and (b) to identify problem stream segments so that efforts can be focused on developing NPDES permits, Water Management Act (WMA) permits, stormwater management, and control of other nonpoint source (NPS) pollution. Specific tasks were:

1. Conduct benthic macroinvertebrate sampling and habitat assessments at locations throughout the Ipswich River watershed.

2. Based upon the macroinvertebrate data, identify river segments within the watershed with potential point/nonpoint source pollution problems; and

3. Using the benthic macroinvertebrate data and supporting water chemistry and field/habitat data:

    - Assess the types of water quality and/or water quantity problems that are present, and

    - if possible, make recommendations for remedial actions or additional monitoring and assessment.

- Provide macroinvertebrate and habitat data to DEP/DWM's Environmental Monitoring and Assessment Program for assessments of aquatic life use-support status required by Section 305(b) of the Federal Clean Water Act (CWA).

- Provide macroinvertebrate and habitat data for other informational needs of Massachusetts regulatory agencies, as well as the Executive Office of Environmental Affairs (EOEA) Massachusetts Watershed Initiative (MWI) Ipswich River Basin Team.

Table 1. List of biomonitoring stations sampled during the 2000 Ipswich River watershed survey, including station identification number, drainage area, station description, and sampling date.

Station ID	Drainage area (mi^2)	IPSWICH RIVER WATERSHED Site description	Sampling Date
FB00*	12.16	Fish Brook, 350 m upstream from Middletown Road, Boxford, MA	17 July 2000
MB02*	13.15	Martins Brook, 50 m downstream from Park Street, North Reading, MA	17 July 2000
BB01	8.07	Boston Brook, 250 m upstream from Liberty Street, Middleton, MA	17 July 2000
IP01.5	18.66	Ipswich River, 170 m downstream from Mill Street, Reading/N. Reading, MA	19 July 2000
IP06*	43.84	Ipswich River, 100 m downstream from Boston Street, Middleton, MA	17 July 2000
GB01	2.15	Gravelly Brook, 60 m upstream from Topsfield Road, Ipswich, MA	19 July 2000
MR01	16.87	Miles River, 370 m downstream from Route 1A, Ipswich, MA	19 July 2000
LB02	5.82	Lubbers Brook, at Concord Street, Wilmington, MA	19 July 2000

* Macroinvertebrate biomonitoring conducted here by MA DEP/DWM in 1995 (Fiorentino 1997)

Table 2. List of perceived problems addressed during the 2000 Ipswich River watershed biomonitoring survey. Specific biomonitoring stations addressing each problem are also listed, as is the sampling methodology employed.

Ipswich River Watershed Stations	Issues/Problems	Sampling Method
FB00	reference condition, new home construction[1]	RBPIII--kick sampling
MB02	miscellaneous NPS (habitat degradation, stormwater/road runoff)[2, 3], organic enrichment/low dissolved oxygen[2, 3], upstream impoundments[3], water treatment plant discharge[5]	RBPIII--kick sampling
BB01	unknown NPS, upstream impoundments[3], "unassessed" for aquatic life use[4]	RBPIII--kick sampling
IP01.5	flow alteration[3], miscellaneous NPS (habitat degradation, stormwater/road runoff), nutrients[3], organic enrichment/low dissolved oxygen[3], "unassessed" for aquatic life use[4], waterdischarge[5]	RBPIII--kick sampling
IP06	flow alteration[3], miscellaneous NPS (habitat degradation, stormwater/road runoff)[2, 3], industrial discharge[5], nutrients[3], organic enrichment/low dissolved oxygen[3]	RBPIII--kick sampling
GB01	"unassessed" for aquatic life use[4]	RBPIII--kick sampling
MR01	"unassessed" for aquatic life use[4], agricultural runoff, organic enrichment/low dissolved oxygen[3]	RBPIII--kick sampling
LB02	miscellaneous NPS (habitat degradation, stormwater/road runoff), upstream impoundments[3], "unassessed" for aquatic life use[4]	Qualitative--multi-habitat jabs

[1](Fiorentino 2001); [2](Fiorentino 1997); [3](MA DEP 1999); [4](MA DEP 2000a); [5](MA DEP 2002)

IPSWICH RIVER WATERSHED
BIOMONITORING STATIONS

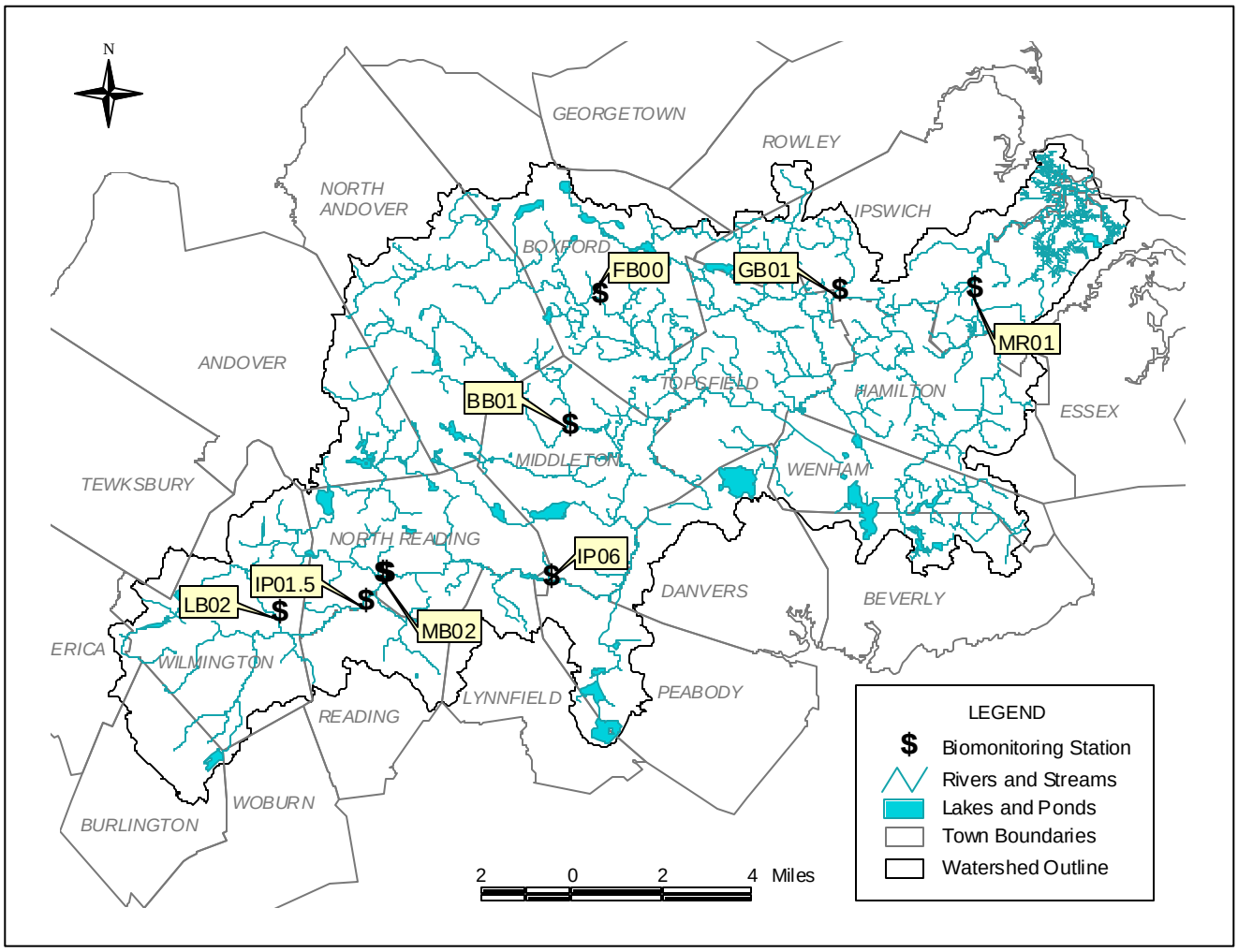


Figure 1. Location of MA DEP/DWM biomonitoring stations for the 2000 Ipswich River watershed survey.

METHODS

Macroinvertebrate Sampling - RBPIII

The macroinvertebrate sampling and processing procedures employed during the 2000 Ipswich River watershed biomonitoring survey are described in the standard operating procedures (Nuzzo 1999), and are based on US EPA Rapid Bioassessment Protocols (RBPs) for wadeable streams and rivers (Barbour et al. 1999). The macroinvertebrate collection procedure utilized kick-sampling, a method of sampling benthic organisms by kicking or disturbing bottom sediments and catching the dislodged organisms in a net as the current carries them downstream (Figure 2). Sampling activities were conducted in accordance with the Quality Assurance Project Plan (QAPP) for benthic macroinvertebrate biomonitoring (Fiorentino 2000). Sampling was conducted by DEP/DWM biologists throughout a 100 m reach, in riffle/run areas with fast currents and rocky (cobble, pebble, and gravel) substrates—generally the most productive habitats supporting the most diverse communities in the stream system. Ten kicks in squares approximately 0.46 m x 0.46 m were composited for a total sample area of about 2 m^2. Samples were labeled and preserved in the field with denatured 95% ethanol, then brought to the DEP/DWM lab for further processing.

Figure 2. MA DEP/DWM biologist collecting macroinvertebrates using the “kick-sampling” technique.

Macroinvertebrate Sample Processing and Analysis

Macroinvertebrate sample processing entailed distributing whole samples in pans, selecting grids within the pans at random, and sorting specimens from the other materials in the sample until approximately 100 organisms (±10%) were extracted. Specimens were identified to genus or species as allowed by available keys, specimen condition, and specimen maturity. Taxonomic data were analyzed using a modification of Rapid Bioassessment Protocol III (RBP III) metrics and scores (Barbour et al. 1999). Based on the taxonomy, various community, population, and functional parameters, or "metrics", were calculated which allow measurement of important aspects of the biological integrity of the community. This integrated approach provides more assurance of a valid assessment because a variety of biological parameters are evaluated. Deficiency of any one metric should not invalidate the entire approach (Barbour et al. 1999). Metric values for each station were scored based on comparability to the reference station, and scores were totaled. The percent comparability of total metric scores for each study site to those for a selected "least-impacted" reference station yields an impairment score for each site. RBP III analysis separates sites into four categories: non-impacted, slightly impacted, moderately impacted, and severely impacted. Each impact category corresponds to a specific aquatic life use-support determination used in the CWA Section 305(b) water quality reporting process—non-impacted and slightly impacted communities are assessed as "support" in the 305(b) report; moderately and severely impacted communities are assessed as "impaired." A detailed description of the *Aquatic Life* use designation is outlined in the *Massachusetts Surface Water Quality Standards* (SWQS) (MA DEP 1996). Impacts to the benthic community may be indicated by the absence of generally pollution-sensitive macroinvertebrate taxa such as Ephemeroptera, Plecoptera, and Trichoptera (EPT); dominance of a particular taxon, especially the pollution-tolerant Chironomidae and Oligochaeta taxa; low taxa richness; or shifts in community composition relative to the reference station (Barbour et al. 1999). Those biological metrics calculated and used in the analysis of Ipswich River watershed macroinvertebrate data are listed and defined below [For a more detailed description of metrics used to evaluate benthos data see Barbour et al. (1999)]:

1. Taxa Richness—a measure based on the number of taxa present. Generally increases with increasing water quality, habitat diversity, and habitat suitability. The lowest possible taxonomic level is assumed to be genus or species.

2. EPT Index—a count of the number of genera/species from the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). As a group these are considered three of the more sensitive aquatic insect orders. Therefore, the greater the contribution to total richness from these three orders, the healthier the community.

3. Biotic Index—Based on the Hilsenhoff Biotic Index (HBI), this is an index designed to produce a numerical value to indicate the level of organic pollution (Hilsenhoff 1982). Organisms have been assigned a value ranging from zero to ten based on their tolerance to organic pollution. Tolerance values currently used by DEP/DWM biologists were originally derived from Hilsenhoff and have since been revised by Bode et al. (1991). A value of zero indicates the taxon is highly intolerant of pollution and is likely to be found only in pollution-free waters. A value of ten indicates the taxon is tolerant of pollution and may be found in highly polluted waters. The number of organisms and the individually assigned values are used in a mathematical formula that describes the degree of organic pollution at the study site. The formula for calculating HBI is:

$$HBI = \sum \frac{x_i t_i}{n}$$

where

x_i = number of individuals within a taxon
t_i = tolerance value of a taxon
n = total number of organisms in the sample

4. Ratio of EPT and Chironomidae Abundance—The EPT and Chironomidae abundance ratio uses relative abundance of these indicator groups as a measure of community balance. Skewed populations having a disproportionate number of the generally tolerant Chironomidae ("midges") relative to the more sensitive insect groups may indicate environmental stress.

5. Percent Contribution Dominant Taxon—is the percent contribution of the numerically dominant taxon (genus or species) to the total numbers of organisms. A community dominated by few species indicates environmental stress. Conversely, more balance among species indicates a healthier community.

6. Ratio of Scraper and Filtering Collector Functional Feeding Groups—This ratio reflects the community food base. The proportion of the two feeding groups is important because predominance of a particular feeding type may indicate an unbalanced community responding to an overabundance of a particular food source (Barbour et al. 1999). Scrapers predominate when diatoms are the dominant food resource, and decrease in abundance when filamentous algae and mosses prevail. Filtering collectors thrive where filamentous algae and mosses are prevalent and where fine particulate organic matter (FPOM) levels are high.

7. Community Similarity—is a comparison of a study site community to a reference site community. Similarity is often based on indices that compare community composition. Most Community Similarity indices stress richness and/or richness and abundance. Generally speaking, communities with comparable habitat will become more dissimilar as stress increases. In the case of the Ipswich River watershed bioassessment, an index of macroinvertebrate community composition was calculated based on similarity (i.e., affinity) to the reference community, expressed as percent composition of the following organism groups: Oligochaeta, Ephemeroptera, Plecoptera, Coleoptera, Trichoptera, Chironomidae, and Other. This approach is based on a modification of the Percent Model Affinity (Novak and Bode 1992). The reference site affinity (RSA) metric is calculated as:

   $100 - (\Sigma\ \delta \times 0.5)$

   where δ is the difference between the reference percentage and the sample percentage for each taxonomic grouping. RSA percentages convert to RBPIII scores as follows: <35% receives 0 points; 2 points in the range from 35 to 49%; 4 points for 50 to 64%; and 6 points for ≥65%.

Habitat Assessment

An evaluation of physical and biological habitat quality is critical to any assessment of ecological integrity (Karr et al. 1986; Barbour et al. 1999). Habitat assessment supports understanding of the relationship between physical habitat quality and biological conditions, identifies obvious constraints on the attainable potential of a site, assists in the selection of appropriate sampling stations, and provides basic information for interpreting biosurvey results (US EPA 1995). Before leaving the sample reach during the 2000 Ipswich River watershed biosurveys, habitat qualities were scored using a modification of the evaluation procedure in Barbour et al. (1999). The matrix used to assess habitat quality is based on key physical characteristics of the water body and the immediate riverfront area. Most parameters evaluated are instream physical attributes often related to overall land use and are potential sources of limitation to the aquatic biota (Barbour et al. 1999). The ten habitat parameters are as follows: instream cover, epifaunal substrate, embeddedness, sediment deposition, channel alteration, velocity/depth combinations, channel flow status, right and left (when facing downstream) bank vegetative protection, right and left bank stability, right and left bank riparian vegetative zone width. Habitat parameters are scored, totaled, and compared to a reference station to provide a final habitat ranking.

Macroinvertebrate Sampling -- Qualitative

Macroinvertebrate biomonitoring was conducted at one station based on modifications to the RBP I protocol, a screening or reconnaissance assessment that documents specific visual observations made in the field by a trained professional. The RBP I procedure was used at this station due to habitat and flow constraints that made the application of the RBP III methodology impractical. RBP I is used to discriminate obviously impacted and non-impacted areas from potentially affected areas. A biosurvey component focuses on qualitative sampling of benthic macroinvertebrates, supplemented by a preliminary field examination of other aquatic biota (periphyton, macrophytes, and fish). Qualitative benthic samples

are collected from all available habitats using a kick net; benthic macroinvertebrate orders/families are listed on a field data sheet. A cursory evaluation of habitat is conducted in lieu of the RBPIII habitat assessment matrix. On the basis of the observations made on habitat, water quality, physical characteristics, and the qualitative biosurvey, the investigator determines whether impairment is detected.

RESULTS AND DISCUSSION

The biological and habitat data collected at each sampling station during the 2000 biosurveys are attached as an Appendix (Tables A1 – A4). Included in the macroinvertebrate taxa list (Table A1) are total organism counts, the functional feeding group designation (FG) for each macroinvertebrate taxon, and the tolerance value (TV) of each taxon.

A summary table (Table A2) of the RBP III macroinvertebrate data analyses, including biological metric calculations, metric scores, and impairment designations, is included in the Appendix as well. Habitat assessment scores for each station are also included in the summary tables, while a more detailed summary of habitat parameters is shown in Table A3. Table A4 summarizes important components of the periphyton community at each biomonitoring station, and includes estimates of canopy cover and algal cover.

The 2000 biomonitoring data for this watershed generally indicate various degrees of nonpoint source-related problems in many of the mainstem and tributary stations examined. Urban runoff, habitat degradation, and other forms of NPS pollution compromise water quality and biological integrity throughout the watershed. In addition, the effects of water quality degradation may be exacerbated by the compromised assimilative capacities of those flow-stressed streams currently impacted by water withdrawals. That said, some tributaries examined (i.e., Fish and Gravelly brooks) in the Ipswich River watershed remain relatively non-impacted and are indicative of the "best attainable" conditions in the watershed. It is imperative that anthropogenic perturbations be kept to a minimum in these unimpaired waterbodies.

Ipswich River Watershed

The Ipswich River is formed by the confluence of Maple Meadow and Lubbers brooks near Woburn Street in Wilmington. The drainage area is 8.6 mi^2 of which 5.6 mi^2 are drained by Maple Meadow Brook. The Ipswich widens into a "pond" as it passes by the Reading Town Forest. Bear Meadow Brook, which flows out of Cedar Swamp to the south of the Ipswich, and Martins Brook, which drains 14 mi^2 of relatively undeveloped wetlands to the north of the river are the next tributaries to flow into the Ipswich River. Below Martins Brook, the Ipswich becomes more distinctly channelized and, as a result, there is a slight increase in stream velocity. The channel then begins to widen as the river passes through the center of North Reading. The river continues eastward in a series of tight meanders and is joined by an unnamed tributary and by Wills Brook before it enters the impoundment created by the Bostik Company Dam (formerly the USM Chemical Dam) in South Middleton. The first of two flow gages maintained by the US Geological Survey (USGS) on the mainstem Ipswich River is located just downstream of this dam. Station 01101500 at South Middleton, MA has a drainage area of 44.5 mi^2 and an average annual flow of 63.2 cubic feet per second (cfs). The river has a vertical fall of approximately 30 feet between its source and the South Middleton gage. One-third of the fall occurs at the dam.

Stream flow, which has followed an easterly course since the confluence with Martin's Brook, turns abruptly to the north approximately 1.4 river miles below the gage. As the Ipswich meanders northward through Middleton, it is joined by Norris Brook, the outlet of Middleton Pond, and Emerson Brook. Again, much of the Ipswich's slowly flowing course is through wetland areas. As it is joined by Boston Brook, the overall direction of flow turns to the east as the stream meanders through Topsfield. Nichols Brook and Fish Brook join the Ipswich prior to its entrance into the northern portion of Wenham Swamp, which is the basin's largest freshwater wetland (3 mi^2). As the meandering journey of the Ipswich again turns north, the rate of flow is so slow and the surface of the stream is so level with the surrounding wetlands that several rather large backwater ponds are formed adjacent to the main "channel".

As the Ipswich flows northward, it is joined by several tributaries including Mile, Idlewild, an unnamed tributary, Howlett, and Gravelly brooks. The stream channel widens considerably and the Ipswich River begins to flow at a higher velocity in the northeasterly direction that will carry it into Ipswich Bay. The channel widens further as the river enters the impoundment created by the Willowdale "Dam", which is actually a series of small dams. The second USGS flow gage on the mainstem Ipswich, station 01102000 near Ipswich, MA, has a drainage area of 125 mi^2 and an average annual discharge of 187 cfs. Below the Willowdale Dam, the Ipswich is joined by Black Brook and the Miles River. The most noticeable vertical fall in the Ipswich River occurs in the stretch between the Willowdale Dam and the Miles River, where there are riffles in the stream. The river slows as it enters the impoundment created by the Sylvania Dam, located in the central village of Ipswich. The Ipswich Estuary begins just downstream of the dam, and the stream flows through extensive saltwater marshlands to its mouth at Ipswich Bay delineated between Little Neck and Crane Beach. There are several estuarine tributaries, but the only stream of any significance is known locally as Greenwood Creek, which receives the treated effluent of the Ipswich Wastewater Treatment Facility.

Fish Brook

Fish Brook drains a large wetland area in North Andover. Mosquito Brook joins Fish Brook as it meanders in an easterly direction through Howes Pond in Boxford where it turns in a southeasterly direction towards its confluence with the Ipswich River. Fish Brook forms the boundary between Boxford and Topsfield as it flows into the Ipswich. Predominant land-use in the Fish Brook subwatershed is 61% forested, 27% residential, and 4% agriculture.

FB00—Fish Brook, mile point 3.5, approximately 350 m upstream from Middletown Road, Boxford, MA.

Habitat

The FB00 sampling reach began approximately 350 m upstream from Middletown Road, in a forested and relatively undeveloped portion of Boxford. The partially (50%) shaded reach was approximately 4 m wide and consisted of a series of short, shallow (0.25 m) riffles interspersed with deeper (0.50 m) pool/run areas. Rocky substrates were prevalent, including an abundance of cobble and pebble, as well as gravel and a fair amount of sand—the latter resulting in occasional small areas of deposition. Instream mosses and emergent macrophytes—most notably burreed (*Sparganium* sp.)—provided additional microhabitat and contributed to the optimal epifaunal habitat for macroinvertebrates. Fish habitat was optimal as well, with submerged logs and overhanging shrubs providing the majority of the cover. Both stream banks were well-vegetated and stabilized with an abundance of herbaceous vegetation. A diverse assemblage of vines, shrubs, and herbaceous growth, consisting of riverbank grape (*Vitis riparia*), rose (*Rosa multiflora*), honeysuckle (*Lonicera* sp.), skunk cabbage (*Symplocarpus foetidus*), Joe-Pye weed, (*Eupatorium* sp.) and ferns, dominated the riparian zone along both banks. Farther from the stream channel riparian vegetation was dominated by a mix of evergreens and hardwoods that included white pine (*Pinus strobus*), red maple (*Acer rubrum*), ash (*Fraxinus americana*), and oak (*Quercus* sp.). Riparian vegetation extended undisturbed from the left (west) bank, while the wide wooded buffer along the right (east) bank eventually gave way to a large uncultivated pasture.

FB00 received a composite habitat score of 182/200—the second highest received by a biomonitoring station during the 2000 Ipswich River watershed survey (Table A3). This was the designated regional reference station by virtue of its habitat evaluation, presumed good water quality, and minimal upstream/nearstream land use impacts (i.e., absence of point source inputs, lack of channelization, minimal development or agricultural activity nearby, undisturbed and well-vegetated riparian zone, minimal NPS inputs).

Benthos

This portion of Fish Brook was characterized by a macroinvertebrate assemblage indicating a healthy aquatic community. A richness of 29, including 8 intolerant EPT taxa, was recorded—the most of any biomonitoring station in the survey—and most of the metric values were indicative of "clean-water" and "least-impacted" conditions (Table A2). In particular, those attributes that measure components of community structure (i.e., Taxa Richness, Biotic Index, EPT Index)—which display the lowest inherent variability among the RBP metrics used (Resh 1988)—scored well, further corroborating the designation as a reference station. A relatively low Biotic Index (4.60) and high Scraper/Filterer metric value (0.90) relative to other biomonitoring stations in the survey indicated the dominance of the Fish Brook benthos assemblage by pollution-sensitive taxa, and good overall trophic balance. FB00 received a total metric score of 40 (Table A2).

MARTINS BROOK

From its source, Martins Pond in North Reading, Martins Brook flows in a westerly direction towards Wilmington and turns south then easterly before joining the Ipswich River in North Reading. Martins Pond receives flow from the Skug River which drains the southeast corner of Andover. Predominant land-use in the Martins Brook subwatershed is 46% forested, 31% residential, and 6% wetland.

MB02—Martins Brook, mile point 0.10, approximately 50 m downstream from Park Street, North Reading, MA

Habitat

Due to the minimal riffle/run habitat in this portion of Martins Brook, the MB02 sampling reach was limited to approximately 50 m in length, beginning downstream from Park Street and ending directly under the road crossing. As sand and gravel dominated the hard substrates in the reach, sampling was mainly confined to the occasional cobble areas. A few "jabs" were also made in the aquatic vegetation, snags, and undercut banks scattered throughout the reach. The partially (40%) shaded stream reach was approximately 4 m wide, with a uniform depth of 0.25 m in the riffle/runs and pool areas. Epifaunal habitat was less than optimal for macroinvertebrates due to the small grain size of the substrates and the lack of swift current velocity. Aquatic vegetation, covering 40% of the reach and consisting mainly of mosses and some rooted macrophytes (watercress, *Nasturtium* sp.; burreed, *Sparganium* sp.; smartweed, *Polygonum* sp.; arrow arum, *Peltandra virginica*), provided additional benthic microhabitat. Fish habitat was limited by the shallow nature of the stream—marginal channel (only 50% full) flow status left many of the snags, submerged logs, and undercut banks exposed and unavailable as cover. Heavy deposits of fine inorganic (sand) and organic (FPOM) materials, causing substrate embeddedness and bar development, further reduced productive epifaunal and fish habitat. While some of this deposition may be naturally-occurring—the result of upstream wetlands and the low-gradient nature of this stream system—the Park Street crossing may offer a significant source of inorganic sediment inputs as well. In addition, stream bank erosion was severe along both banks in the sampling reach and the extremely reduced riparian zone along the right (southwest) bank provided little buffer from nonpoint source pollution inputs (i.e., yard waste) associated with an adjacent residence. Riparian vegetation was better established along the left (northeast) bank, consisting of a shrub/vine/herbaceous (alder, *Alnus* sp.; riverbank grape, *Vitis riparia*; Japanese knotwood, *Polygonum cuspidatum*; poison ivy, *Rhus radicans*; ferns) layer that gave way to a hardwood-dominated forest of beech (*Fagus grandifolia*) and maples (*Acer* spp.).

MB02 received a total habitat assessment score of 108/200—the poorest evaluation received by a biomonitoring station in the 2000 Ipswich River watershed survey (Table A3). Sediment deposition and riparian disruption along the right bank affected the overall assessment most negatively.

Benthos

MB02 received a total metric score of 18, representing 45% comparability to the reference station and resulting in an assessment of "moderately impacted" for biological condition (Table A2). Pollution sensitive EPT taxa were almost completely displaced by taxa more tolerant of organic pollutants and low dissolved

oxygen levels. The low-scoring (score=0) Percent Dominant Taxon metric was mainly the result of hyperdominance by the tolerant gammarid amphipod, *Gammarus* sp. In addition, the filter-feeding caddisfly, *Cheumatopsyche* sp., was common in the MB01 assemblage and, along with the numerical dominance of *Gammarus* sp. and a low-scoring (score=2) Scraper/Filterer metric, suggests an unbalanced community responding to an abundance of organic matter (both deposited and suspended forms) in this portion of the stream. The low metric value (12) for Taxa Richness—one of the lowest in the entire survey—corroborates the less than optimal community structure encountered here.

The degree of impairment observed here following the 2000 biosurvey was higher than that seen during the 1995 bioassessment of MB02, when the benthos was found to be "slightly impaired" relative to the reference conditions at Fish Brook (Fiorentino 1997). Filter-feeding hydropsychids were by far the numerically dominant taxa in the 1995 assemblage while only 7 gammarids were observed. This suggests that suspended forms of FPOM were a more important food resource than deposited forms of organic matter during the 1995 biomonitoring survey. And while algal grazers such as the elmid beetle, *Stenelmis* sp., remained an important component of MB02 trophic structure during the 1995 bioassement, these scraping taxa were virtually absent from the 2000 benthic community (Table A1). It is also possible that dissolved oxygen levels were higher during the 1995 biosurvey here, as the oxygen requirements for hydropsychid caddisflies (and elmid beetles for that matter) are generally higher than for the Amphipoda.

Comparisons of the 2000 benthos data at MB02 to previous sampling years should be made with caution due to the potential for metric variability attributable to natural (e.g., temporal) factors, as well as variability that may result from differing sampling methodologies employed during the two biosurveys. However, this most recent biological assessment of the MB02 aquatic community—based on comparisons to current reference conditions—is discouraging, and is strongly suggestive of a stressed community structured in response to organic enrichment and associated low dissolved oxygen levels. Not surprisingly, the entire length of Martins Brook is 303(d)-listed due to organic enrichment/low DO (MA DEP 1999). Numerous nonpoint sources associated with the urbanized nature of this subwatershed may contribute organic loads to Martins Brook. In addition, the Town of Wilmington Water and Sewer Department is permitted (MAG640020 effective August 2001) to discharge treated (chlorinated) wastewater (filter backwash) from the E. H. Sargent Water Treatment Plant in Wilmington, MA to Martins Brook (MA DEP 2002).

Instream habitat constraints—especially sediment deposition—compromise biological potential at MB02 as well. Sand and other fine sediments drastically reduce macroinvertebrate microhabitat. These fine materials can be deleterious because they can reduce light penetration (and consequently plant/algal growth), smother hard surfaces, and fill the interstitial spaces within epifaunal substrates (Wiederholm 1984). Resident biota at MB02, then, may be subsequently affected by obstructions to food collection or respiration caused by fine deposits of organic/inorganic matter. In addition, the filling of pools with sediment reduces fish cover and may be detrimental to fish spawning habitat and egg incubation. In addition to localized nonpoint source pollution (e.g., Park Street runoff, bank erosion, yard runoff), numerous upstream sand/gravel operations may contribute sediment loads to this portion of Martins Brook. The periodic release of filter backwash wastewater from the Sargent Water Treatment Plant offers another potential source of inorganic particulates.

Boston Brook

Boston Brook flows from the outlet of Towne Street Pond in North Andover along a generally southeasterly course to the confluence with the Ipswich River in Middleton. The headwater drainage area of the Boston Brook subwatershed includes drainage from Boston Hill near the Salem Turnpike in North Andover through Brook Street Pond into Towne Street Pond. Predominant land-use in the Boston Brook subwatershed is 70% forested, 19% residential, and 3% open land.

BB01—Boston Brook, mile point 1.25, approximately 250 m upstream from Liberty Street, Middleton, MA

Habitat

The BB01 sampling reach began approximately 250 m upstream from Liberty Street and the inlet to Pritchards Pond in a forested and relatively undeveloped (Harold Parker State Forest occupies much of the land in the upper portion of this subwatershed) portion of the Boston Brook subwatershed. The mostly (75%) shaded, riffle-dominated reach meandered through a forested area of mainly deciduous trees (beech, *Fagus grandifolia*; maple, *Acer* sp.; oak, *Quercus* sp.) and a few white pines (*Pinus strobus*) before ending at a small wooden footbridge. Stream width was uniformly 3 m, with a depth ranging from 0.25 m in the riffle run areas to 0.75 in the deepest pools. Large rocky substrates (boulder and cobble) subjected to a variety of flow regimes provided macroinvertebrates with excellent epifaunal habitat. Dense instream moss growth provided additional benthic microhabitat throughout most of the sampling reach. Fish habitat was also optimal, with boulders, submerged woody material, and overhanging shrubs providing the majority of cover. Channel flow status was optimal, with water reaching the base of both banks and leaving no exposed substrates. Instream algal growth was minimal, consisting of a thin film of brown algae on rocky substrates in less than 5% of the reach. Riparian and bank parameters scored well—both stream banks were well-vegetated with herbaceous growth (especially ferns) and stabilized with boulders and naturally occurring vegetation. Riparian vegetation, consisting of mostly hardwoods and a fern understory, extended undisturbed along the left (west) bank. Riparian growth was well-established along the right (east) bank as well and only minimally affected by an adjacent footpath. Nonpoint source pollution was not observed in the BB01 sampling reach—the stream was well-buffered against potential inputs from the adjacent roads (Liberty and School streets). Slight instream turbidity was noted during the biosurvey here.

BB01 received a total habitat assessment score of 191/200, which was not only higher than that of the reference station in Fish Brook, but easily the highest evaluation received by any biomonitoring station during the 2000 Ipswich River watershed survey (Table A3).

Benthos

Despite the high quality instream habitat available, the BB01 benthic community received a total metric score of only 20, representing 50% comparability to the reference station and resulting in a "moderately impacted" bioassessment (Table A2). *Gammarus* sp. was again the numerically dominant taxon, with filter-feeding taxa—most notably the pisidiid clam, *Pisidium* sp., and the blackfly larva, *Simulium* sp.—common as well (Table A1). The abundance of these three taxa contributed to low-scoring Taxa Richness (score=2) and EPT richness (score=0) metric values and a low ratio of Scraper/Filterer organisms, indicating an unbalanced community responding to an overabundance of organic matter in this portion of the stream.

The lentic nature of much of Boston Brook and the extensive wetlands drained by the upper portions of the stream may account for the organic loading and potentially low levels of dissolved oxygen reflected in the BB01 macroinvertebrate community. In addition, there are several impoundments in the upper portion of the Boston Brook subwatershed that may contribute FPOM loads to downstream lotic communities such as BB01, although there are no data that suggest these are overly productive waterbodies (i.e., they are not 303(d)-listed for nutrients or noxious aquatic plants). The presence of upstream impoundments may also be significant in that flow regulation at outlet structures may result in occasional baseflow reductions downstream. While channel flow status was good at BB01 during the biosurvey, the conspicuously depauperate periphyton community here—percent algal cover was <5% and algal grazers were virtually absent despite substrate availability (Table A4)—may be indicative of flow-related stress to the biota in this portion of Boston Brook (Beskenis MA DEP/DWM, personal communication). Reduced algal growth may also be the result of poor sunlight penetration caused by instream turbidity, which was noted during the biosurvey here.

Ipswich River

Formed at the confluence of Maple Meadow and Lubbers Brooks near Woburn Street in Wilmington, the Ipswich River flows under Route 93 and forms the boundary between Reading and North Reading widening into a "pond" as it passes by the Reading Town Forest. It is joined by Bear Meadow Brook from the south and Martins Brook from the north where the river becomes more distinctly channelized and the velocity increases slightly. The channel then begins to widen as the river passes through the center of North Reading. The Ipswich flows eastward in a series of tight meanders and is joined by an unnamed tributary from the north and Wills Brook from the south before it enters the impoundment created by the Bostik Company Dam (formerly the USM Chemical Dam) in South Middleton. Bostik Findley, Inc. in Middleton, a manufacturer of industrial grade adhesives and glues, is permitted (MA0001180 issued in July 1991) to discharge contact and non-contact cooling water and stormwater runoff to the Ipswich River (MA DEP 2002). While it has followed an easterly course since its confluence with Martin's Brook, the Ipswich River is joined by Norris Brook from the south and turns abruptly to the north approximately 1.4 river miles below the USGS gage. As the Ipswich meanders northward through Middleton, it is joined by two unnamed tributaries and Boston Brook. It turns east again as it meanders through Topsfield and picks up flow from Nichols and Fish Brooks prior to its entrance into the northern portion of Wenham Swamp, which is the basin's largest freshwater wetland (3 mi^2). It is here that the Salem Beverly Waterway Canal diverts Ipswich River water to supply the communities of Salem and Beverly with treated drinking water. Predominant land-use in this portion of the Ipswich River watershed is 50% forested, 31% residential, and 5% open land.

As the meandering journey of the Ipswich again turns north, the rate of flow is so slow and the surface of the stream so level with the surrounding wetlands that several rather large backwater ponds are formed adjacent to the main "channel". As the Ipswich flows northward, it is joined by Idlewild and Mile Brooks, an unnamed tributary, Howlett Brook and Gravelly Brook. The stream channel widens considerably and the Ipswich begins to flow at a higher velocity in the northeasterly direction which will carry it into Ipswich Bay. The channel widens further as the river enters the impoundment created by the Willowdale "Dam," which is actually a series of small dams. The second USGS flow gage on the mainstem Ipswich, station 01102000 near Ipswich, MA, has a drainage area of 125 mi^2 and an average annual discharge of 187 cfs. Below the Willowdale Dam, the Ipswich is joined by Black Brook and the Miles River. The most noticeable vertical fall in the Ipswich River occurs in the stretch between the Willowdale Dam and the Miles River, where there are riffles in the stream. The river slows as it enters the impoundment created by the Sylvania Dam, located in the central village of Ipswich. Predominant land-use in this portion of the Ipswich River watershed is 50% forested, 28% residential, and 6% agriculture.

The Ipswich River estuary begins just downstream from the Sylvania Dam and flows through extensive saltwater marshlands to its mouth at Ipswich Bay delineated between Little Neck and Crane Beach. There are several estuarine tributaries to this segment of the Ipswich River. Predominant land-use in this portion of the Ipswich River watershed is 49% forested, 28% residential, and 6% wetland.

IP01.5—Ipswich River, mile point 34.0, approximately 170 m downstream from Mill Street, Reading/North Reading, MA

Habitat

IP01.5 began approximately 170 m downstream from Mill Street on the Reading/North Reading border, in an area of forest and pasture. The mostly (75%) shaded sampling reach was extended beyond 100 m so as to include two well-developed riffles at both the top and bottom of the reach. As a result, much of the reach between these two riffle areas—dominated by vast pool (0.75 – 1 m deep) areas and deep (0.50 m) runs—was not sampled. Both riffle areas, though short, offered macroinvertebrates excellent habitat as a result of cobble substrates and swift current velocity of varying depths (0.25 – 0.40 m). Mosses and rooted emergent/submergent macrophytes (pickerelweed, *Pontederia cordata*; arrowhead, *Sagittaria* sp.; water starwort, *Callitriche* sp.; burreed, *Sparganium* sp.) provided additional benthic microhabitat throughout the reach. Fish habitat was optimal, with boulders, overhanging shrubs, large submerged logs, and dense beds of aquatic vegetation offering stable cover in both riffle/run and pool areas. Instream algae covered only about 10% of the reach and consisted of a thin film found on cobble substrates in the riffles. Floodplain vegetation (riverbank grape, *Vitis riparia*; arrowwood, *Viburnum* sp.; purple loosestrife, *Lythrum salicaria*; pickerelweed, *Pontederia cordata*) dominated the margins of the stream, providing good bank stability

before giving way to a forested (willow, *Salix* sp.; maple, *Acer* spp.; alder, *Alnus* sp.) riparian zone along the left (north) bank and uncultivated pasture along the right (south) bank. Riparian vegetative growth was slightly disturbed along the right bank due to an adjacent concrete "walkway" (possibly the remnants of an old dam or bridge structure). Nonpoint source pollution was not observed, though the upstream road crossing offered potential inputs.

IP01.5 received a total habitat assessment score of 180/200, which was highly comparable to the reference station at Fish Brook (Table A3). Riparian disturbances associated with the old dam (or bridge) structure affected the habitat score, but only slightly.

Benthos

Resident biota at IP01.5 received a total metric score of 18, representing only 45% comparability to the reference station and resulting in an assessment of "moderately impacted" for biological condition (Table A2). That habitat quality here was found to be highly comparable to the reference condition suggests that water quality limits biological potential in this portion of the Ipswich River. Metric values for the IP01.5 benthos are strongly suggestive of water quality degradation related to organic enrichment and low dissolved oxygen levels. The IP01.5 macroinvertebrate assemblage was co-dominated by pollution tolerant chironomids (especially *Tanytarsus* sp. and *Paratanytarsus* sp.) and gammarid (*Gammarus* sp.) amphipods which contributed to the lowest EPT/Chironomidae abundance ratio (0.02) and one of the highest Biotic Indexes (6.06) in the entire survey (Table A2). That these chironomid and gammarid taxa were primarily filter-feeders and gathering collectors respectively suggests high amounts of both suspended and deposited organic material in the IP01.5 sampling reach. Pollution sensitive EPT taxa, as well as algal scrapers (Tables A1 and A4)—generally less tolerant than filter-feeders and gathering collectors, were virtually absent from the benthos sample taken here and suggest an oxygen-stressed community.

Despite ample riffle habitat in the IP01.5 sampling reach, the low-gradient, wetland-dominated nature of much of the Ipswich River upstream from IP01.5 may account for the organic enrichment and associated low levels of dissolved oxygen that appear to be reflected in the resident biota at IP01.5. Organic loadings originating from anthropogenic sources (nonpoint and point sources) probably exist as well in this heavily developed portion of the watershed. The Town of Reading Department of Public Works is permitted (MAG640038 effective April 2001) to discharge treated (chlorinated) wastewater (filter backwash) from the Louanis Water Treatment Plant in Reading, MA to the Ipswich River just upstream from IP01.5. The ability of the Ipswich River to adequately assimilate these and other pollutant loadings may be seriously compromised due to baseflow reductions resulting from numerous groundwater and surface water withdrawals in this portion of the watershed. The conspicuously depauperate periphyton community here—algal cover is minimal and scraper abundance is <2% (Table A4)—may corroborate the effects of flow-related stress on the IP01.5 biota in (Beskenis MA DEP/DWM, personal communication).

IP06—Ipswich River, mile point 28.6, approximately 100 m downstream from Boston Street, Middleton, MA

Habitat

The IP06 biomonitoring reach began approximately 100 m downstream from Boston Street and about 70 m downstream from the Bostik discharge. The mostly (75%) shaded reach was approximately 10 m wide with a depth of 0.30 m in the riffle/runs and 1 m in the deepest pool areas. While most "kicks" were made downstream from the Bostik outfall, a few were conducted upstream from the discharge due to the somewhat restricted riffle habitat in this portion of the river. Epifaunal habitat was less than optimal for macroinvertebrates due to a lack of well-established riffles and a preponderance of fine sediments (especially sand) in the sampling reach. Aquatic vegetation comprised of equal amounts of mosses and rooted macrophytes (burreed, *Sparganium* sp.; water starwort, *Callitriche* sp.) provided some additional microhabitat for benthic organisms. Fish cover was marginal at best, with a lack of stable habitat save for a few large boulders and some small snags. Instream algal cover was minimal and consisted of thin films on cobble substrates. Channel flow status was optimal, with water reaching the base of both banks and leaving virtually no exposed substrates other than the sand bars along the right (south) side of the channel. Vegetative protection was adequate along the moderately stable left (north) bank, where a thin shrub/vine (alder, *Alnus* sp.; riverbank grape, *Vitis riparia*) layer gave way to a well-establish riparian zone dominated by beech (*Fagus* sp.), maple (*Acer rubrum*), and oak (*Quercus* sp.). Serious erosion was observed along

the right (south) bank and was probably exacerbated by anthropogenic disruption (i.e., removal of bank and riparian vegetation) of the riparian zone.

Nonpoint source pollution inputs existed mainly in the form of sediment deposition, which appeared to originate from the Boston Street crossing and possibly the Bostik discharge. Sedimentation seriously compromised fish and macroinvertebrate habitat, causing embeddedness of instream substrates, bar formation, and deposits of fine materials in pools. Deposition was particularly severe along the right (south) bank in the vicinity of the Bostik discharge.

IP06 received a total habitat assessment score of 123/200 (Table A3). Instream sedimentation effects and bank/riparian disturbances (e.g., bank erosion, reduced riparian vegetative zone) along the right bank affected the total habitat score negatively.

Benthos

IP06 received a total metric score of 24, which was 60% comparable to the reference station at Fish Brook and resulted in an assessment of "slightly impacted" for biological condition (Table A2). The IP06 biota received a similar bioassessment here following the 1995 biosurvey, when the macroinvertebrate community was found to be "slightly impaired" (Fiorentino 1997). Filter-feeders, especially blackflies (Simuliidae) and net-spinning caddisflies (Hydropsychidae; Philopotamidae), comprised more than half the IP06 benthos assemblage and contributed to the unbalanced trophic structure that characterizes this portion of the Ipswich River (Table A1). Community composition metrics performed most poorly, with values for Taxa Richness (16) and EPT Index (5) scoring 2 and 0 respectively. Also of note were the low densities of scrapers in the IP06 assemblage. While algal grazers such as the riffle beetle, *Stenelmis* sp., dominated the benthos sample collected here in 1995 and led to a high-scoring (score=6) Scraper/Filterer metric value (Fiorentino 1997), they contributed less to the 2000 assemblage (Scraper/Filterer metric score=2; Tables A2 and A4). In addition, periphyton cover here was low (<5% cover) (Table A4), despite the nutrient-enriched conditions documented by MA DEP (1999). This may indicate a shift in trophic structure at IP06 from a periphyton-based community to one that is mainly structured in response to the preponderance of suspended and deposited organic matter. Thus, while the impairment designation for the resident aquatic biota has remained unchanged here since the 1995 bioassessment, the effects of organic enrichment (i.e., dominance of filter-feeders, instream FPOM deposits) may now be more pronounced and indicative of worsening water quality in this portion of the Ipswich River. It is also possible that water quality degradation here may be exacerbated by occasional baseflow reductions resulting from water withdrawals, though it is unknown to what extent. The conspicuously depauperate periphyton community here, as mentioned above, may corroborate the effects of flow-related stress on the biota in this portion of the Ipswich River (Beskenis MA DEP/DWM, personal communication). This segment of the Ipswich River is currently awaiting confirmation for 303(d)-listing due to both water quality impairment (nutrients, organic enrichment, low dissolved oxygen) and flow alteration (MA DEP 1999).

Instream deposits of sand and FPOM threaten habitat quality and biological potential here as well. The reduction in EPT taxa may be at least partially attributed to sediment deposition and associated substrate embeddedness—two of the lowest scoring habitat parameters of all the Ipswich River watershed biomonitoring stations (Table A3). A recent study by Zweig and Rabeni (2001) found EPT density and EPT richness to be significantly negatively correlated with deposited sediment at all their biomonitoring study sites.

Gravelly Brook

Gravelly Brook flows through a large wetland in the Willowdale State Forest in Ipswich to its confluence with the Ipswich River in Ipswich. Predominant land-use in the Gravelly Brook subwatershed is 88% forested, 6% residential, and 2% agriculture.

GB01—Gravelly Brook, mile point 0.10, approximately 60 m upstream from Topsfield Road, Ipswich, MA

Habitat

The GB01 biomonitoring station began approximately 60 m upstream from Topsfield Road in a forested and undeveloped portion of Ipswich that is dominated by Willowdale State Forest. The mostly (80%) shaded sampling reach meandered through an area of dense, mainly deciduous woodland. The small, riffle-dominated stream was approximately 3 m wide, with a uniform depth of about 0.25 m. Water filled >75% of the available channel, leaving only small isolated areas of exposed substrates. An abundance of rocky substrates (cobble, pebble, and gravel) provided excellent epifaunal habitat for macroinvertebrates. Dense instream moss cover provided additional benthos habitat. Macrophytes and algae were virtually absent. Fish habitat was also considered excellent, with snags and boulders providing a good mix of stable cover. Riparian/bank habitat parameters scored well—banks were well-vegetated with herbaceous growth, especially mosses, ferns, and skunk cabbage (*Symplocarpus foetidus*). Bank stability was generally good, with occasional areas of bank sloughing along the mossy margins of the channel. Riparian vegetation extended undisturbed along the forested left (east) bank, consisting of a deciduous/evergreen mix of maple (*Acer rubrum*), beech (*Fagus* sp.), and white pine (*Pinus strobus*) with a fern understory. Riparian vegetation along the right (west) bank, though fairly well-established, was disrupted somewhat by an adjacent dirt road. Nonpoint source pollution was not observed, though there exists the potential for runoff from the dirt road.

GB01 received a total habitat assessment score of 175/200, which was highly comparable to the reference condition (Table A3). Habitat quality was compromised only slightly by the shallow nature of the stream and the nearby unpaved road.

Benthos

The GB01 benthos assemblage received a total metric score of 40, representing high (100%) comparability to the reference station and resulting in a "non-impacted" bioassessment (Table A2). EPT taxa—including some highly intolerant (TV=0; e.g., *Leuctra* sp.) forms—were well represented in the GB01 sample and contributed to one of the highest EPT Index values (8) in the Ipswich River watershed survey. Other pollution sensitive taxa (e.g., *Nigronia* sp.; *Diplectrona* sp.; *Psilotreta* sp.; *Glossosoma* sp.) were common as well, contributing to the lowest Biotic Index (3.78) in the survey. In addition, a high-scoring Scraper/Filterer metric value and low Percent Dominant Taxon contribution indicate optimum community structure and well-balanced trophic structure among the GB01 macroinvertebrate community. Finally, the high (87%—the highest in the survey) Reference Affinity corroborates that this is indeed a healthy aquatic community, comparable to the "least-disturbed" conditions found at the Fish Brook reference station in terms of community composition.

Miles River

The Miles River flows from the outlet of Longham Reservoir in Wenham/Beverly and meanders in a northerly direction to its confluence with the Ipswich River in Ipswich. The upper subwatershed flow is generally in a southwesterly direction into Longham Reservoir. The river flows through a wetland along much of its length and forms the boundary between Hamilton and Ipswich where it is joined by Long Causeway Brook. Predominant land-use in the Miles River subwatershed is 40% forested, 26% residential, and 14% agriculture.

MR01—Miles River, mile point 0.40, approximately 370 m downstream from Route 1A (County Road), Ipswich, MA

Habitat

The MR01 sampling reach began approximately 370 m downstream from Route 1A and immediately upstream from a private driveway crossing. With the exception of a few new homes, the partially (40%) shaded reach meandered through mostly forested land. The riffle/run dominated stream was approximately 5 m wide with good depth (0.50 – 0.75 m) throughout. The swift current velocity and abundance of large

rocky substrates provided macroinvertebrates with excellent epifaunal habitat. Dense moss cover throughout much of the reach, and occasional beds of burreed (*Sparganium* sp.), provided additional benthic microhabitat. Fish habitat was slightly less than optimal, with the majority of cover in the form of boulders and occasional snags. Channel flow status was good, with water easily reaching the base of both banks and leaving only the largest substrates (i.e., boulders) partially exposed. Both stream banks were well vegetated and stabilized with shrubs (cherry, *Prunus* sp.; honeysuckle, *Lonicera* sp.), vines, and herbaceous growth—especially ferns and riverbank grape (*Vitis riparia*). Boulders provided additional stability to both stream banks. Riparian vegetation consisted mainly of deciduous trees, especially ash (*Fraxinus americana*). Adjacent residences resulted in some riparian disruption, most notably near the top of the reach where lawns and yard waste were situated close to the stream. In addition to runoff from the nearby residential properties, an adjacent horse bridal trail and a horse farm in the vicinity of Route 1A offered potential nonpoint source pollution inputs as well. Instream turbidity was observed during the biosurvey.

MR01 received a total habitat assessment score of 179/200 which was highly comparable to habitat at the reference station (Table A3). Riparian disruption and the suboptimal fish habitat (due to a lack of deep pools and variety of stable cover) affected the evaluation most negatively.

Benthos

Despite the excellent epifaunal habitat available, the MR01 benthos assemblage received a total metric score of only 10, representing 25% comparability to the reference station and placing the community at the low end of the "moderately impacted" category for biological condition (Table A2). Water quality conditions that have resulted in the 303(d)-listing of this stream are clearly reflected in the MR01 benthic community as well. Gammarid amphipods (*Gammarus* sp.) were the hyperdominant taxon in the MR01 assemblage, comprising 65% of the total sample and contributing to the highest Biotic Index received by an Ipswich River watershed biomonitoring station during the 2000 survey (Table A2). The high density of this taxon, coupled with the virtual absence of EPT taxa (only one individual observed), suggests not only organically enriched conditions but depleted oxygen levels as well. And a taxa richness of 11—the lowest in the survey despite the diversity of benthos habitat throughout the MR01 sampling reach—corroborates the effects of water quality degradation in this portion of the stream.

While the extensive wetland areas just upstream from MR01 may be responsible for observed turbidity, organic inputs, and naturally-occurring low levels of dissolved oxygen in this portion of Miles River, anthropogenic perturbations should also be considered. Agricultural areas, horse farms, and a golf course all lie within the drainage area of the lower Miles River subwatershed. In addition, water quality degradation may be exacerbated by occasional low streamflow conditions in portions of the Miles River—the result of surface water withdrawals by the Salem & Beverly Water Supply Board, who is authorized (WMA permit #9P31725801) to withdraw water from Wenham Lake and Longham Reservoir. Indeed, DWM observed a similar, amphipod-dominated macroinvertebrate community at its Ten Mile River watershed reference station (Seven Mile River), a site with excellent epifaunal habitat yet suspected of periodic low streamflow conditions from flow regulation associated with an upstream surface water withdrawal and seasonal "draw-downs" (MA DEP 2000b). And the conspicuously depauperate periphyton community at MR01—algal cover was minimal (<5%) and scraper abundance was only 4% (Table A4)—may corroborate the effects of flow-related stress on the biota in this portion of the river (Beskenis MA DEP/DWM, personal communication). Reduced algal growth may also be the result of poor sunlight penetration caused by instream turbidity, which was noted during the biosurvey here.

Lubbers Brook

Lubbers Brook flows in a meandering course along the Billerica/Burlington boundary into Billerica, through Lubber Pond West and Lubber Pond East in Wilmington and flows northeast into North Wilmington where it turns in a southerly direction and joins Maple Meadow Brook to form the Ipswich River. Predominant land-use in the Lubbers Brook subwatershed is 54% residential, 31% forested, and 6% wetland.

LB02—Lubbers Brook, mile point 0.50, immediately upstream and downstream from Concord Street, Wilmington, MA

Habitat

Due to the lentic nature of this portion of Lubbers Brook, LB02 differed greatly from other biomonitoring stations in the Ipswich River watershed survey in terms of epifaunal/riparian habitat, channel morphology, and hydrology. DWM conducted only a qualitative assessment of habitat and biological integrity at LB02, where soft substrates and imperceptible current velocity made comparisons to the more lotic Fish Brook reference station inappropriate. Rather than conduct "kick" sampling throughout a 100 m reach, net "jabs" were made in the most productive habitat available to macroinvertebrates in this portion of the stream—namely submerged macrophytes, snags, and undercut stream banks. Virtually all sampling was confined to the area immediately upstream and downstream from the Concord Street crossing. The LB02 biomonitoring station was characterized by a completely open-canopied, poorly defined and stagnant channel bordered by a profusion of wetland vegetation—typical of much of the Lubbers Brook system. Fish and macroinvertebrate habitat were marginal, consisting mostly of macrophytes and occasional snags. The soft, muck-mud substrates that comprised most of the stream bottom provided very little epifaunal habitat, though channel sinuosity was good in this meandering portion of Lubbers Brook. Stream depth was approximately 1.5 m, with water easily reaching the base of both banks. Aquatic vegetation was abundant both instream and along the margins of the stream—rooted emergent macrophytes (pickerelweed, *Pontederia cordata*; arrow arum, *Peltandra virginica*), rooted submergent macrophytes (water starwort, *Callitriche* sp.; milfoil, *Myriophyllum* sp.), and free floating macrophytes (duckweed, *Lemna* spp.) were all common. Instream algae was not observed; however, the deep nature of this site made it difficult to conduct accurate visual estimates of algal cover.

Both stream banks were well-vegetated, though the invasive purple loosestrife (*Lythrum salicaria*) dominated. Bank stability was generally good except at the road crossing where bank erosion and road runoff were observed and exacerbated by the removal of bank vegetation. Other types of nonpoint source pollution were not observed. Riparian vegetation extended undisturbed from both banks and consisted of loosestrife and other herbaceous growth (especially cattail, *Typha* sp.). Shrubs (alder, *Alnus* sp.) and trees (maple, *Acer* spp.; unidentified conifers) were scattered throughout the riparian zone as well. Instream turbidity was observed during the biosurvey here.

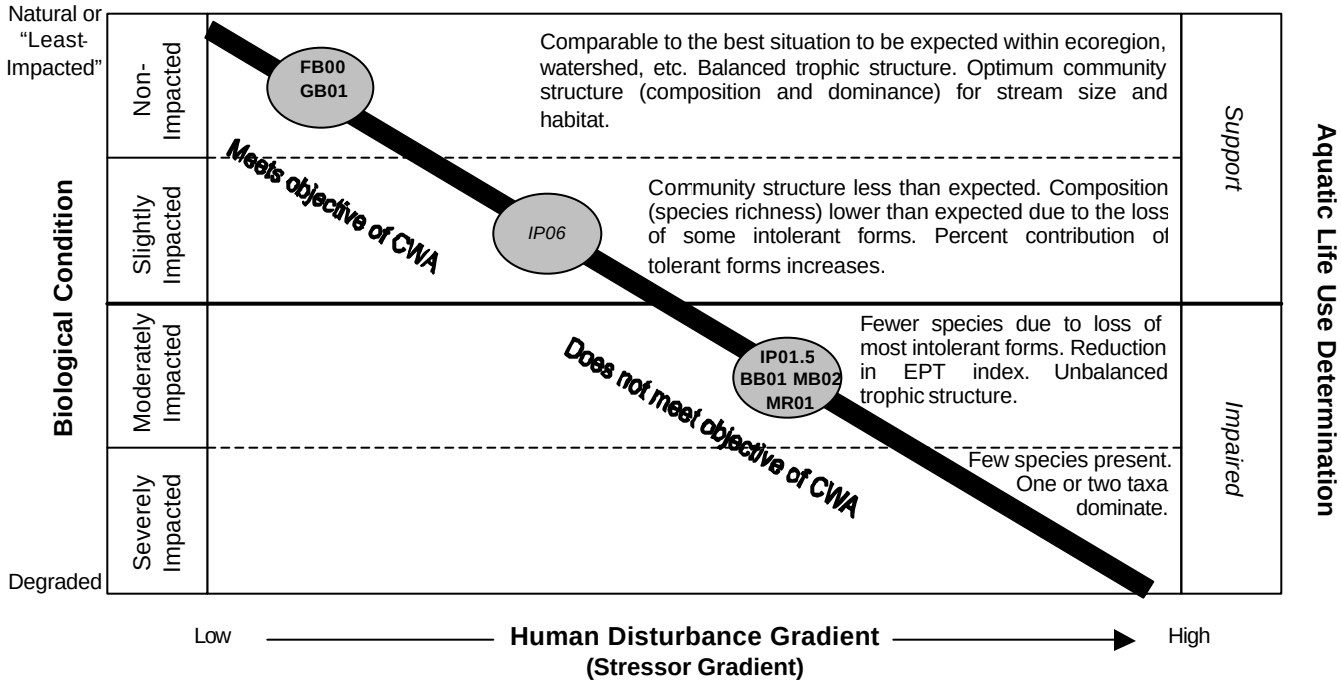
Benthos

The LB02 benthic community was comprised of a total of 14 taxa (mainly at the family-level) and included high densities of taxa (e.g., Gastropoda, Hemiptera, Amphipoda) commonly found in lentic stream systems. The assemblage displayed good trophic structure, with virtually every major feeding guild represented. EPT taxa, generally not abundant in low-gradient wetland dominated stream systems such as Lubbers Brook, were represented by two fairly pollution-sensitive caddisfly genera—*Limnephilus* sp. and *Oecetis* sp. (Table A1). Due to the qualitative nature of the biosurvey conducted at LB02, an assessment of biological condition could not be made; however, the macroinvertebrate community encountered here does not appear to suggest the presence of gross organic pollution in this portion of Lubbers Brook.

SUMMARY AND RECOMMENDATIONS

With the exception of a few tributaries (Gravelly and Fish brooks) exhibiting reference-quality (i.e., least-impacted) conditions for the Ipswich River watershed, most biomonitoring stations investigated during the 2000 survey indicated various degrees of impairment. Impacts to the resident biota at these sites were generally a result of habitat degradation and/or nonpoint source-related water quality impairment.

The schematic below is based on a proposed conceptual model that predicts the response of aquatic communities to increasing human disturbance. It incorporates both the biological condition impact categories outlined in the RBPIII biological assessment methodology currently used by MA DEP and the Tiered Aquatic Life Use (TALU) conceptual model developed by US EPA and refined by various state environmental agencies (2003). The model summarizes the main attributes of an aquatic community that can be expected at each level of the biological condition category, and how these metric-based bioassessments can then be used to make aquatic life use determinations as part of the 305(b) reporting process. Minimally or non-impacted aquatic communities—such as those encountered at FB00 (Fish Brook), GB01 (Gravelly Brook), and IP06 (Ipswich River)—support the Massachusetts SWQS designated *Aquatic Life* use in addition to meeting the objective of the Clean Water Act (CWA), which is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (Environmental Law Reporter 1988). Moderately impacted communities observed at MB02 (Martins Brook), BB01 (Boston Brook), IP01.5 (Ipswich River), and MR01 (Miles River) do not support the *Aquatic Life* use and fail to meet the goals of the CWA.



Fish Brook

FB00

Benthos: Ipswich River watershed reference station.
Habitat: Ipswich River watershed reference station.

The FB00 benthic community was thought to represent the "best attainable" conditions in the watershed with respect to biological integrity, habitat quality, and water quality. As a reference condition, biomonitoring is recommended here during the next DEP Ipswich River watershed survey in 2005. Fish population sampling, which has not historically been performed by DEP at this station, should accompany the macroinvertebrate sampling effort.

Nonpoint source pollution associated with new home construction threatens water quality, habitat quality and biological potential at FB00. Maintaining an adequate vegetative riparian buffer between adjacent homes and the stream should be encouraged.

Martins Brook

MB02

Benthos: "Moderately impacted" compared to reference station.
Habitat: 59% comparable to reference station.

MB02 was characterized by an unbalanced community responding to an abundance of organic matter (both deposited and suspended forms). In fact, biological conditions may have worsened here since the last DEP survey conducted in 1995. Productive waterbodies upstream, as well as various naturally-occurring (i.e., wetlands) and/or nonpoint (urban runoff) and point source-related nutrient/organic loadings to Martins Brook, appear most responsible for biological impairment and suspect water quality at MB02.

Nonpoint source pollution also compromises habitat potential at MB02. Sediment deposition, probably originating from multiple sources (upstream point sources and sand/gravel operations, road runoff, eroding banks), and riparian disruption along the left bank of the reach affect habitat quality most negatively. In addition, the restoration of a more adequate vegetative buffer along the sampling reach would help alleviate the effects of some of these NPS inputs.

Biomonitoring is recommended here during the next DEP Ipswich River watershed survey in 2005. Fish population sampling should accompany the macroinvertebrate sampling effort. As water quality limits biological integrity in this portion of Martins Brook, additional monitoring of various physico-chemical parameters would be instrumental in determining the specific types of water quality degradation present here. In addition, a site investigation and NPDES permit review of the Sargent Water Treatment Plant, including a review of filter backwash treatment and release procedures, is recommended.

Boston Brook

BB01

Benthos: "Moderately impacted" compared to reference station.
Habitat: >100% comparable to reference station.

Despite the high quality benthos habitat available throughout the BB01 sampling reach, the macroinvertebrate community appeared structured in response to organic enrichment, with low total taxa richness and a lack of pollution sensitive EPT taxa. The lentic nature of much of Boston Brook and the extensive wetlands drained by the upper portions of the subwatershed may account for the organic loading and potentially low levels of dissolved oxygen reflected in the BB01 biota. Possible flow regulation (i.e., dams and other outlet structures) associated with the numerous upstream impoundments may result in

occasional baseflow reductions and impairment at downstream lotic communities (periphyton and benthos) such as BB01. Anthropogenic flow regulation of upstream impoundments should be investigated, and minimum baseflows downstream from these waterbodies should be established/maintained.

Biomonitoring is recommended here during the next DEP Ipswich River watershed survey in 2005. Fish population sampling should accompany the macroinvertebrate sampling effort. As water quality appears to limit biological integrity in this portion of Boston Brook, additional monitoring of various physico-chemical parameters would be instrumental in determining the specific types of water quality degradation present here.

Ipswich River

IP01.5

Benthos: "Moderately impacted" compared to reference station.
Habitat: 99% comparable to reference station.

Despite the excellent habitat evaluation here, pollution sensitive taxa have been displaced by taxa more tolerant of organic pollution. The low-gradient, wetland-dominated nature of much of the Ipswich River upstream from IP01.5 may account for the organic enrichment and associated low levels of dissolved oxygen that appear to be reflected in the resident biota in this portion of the river. Organic loadings originating from anthropogenic sources (nonpoint and point sources) probably exist as well in this heavily developed portion of the watershed. Water quality degradation may be exacerbated by seasonal baseflow reductions associated with water withdrawals along the mainstem Ipswich River. Maintaining current baseflows here will be instrumental in minimizing low flow effects on the resident biota (periphyton and benthos).

Biomonitoring is recommended here during the next DEP Ipswich River watershed survey in 2005. Fish population sampling should accompany the macroinvertebrate sampling effort. As water quality appears to limit biological integrity in this portion of the Ipswich River, additional monitoring of various physico-chemical parameters would be instrumental in determining the specific types of water quality degradation present here. In addition, a site investigation and NPDES permit review of the Louanis Water Treatment Plant, including a review of filter backwash treatment and release procedures, may be warranted.

IP06

Benthos: "Slightly impacted" compared to reference station.
Habitat: 68% comparable to reference station.

While the impairment designation for the resident aquatic biota has remained unchanged here since the 1995 bioassessment, the effects of organic enrichment (i.e., dominance of filter-feeders, instream FPOM deposits) may now be more pronounced and indicative of worsening water quality in this portion of the Ipswich River. It is also possible that water quality degradation here may be exacerbated by occasional low streamflow conditions resulting from water withdrawals along the mainstem Ipswich River. Maintaining current baseflows here will be instrumental in minimizing low flow effects on the resident biota (periphyton and benthos).

Instream deposits of sand and FPOM threaten habitat quality and biological potential here as well. BMP implementation at the Park Street crossing would help reduce some of the inorganic sediment inputs to the IP06 sampling reach. A review of Bostik Findley's stormwater management practices, including a review of their discharge permit, is also recommended.

Biomonitoring is recommended here during the next DEP Ipswich River watershed survey in 2005. Fish population sampling should accompany the macroinvertebrate sampling effort.

Gravelly Brook

GB01

Benthos: "Non-impacted" compared to reference station.
Habitat: 96% comparable to reference station.

GB01 was characterized by a healthy and non-impacted benthic macroinvertebrate community, with a high number of pollution sensitive taxa (i.e., EPTs) compared to most of the Ipswich River watershed biomonitoring stations. Several metrics outperformed those calculated for the reference community. Biomonitoring is recommended here during the next DEP Ipswich River watershed survey in 2005 to continue to assess the biological health in what appears to be one of the least-impacted tributaries in the entire watershed. In addition to benthic macroinvertebrate biomonitoring, attempts should be made to conduct fish population sampling here to determine the stream's potential as a cold-water fishery. In addition, water quality monitoring here would help to establish baseline conditions while supplementing the biological data. To maintain the biological integrity of Gravelly Brook, every effort should be made to properly manage land development in this relatively pristine subwatershed.

Miles River

MR01

Benthos: "Moderately impacted" compared to reference station.
Habitat: 98% comparable to reference station.

Despite an abundance of productive epifaunal habitat, the MR01 benthos assemblage displayed the lowest comparability to reference conditions in the entire Ipswich River watershed survey. The high density of a single pollution tolerant taxon, coupled with the virtual absence of EPT taxa (only one individual observed), suggests not only organically enriched conditions but depleted oxygen levels as well. While extensive upstream wetlands may contribute organic loads to this portion of the stream, nonpoint source anthropogenic perturbations (e.g., horse farms, agriculture) are probably most responsible for the water quality degradation (organic enrichment, low dissolved oxygen, pathogens) that has led to impairment of the MR01 biota and the 303(d)-listing of this stream. Water quality degradation may be exacerbated by occasional baseflow reductions in portions of Miles River—the result of upstream surface water withdrawals and reservoir draw-downs. Maintaining current baseflows here will be instrumental in minimizing low flow effects on the resident biota (periphyton and benthos).

Macroinvertebrate biomonitoring is recommended here during the next DEP Ipswich River watershed survey in 2005. Fish population sampling should accompany the macroinvertebrate sampling effort. As water quality appears to limit biological integrity in this portion of the Ipswich River, additional monitoring of various physico-chemical parameters would be instrumental in determining the specific types of water quality degradation present here. Monitoring throughout the Miles River subwatershed—especially bacteria and nutrient sampling—may help to isolate sources (e.g., agricultural runoff) of nutrient/organic loads to the Miles River.

Lubbers Brook

LB02

Benthos: Qualitative assessment. Reference condition unavailable.
Habitat: Reference condition unavailable.

While habitat constraints made it impossible for DWM to effectively assess the aquatic community in this portion of Lubbers Brook, efforts should be made to re-assess biological status during the 2005 Ipswich River biomonitoring survey—possibly after further development by DWM of macroinvertebrate sampling methodologies that accurately assess biological condition in low gradient, wetland-dominated stream

systems. Efforts to control nonpoint source pollution inputs (sand and other road runoff) originating from the Concord Street crossing should be made, possibly through BMP implementation and restoration of riparian vegetation. Biomonitoring is recommended here again as part of the 2005 monitoring efforts for the Ipswich River watershed. Additional monitoring of various physico-chemical parameters would be instrumental in determining the presence or absence of water quality impairment here.

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Appendix

Macroinvertebrate taxa list, RBPIII benthos analyses, Habitat evaluations, and Periphyton cover

Table A1. Species-level taxa list and counts, functional feeding groups (FG), and tolerance values (TV) for macroinvertebrates collected from stream sites during the 2000 Ipswich River watershed survey between 17 and 19 July 2000. An "x" indicates taxon presence at those stations sampled qualitatively. Refer to Table 1 for a listing and description of sampling stations.

TAXON	FG[1]	TV[2]	FB00[3]	GB01	IP01.5	IP06	MB02	BB01	MR01	LB02
Physa sp.	GC	9			1			2		x
Planorbidae	SC	6								x
Musculium sp.	FC	6								x
Pisidium sp.	FC	6	3	16		1	2	18	9	
Naididae	GC	9								x
Tubificidae (without hair chaetae)	GC	10				1	3		2	
Tubificidae (with hair chaetae)	GC	10	1							
Lumbriculus variegatus	GC	5	1	3	3	16	2	3		
Erpobdellidae	PR	8			1					
Caecidotea communis	GC	8			2			2	9	x
Crangonyx sp.	GC	6			4					x
Gammarus sp.	GC	6	28	8	21	13	58	40	59	
Hyalella azteca	GC	8			1					x
Hydrachnidia	PR	6								x
Baetis sp. (with two cerci)	GC	6				1				
Stenonema sp.	SC	3		4						
Leptophlebiidae	GC	2	1	2						
Boyeria sp.	PR	2	1							
Coenagrionidae	PR	9								x
Stylogomphus sp.	PR	1	1							
Leuctra sp.	SH	0	3	17						
Acroneuria sp.	PR	0	7							
Corixidae	na	na								x
Nigronia sp.	PR	0	2	8						
Glossosoma sp.	SC	0	4	1						
Cheumatopsyche sp.	FC	5	1		1	23	17	1		
Diplectrona sp.	FC	0	1	4				9		
Hydropsyche betteni gr.	FC	6	5	5					1	
Hydropsyche morosa gr.	FC	6				13				
Lepidostoma sp.	SH	1				2				
Oecetis sp.	PR	5								x
Limnephilus sp.	SH	4								x
Psilotreta sp.	SC	0	1	1						
Chimarra sp.	FC	4		1		9				
Optioservus sp.	SC	4	2	2						
Optioservus ovalis	SC	4						1		
Oulimnius latiusculus	SC	4	7	2		1				
Stenelmis sp.	SC	5	3		2	13	4	3	3	
Stenelmis crenata gr.	SC	5	1			1	1		1	

Table A1 (cont.)

TAXON	FG[1]	TV[2]	FB00[3]	GB01	IP01.5	IP06	MB02	BB01	MR01	LB02
Ectopria nervosa	SC	5		3						
Psephenus herricki	SC	4	1							
Chironomidae	GC	6								x
Cryptochironomus sp.	PR	8			1					
Dicrotendipes sp.	GC	8			1					
Microtendipes pedellus gr.	FC	6	2					2		
Microtendipes rydalensis gr.	FC	6							1	
Polypedilum flavum	SH	6					1			
Polypedilum illinoense	SH	6			2			1		
Polypedilum scalaenum	SH	6			1					
Micropsectra sp.	GC	7	13	14	5		1			
Paratanytarsus sp.	FC	6			21					
Rheotanytarsus exiguus gr.	FC	6	3		1	1			1	
Tanytarsus sp.	FC	6	1		21			2	3	
Cardiocladius sp.	PR	5	1			1	1			
Cricotopus sp.	SH	7			1					
Cricotopus bicinctus	GC	7			2	1				
Cricotopus bicinctus gr.	GC	7			1					
Cricotopus/Orthocladius sp.	GC	7				1				
Eukiefferiella devonica gr.	GC	4				3			1	
Parametriocnemus sp.	GC	5		3				1		
Thienemanniella sp.	GC	6			1					
Conchapelopia sp.	PR	6	1	1			1			
Trissopelopia sp.	PR	4	1	1						
Hemerodromia sp.	PR	6					1			
Sciomyzidae	na	na								x
Simulium sp.	FC	5	5	1	12	9	7	18	1	
Simulium tuberosum cpl.	FC	4		1						
Tipulidae	SH	5		1						
Dicranota sp.	PR	3	1	1						
Molophilus sp.	SH	3	1							
Pseudolimnophila sp.	SH	3		2						
TOTAL			**103**	**102**	**106**	**110**	**99**	**103**	**91**	**na**

[1]Functional Feeding Group (FG) lists the primary feeding habit of each species and follows the abbreviations: SH-Shredder; GC-Gathering Collector; FC-Filtering Collector; SC-Scraper; PR-Predator.

[2]Tolerance Value (TV) is an assigned value used in the calculation of the biotic index. Tolerance values range from 0 for organisms very intolerant of organic wastes to 10 for very tolerant organisms.

[3] Reference Station

Table A2. Summary of RBP III data analysis for macroinvertebrate communities sampled during the Ipswich River watershed survey between 17 and 19 July 2000. Shown are the calculated metric values, metric scores (in italics) based on comparability to the regional reference station (FB00), and the corresponding assessment designation for each biomonitoring station. Refer to Table 1 for a listing and description of sampling stations.

STATION	**FB00**		**MB02**		**BB01**		**IP06**		**IP01.5**		**GB01**		**MR01**	
STREAM	Fish Brook		Martins Brook		Boston Brook		Ipswich River		Ipswich River		Gravelly Brook		Miles River	
HABITAT SCORE	182		108		191		123		180		175		179	
TAXA RICHNESS	29	*6*	12	*2*	14	*2*	16	*2*	20	*4*	22	*4*	11	*0*
BIOTIC INDEX	4.60	*6*	5.81	*4*	5.30	*6*	5.15	*6*	6.06	*4*	3.78	*6*	6.21	*4*
EPT INDEX	8	*6*	1	*0*	2	*0*	5	*0*	1	*0*	8	*6*	1	*0*
EPT/CHIRONOMIDAE	1.05	*6*	4.25	*6*	1.67	*6*	6.86	*6*	0.02	*0*	1.84	*6*	0.17	*0*
SCRAPER/FILTERER	0.90	*6*	0.19	*2*	0.08	*0*	0.27	*2*	0.04	*0*	0.46	*6*	0.25	*2*
% DOMINANT TAXON	27%	*4*	59%	*0*	39%	*2*	21%	*4*	20%	*4*	17%	*6*	65%	*0*
REFERENCE AFFINITY	100%	*6*	64%	*4*	62%	*4*	55%	*4*	66%	*6*	87%	*6*	55%	*4*
TOTAL METRIC SCORE	*40*		*18*		*20*		*24*		*18*		*40*		*10*	
% COMPARABILITY TO REFERENCE	100%		45%		50%		60%		45%		100%		25%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	**REFERENCE**		**MODERATELY IMPACTED**		**MODERATELY IMPACTED**		**SLIGHTLY IMPACTED**		**MODERATELY IMPACTED**		**NON-IMPACTED**		**MODERATELY IMPACTED**	

Table A3. Habitat assessment summary for biomonitoring stations sampled during the 2000 Ipswich River watershed survey. For primary parameters, scores ranging from 16-20 = optimal; 11-15 = suboptimal; 6-10 = marginal; 0-5 = poor. For secondary parameters, scores ranging from 9-10 = optimal; 6-8 = suboptimal; 3-5 = marginal; 0-2 = poor. Refer to Table 1 for a listing and description of sampling stations.

STATION	FB00	MB02	BB01	IP06	IP01.5	GB01	MR01	LB02*
PRIMARY PARAMETERS (range is 0-20)	**SCORE**							
INSTREAM COVER	17	11	18	8	19	17	15	-
EPIFAUNAL SUBSTRATE	17	15	18	14	18	18	18	-
EMBEDDEDNESS	19	12	19	13	17	20	19	-
CHANNEL ALTERATION	20	14	20	14	15	20	19	-
SEDIMENT DEPOSITION	16	2	19	5	16	18	19	-
VELOCITY-DEPTH COMBINATIONS	17	12	18	11	19	12	14	-
CHANNEL FLOW STATUS	20	9	20	17	20	18	20	-
SECONDARY PARAMETERS (range is 0-10 for each bank)	**SCORE**							
BANK VEGETATIVE PROTECTION left	10	7	10	8	10	10	10	-
BANK VEGETATIVE PROTECTION right	10	6	10	7	9	10	10	
BANK STABILITY left	9	5	10	8	10	8	9	-
BANK STABILITY right	9	5	10	5	9	8	10	
RIPARIAN VEGETATIVE ZONE WIDTH left	8	8	10	9	10	10	8	-
RIPARIAN VEGETATIVE ZONE WIDTH right	10	2	9	4	8	6	8	
TOTAL SCORE	**182**	**108**	**191**	**123**	**180**	**175**	**179**	-

*habitat parameters not scored as part of qualitative assessment

Table A4. Summary of the periphyton community observed at each biomonitoring station in the Ipswich River watershed between 17 and 19 July 2000. Canopy cover and algal cover are percent estimates based on visual observations. Relative abundance of scrapers is the percentage of scraping forms of macroinvertebrates in the benthos sample collected at each station.

IPSWICH RIVER WATERSHED 2000 Periphyon Community			
Station	% Canopy Cover	% Algal Cover	Relative Abundance - Scrapers
Lubbers Brook, (LB02) upstream from Middleton Rd., Boxford	0	0	Not determined
Ipswich River, (IP01.5) downstream from Mill St., Reading/North Reading	75	10	<2%
Martins Brook, (MB02) downstream from Park St., North Reading	40	--	5%
Boston Brook, (BB01) upstream from Liberty St., Middleton	75	<5	<4%
Fish Brook, (FB00) upstream from Ipswich Rd., Ipswich (segment 92-14)	50	<5	18%
Gravelly Brook, (GB01) upstream from Topsfield Rd., Ipswich	80	<1	13%
Miles River, (MR01) downstream from Route 1A (near Lakeman Rd.) Ipswich	40	<5	4%
Ipswich River, (IP06) downstream from Main St., Middleton	75	<5	<2%

-- thin film, % cover not recorded

APPENDIX E

TECHNICAL MEMORANDUM TM-92-1

IPSWICH RIVER WATERSHED BENTHIC MACROINVERTEBRATE BIOMONITORING

To: Ipswich River Basin Team

From: John Fiorentino

Date: 13 February 1997

INTRODUCTION

Biological monitoring is a useful means of detecting anthropogenic impacts on the aquatic community. Resident biota (e.g. benthic macroinvertebrates, fish, periphyton) in a water body are natural monitors of environmental quality and can reveal the effects of episodic as well as cumulative pollution and habitat alteration (Plafkin et al. 1989, Barbour et al. 1995). Biological surveys and assessments are the primary approaches to biomonitoring.

Robert Nuzzo and I conducted biomonitoring based on USEPA Rapid Bioassessment Protocols (RBP) at 4 sites requested by the DEP Ipswich River Basin Team as part of the 1995 watershed survey. A biosurvey, which focused on the standardized sampling of benthic macroinvertebrates, was supplemented with a habitat assessment to evaluate water quality and habitat quality at each study site. The sampling sites were in: Fish Brook (FB01), Topsfield; Howlett Brook (HB02), Topsfield; Martins Brook (MB02), North Reading; Ipswich River (IP06), Middleton--all in Massachusetts.

METHODS

The macroinvertebrate collection procedure utilized kick sampling, a method of sampling benthic organisms by kicking or disturbing bottom sediments and catching the dislodged organisms downstream with an aquatic net. Sampling was conducted in riffle/run areas with fast currents and cobble and gravel substrates--generally the most productive habitats, supporting the most diverse communities in the stream system. A kick net with an opening approximately 0.45 m wide and a mesh size of 590 microns was used to collect a sample from an approximately 1 m^2 area. Two 1 m^2 samples were collected at each station--one from an area of fast current velocity and one from an area of slower current velocity. The two samples were then composited in the field and preserved with 95% ethanol before processing.

In the laboratory, a subsample of 100 macroinvertebrates was separated from the original sample collected at each site, and specimens were identified to family (Rapid Bioassessment Protocol II, or RBP II) to the extent their condition allowed. Based on this family-level taxonomy, various community, population, and functional parameters, or "metrics," are calculated which allow us to measure important aspects of the biological integrity of the community. This integrated approach provides more assurance of a valid assessment because a variety of biological parameters are evaluated. Deficiency of any one metric should not invalidate the entire approach (Plafkin et al. 1989). The percent comparability of study site metric scores to those for a selected unimpaired regional reference station (i.e. "best attainable situation") yields an impairment score for each site. RBP II analysis separates sites into three categories: non-impaired, moderately impaired, and severely impaired. Impairment of the benthic community may be indicated by the absence of generally pollution-sensitive macroinvertebrate taxa such as Ephemeroptera, Plecoptera, and Trichoptera (EPT); dominance of a particular taxon, especially the pollution-tolerant Chironomidae and Oligochaeta taxa; low taxa richness; or shifts in community composition relative to the reference station (Plafkin et al. 1989).

RBP II also utilizes a habitat assessment matrix for rating habitat quality, an integral component in the final evaluation of impairment. The habitat assessment is intended to support the biosurvey and enhance the interpretation of the biological data. The matrix used to assess habitat quality is based on key physical characteristics of the water body and surrounding land use. All parameters evaluated are related to overall land use and are potential source of limitation to the aquatic biota (Plafkin et al. 1989). The habitat parameters included in the matrix were evaluated at all sites sampled in the Ipswich River watershed. Ratings were then totaled and compared to a regional reference station to provide a final habitat ranking.

It is important to recognize that Rapid Bioassessment Protocol II is primarily a semi-quantitative screening tool which allows agencies to evaluate a large number of sites with relatively limited time and effort. The protocol is best used to prioritize sites for more intensive evaluation, such as RBP III, toxicity testing, or quantitative replicate sampling. The information derived from RBP II provides a basis for ranking sites as non, moderately, or severely impaired. This classification can then be used to focus on additional study or regulatory action.

All of the study sites investigated in the Ipswich River watershed received RBP II scores indicating moderate impairment. Because this category offers a wide ranging and somewhat ambiguous assessment, it was my recommendation that more information be gathered on the aquatic invertebrate assemblage collected at these stations. This was achieved by applying Rapid Bioassessment Protocol III (RBP III), a more rigorous bioassessment technique than RBP II, which allows detection of more subtle degrees of impairment. By increasing the level of taxonomic resolution; that is, by performing taxonomic identification to the lowest practical level (thereby providing information on population as well as community level effects), the ability to discriminate the level of impairment is enhanced. While this additional taxonomy (genus/species-level identification) requires considerably more time, discrimination of four levels of impairment--non, slight, moderate, and severe--becomes possible following recalculation of metrics.

RESULTS

The taxonomic list of macroinvertebrates obtained from subsamples taken from each site is attached as an appendix (Appendix A). Table 1 includes the family-level taxonomic list of macroinvertebrates from all sites sampled, while Table 2 is a genus/species-level taxonomic list of macroinvertebrates obtained from those sites that scored moderately impaired following RBP II analysis. Included in both taxa lists are total organism counts, and the functional feeding group (FFG) and tolerance value (TV) of each taxon.

Summary tables of the RBP data analyses, including biological metric calculations, metric scores, and impairment scores, are attached as Appendix B. Table 1 is the summary table for all sites when RBP II analysis is applied. Table 2, the RBP III data analysis summary, includes metric calculations and impairment scores for those stations which were found to be moderately impaired following RBP II analysis. Habitat assessment scores for each station are also included in the summary tables.

HB02--Howlett Brook, Topsfield MA (19 July 1995)

HABITAT

The sampling station was located approximately 5 m upstream of Ipswich Rd., in a well-shaded reach flowing through a fairly dense forest of black locust and wetland vegetation (purple loosestrife, skunk cabbage, arrowhead). Moss-covered boulder and cobble/gravel-dominated riffles, with minimal embeddedness, provided very good instream habitat for invertebrates. While submerged logs and undercut banks provided adequate fish cover, habitat was somewhat lacking due to inadequate depth in pools and runs. Those parameters measuring channel morphology and riparian/bank stability generally scored good to excellent.

HB02 received a habitat assessment score of 109 out of a possible 135. While this was the highest score of the four sites where biomonitoring was conducted, HB02 was not designated as a reference station for two reasons: 1) The bottom substrates and velocity/depth regimes--two important determinants of benthic community integrity--were markedly different from stations FB01, MB02, and IP06 (all three <<80% comparable to HB02). While HB02 consisted of productive boulder and cobble/gravel substrates subjected to a variety of flow regimes, the remaining survey stations--particularly IP06 and MB02--were comprised of mainly gravel and sandy substrates in poorly developed riffles. Since both the quality and quantity of available habitat affect the structure and composition of residential biological communities, effects of such features should be minimized by sampling similar habitats at all stations being compared (Plafkin et al. 1989). Sampling highly similar habitats will also reduce metric variability, attributable to factors such as current speed and substrate type. Furthermore, unless basically similar physical habitat is sampled at all stations, community differences attributed to a degraded habitat will be difficult to separate from those resulting from water quality degradation. The discrepancy in habitat, then, between HB02 and the remaining three sites would probably be reflected in the invertebrate assemblages found there as well; however, it would be impossible to determine whether water quality or habitat quality is limiting to the biological integrity of the study site. 2) A variety of anthropogenic influences prevented HB02 from receiving the status of "best attainable" condition for the watershed. A storm drain entering the reach in the vicinity of the sample site, and a horse farm adjacent to the reach, were potential non-point source pollution inputs and water quality impacts to the stream. In addition, the proximity of the kick samples to the road crossing raised concerns regarding road runoff and possible effects on habitat and water quality in the sampling reach.

To investigate the biological integrity of the macroinvertebrate community at HB02, it was necessary to use a reference station from outside the Ipswich River watershed. MR03 (Mill River) in the Parker River watershed was determined to possess a similar habitat to HB02 in terms of instream substrate type, flow regime (velocity/depth patterns), and discharge. MR03 received a habitat assessment score of 118 out of a possible 135. With a habitat score of 109, HB02 was found to be comparable (>90%) to the reference condition.

BENTHOS

RBP II analysis found HB02, with a total metric score of 33, to be 71% comparable to the reference station MR03. As this placed HB02 in the moderately impaired category, additional taxonomic identification and subsequent RBP III analysis was conducted to enhance the ability to discriminate the degree of impairment to the benthic community.

When RBP III analysis was applied to the genus/species-level benthos data, HB02 received a total metric score of 34, representing a 81% comparability to the metric scores for MR03. As this percent value is intermediate to the ranges for the non-impaired and slightly impaired categories, subjective judgement as to the correct placement is required. While I leave this decision to the Ipswich River Basin Team, the use of the habitat assessment and physicochemical data for this station should prove useful in the decision process.

The dominance of filter-feeders (Philopotamidae, Pisidiidae, and especially Hydropsychidae) at HB02 is not surprising, as the station lies below an impoundment which is a potential source of organic enrichment and associated suspended Fine Particulate Organic Material (FPOM) for the downstream community (Wiederholm 1984). The abundance of aquatic mosses and filamentous algae at HB02 probably accounts for the low densities of scrapers (organisms that thrive in a healthy diatom-dominated periphyton community) which can not effectively harvest this food source. In particular, the thick cellulose and lignin-based cell walls of filamentous macroscopic algae are apparently far less readily digested than diatoms (Lamberti and Moore 1984). However, while these mosses and filamentous algae displace the scraper community, they provide good attachment sites and additional microhabitat for filtering collectors (Plafkin et al. 1989).

While the predominance of a particular feeding type generally indicates an unbalanced community responding to an overabundance of a particular food source (often FPOM resulting from organic enrichment), the presence of a relatively diverse and pollution- sensitive benthos assemblage, a high score for the EPT/Chironomidae metric, and a low percent contribution by the dominant taxon, indicates good community balance and a relatively healthy biotic condition at HB02. As habitat at HB02 is comparable to the "best

attainable" condition, detected impairment--if any--can be attributed to water quality factors such as organic/nutrient enrichment from either upstream sources or nearstream non-point sources.

FB01--Fish Brook, Topsfield MA (19 July 1995)

HABITAT

The FB01 site produced two composited kick samples taken from a shallow riffle immediately upstream (10 m) of Endicott Rd. The stream reach meandered sluggishly through a partly shaded canopy of alder and maple trees. Although sediment deposition was prevalent throughout the low flow areas along the reach, occasional riffles, pools, snags, overhanging vegetation, and patches of *Sparganium* sp. provided good habitat for fish and invertebrates.

FB01 received a habitat assessment score of 75. Those primary instream habitat parameters directly pertinent to the support of benthic communities and weighted the highest in the assessment matrix--substrate type and stability, availability of refugia, and passage potential--were classified as good. FB01 was designated as a reference station for those study sites sampled (except HB02) by virtue of its high habitat assessment score, and minimal upstream and surrounding land use abuses (e.g. absence of point sources, lack of nearstream agriculture and/or industrial activities, relatively little development, wide and undisturbed riparian buffer zone) relative to the overall watershed. While it is impossible to find a non-impacted stream in the Ipswich River watershed, we felt FB01 represented the "best attainable" conditions in the watershed in terms of habitat and water quality.

BENTHOS

Because FB01 is a reference station, it does not receive an impairment score. However, the metric values calculated as part of the RBP II and RBP III analysis seem to reflect the healthy benthic community one would expect to find in a "least impacted" stream site. In particular, those parameters that measure components of community structure (taxa richness, biotic index, and EPT index)--which display the lowest inherent variability among the RBP metrics used (Resh 1988)--scored well and corroborate the designation as a reference station. The only metric to score poorly, percent contribution by dominant taxon (31%; metric score=2), was a result of the predominance of Hydropsychidae (*Cheumatopsyche* sp., *Hydropsyche morosa* gr.). The high density of this taxon is not surprising, as the extensive wetland margins along and upstream of the FB01 reach offer substantial organic inputs in the form of allochthonous materials. Through a variety of abiotic and biotic processes, these organic materials become available as high quality FPOM for filter-feeders such as Hydropsychidae, who use silken nets to capture this food resource as it is suspended in the water column.

MB02--Martins Brook, North Reading MA (18 July 1995)

HABITAT

MB02 was located in a slowly meandering and partially shaded stream segment bordered by a profusion of wetland vegetation (*Phalaris* sp., *Cephalanthus* sp., *Cornus* sp., *Bohmeria* sp.) and maple-dominated hardwoods. Benthic habitat for both fish and macroinvertebrates was considered fair at best due to considerable sediment deposition in pools and poorly developed riffle areas. Where cobble/gravel substrates or other stable cover existed, significant embeddedness had displaced much of the available habitat. The high percent composition of sand and silt throughout the reach may be naturally occurring, as these substrates are typical of a low-gradient floodplain stream--especially one located immediately below an impoundment. There was no evidence of local watershed erosion, and bank stability and bank vegetative stability were considered excellent. While surrounding land use was residential, the stream was well buffered with an extensive riparian zone.

MB02 received a habitat assessment score of 67, which was 89% comparable to the reference station FB01. Low stream flow, limited variety of velocity/depth combinations (deep areas lacking), and sedimentation made

it difficult to locate two distinct and productive 1 m^2 habitats. Nevertheless, two composited kick samples were collected approximately 15 m upstream of Park Street.

BENTHOS

MB02 received a total metric score of 27 following RBP II analysis. This represents a 75% comparability to the reference station, placing the benthic community condition intermediate to the ranges for non-impairment and moderate impairment. Because of the ambiguity of this impairment score, RBP III analysis was completed (genus/species-level taxonomy and recalculation of metrics) to improve the resolution of impairment ranges and increase the reliability of the assessment. As a result, both the total metric score (27) and percent comparability (63%) to the reference station decreased, placing MB02 in the slightly impaired category. Because habitat quality at MB02 was found to be comparable to the reference station FB01, detected impacts to the aquatic community can be attributed to water quality factors.

The macroinvertebrate community structure and composition at MB02 appears to be directly related to its location immediately downstream of the impoundment and surrounding wetland. That the assemblage is dominated by the filter-feeding Hydropsychidae is not surprising, as the impoundment no doubt is a contributing source of suspended fine particulate organic material; however, the sheer numbers represented by this taxon are somewhat disconcerting and perhaps indicative of effects from excessive upstream organic enrichment. Typically, in lentic systems such as the impoundment upstream of MB02, the primary source of organic matter is autochthonous (produced within the system), with secondary inputs of allochthonous (transported into the system from someplace else) materials from shoreline vegetation and fluvial inputs (Wetzel 1974, Merritt et al. 1984). Phytoplankton production--and to a lesser extent, littoral vascular plant production--and associated dissolved organic matter (DOM), is the primary source of authocthonous matter (Wetzel 1975). It is the physical-chemical flocculation of this DOM which leads to the formation of FPOM, the primary nutrition resource utilized by filter-feeders such as Hydropsychidae (Wetzel 1975). While FPOM production in lotic systems is primarily a result of the processing of microbially colonized Course Particulate Organic Material (CPOM) by aquatic shredders, the high concentration of FPOM in stream systems immediately below pond and reservoir outlets have mainly lentic origins. If these lentic systems are subjected to increasingly eutrophic conditions and/or excessive organic inputs--either from precipitation or land-based anthropogenic inputs (e.g. agriculture, urban land uses)--the resulting effects of enrichment (i.e. increased algal, plant, and DOM production) can be seen not only in the lentic fauna, but also the aquatic communities immediately downstream. The rich filter-feeding invertebrate assemblage at MB02 appears to reflect the effects of only mild enrichment, as those Hydropsychidae taxa--and for that matter, Elmidae (*Stenelmis* sp.)--would not be found in a zone of gross organic or inorganic pollution typically dominated by Chironomidae and Oligochaeta. However, the lack of Ephemeroptera and Plecoptera representation (the EPT index metric scored a 0), especially those that are grazers, suggests that enrichment upstream may be due to more than just natural processes; although, embedded substrates and poorly-developed riffles may be displacing these taxa as well.

IP06--Ipswich River, Middleton MA (18 July 1995)

HABITAT

IP06 was located approximately 20 m downstream of Russell St. and immediately below the Bostik Chemical Company effluent discharge stream. Flow throughout the sampling reach was minimal and dominated by the discharge. The abundance of cobble substrate offered limited habitat for invertebrates, as extremely shallow riffles left much of the substrate exposed. Fish cover was only fair due to shallow riffles and pools. Sediment deposition, possibly a result of road runoff, further reduced productive habitat for fish and invertebrates. Bank stability, bank vegetative stability, and streamside cover were good, as a well vegetated riparian zone dominated by maple, alder, ash, and loosestrife buffered both sides of the stream without disturbance. Potential sources of non-point source pollution were road runoff above the reach, and residential land use.

IP06 received a habitat assessment score of 65, which represented a 86% comparability to the reference FB01. This indicates that the site is supportive of the aquatic life expected under reference conditions in

terms of habitat quality and quantity. The limiting habitat parameters at IP06 appear to be the lack of productive and available habitat and cover due to inadequate flow regimes (velocity/depth combinations) and current velocity.

BENTHOS

RBP II analysis found the benthic community at IP06 to be moderately impaired, with a total metric score of 24 representing a 67% comparability to the reference station FB01. The percent comparability further declined (58%; total metric score=24) after completing the RBP III metric analysis for genus/species-level taxonomic data, placing IP06 in the slightly impaired category for biological condition.

The macroinvertebrate community at IP06, like MB02, indicates the presence of significant amounts of FPOM. Unlike at MB02, however, these fine particulates are probably available primarily as settled, decomposing material rather than as suspended material. *Gammarus* sp., a gatherer of particulate organic matter, is the dominant taxon while densities of filter-feeding Hydropsychidae are significantly less. In addition, the high density of the scraper *Stenelmis* sp. indicates that attached algae and associated materials are a contributing food resource as well. It is, unfortunately, difficult to determine the primary source of organic and/or inorganic enrichment responsible for the proliferation of these food items--the impoundment (bordered by a golf course and several residences) immediately upstream, or the Bostik effluent inputs. Regardless, it is evident that the aquatic community structure at IP06 is less than expected relative to the reference site, particularly in terms of composition (species richness=10; EPT index=4) and community similarity (20% comparable to reference).

While inorganic and/or organic inputs from the Bostik discharge may be contributing to impairment at IP06, there is little evidence of toxic effects on the benthic macroinvertebrate community. The filter-feeding Hydropsychidae, although less numerically dominant than at other survey stations (possibly do to the variety of food resources available), is still well represented. Filtering collectors are sensitive to toxicant bound to fine particles. By readily adsorbing to dissolved organic matter (DOM) forming FPOM during flocculation, these toxicant become available to filterers via FPOM (Plafkin et al. 1989). While densities of filter-feeders and other less tolerant taxa (e.g. EPTs) are expected to decline when exposed to toxic effects, increases are expected in the numbers of Chironomidae and Oligochaeta, which display high tolerance to the extreme conditions of heavy metal pollution (Wiederholm 1984). The presence of several filter-feeding caddis flies and other pollution/toxicant-intolerant taxa (e.g. Heptageniidae, *Lepidostoma* sp., *Psephenus herricki*) at IP06, coupled with the virtual absence of the more tolerant Chironomidae and Oligochaeta, suggest the absence of heavy metal concentrations and toxic effects in the community.

While water quality factors such as nutrient loading and organic enrichment are probably the primary causes of impairment to the aquatic community at IP06, habitat constraints--specifically to flow regime and current velocity--will be briefly considered. The seasonably low rainfall levels for the summer of 1995 have placed additional stress on a watershed that is already subjected to considerable anthropogenic-induced pressures (e.g. water withdrawals) on overall basin hydrology. Flow at the IP06 sampling reach is completely dominated by the Bostik discharge--there is virtually no moving water from above the discharge stream to the impoundment. The combination of fluctuating (Bostik) discharge and low natural flows, then, has supplemental effects on an already altered lotic environment (the IP06 location below an impoundment and associated lentic effects on the lotic community have been discussed). Flow regime and current velocity are important hydrologic determinants of benthic community ecology. Flow volume and velocity/depth combinations can have effects on substrate composition and stability, the amount of channel under water, and food availability (Minshall 1984). Current plays a crucial role in the distribution of benthic macroinvertebrates--current velocity affects an insect's ability to gather food, meet respiratory requirements, avoid competition and predation, and colonize or vacate certain habitats (Minshall 1984). Short-term flow fluctuations may modify aquatic insect communities in several ways, most notably by stranding aquatic insect in pockets of standing water or on exposed substrates. The potential for stranding at IP06 may explain the lack of Ephemeroptera, as mayflies are particularly susceptible to stranding (Ward 1984). Increasing and decreasing discharge may induce drift of aquatic insects; that is, the downstream transport by current of benthic animals as a means of escape or dispersal (Wiley and Kohler 1984; Ward 1984). Populations of certain lotic forms may thus be depleted in streams below dammed impoundments because drift from

upstream lotic reaches is unable to replenish the individuals lost from the regulated or fluctuating flow segment. This taxa depletion, either by drift or the periodic loss of a riffle habitat, may contribute to the low taxa richness at IP06. Finally, it is possible that low current velocity at IP06 has resulted in the displacement of a filter-feeding dominated community by a deposit-collector/scraper dominated assemblage typical of slow current or standing water habitats where there is a large accumulation of deposited organic matter.

The combination of sample station location (below an impoundment and point source discharge) and habitat constraints (limited flow/velocity, deposition) make it difficult to discern causes of impairment to the aquatic community at IP06. More than likely, impairment is due to water quality factors such as organic and/or inorganic enrichment, and is compounded by habitat limitations. Impacts from the Bostik discharge, in particular, may be magnified by the low flow problems characteristic of the Ipswich River watershed. Regardless, it is important to exercise caution when attempting to target specific contributors of environmental stress.

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Appendix A

Table 1. List of macroinvertebrate taxa collected from stream sites in the Ipswich River watershed between 18 and 19 August 1995. The sampling sites were in: Fish Brook (FB01), Topsfield; Howlett Brook (HB02), Topsfield; Martins Brook (MB02), North Reading; Ipswich River (IP06), Middleton--all in Massachusetts.

TAXON	FFG	TV	FB01	HB02	MB02	IP06
Pisidiidae	FC	6		10		
Lumbriculidae	GC	7				2
Gammaridae	GC	6	2	2	7	39
Baetidae	GC	4	1			
Heptageniidae	SC	4	2	1		1
Calopterygidae	PR	5		2		
Perlidae	PR	1	2	1		
Corydalidae	PR	5	16	2		
Philopotamidae	FC	3	2	18		
Hydropsychidae	FC	4	51	32	76	17
Glossosomatidae	SC	0	2			
Lepidostomatidae	SH	1				1
Leptoceridae	PR	4		1		
Psephenidae	SC	4		2		1
Elmidae	SC	4	5	7	18	38
Chironomidae	GC	6	7	16	6	1
Empididae	PR	6			1	
TOTAL			90	94	108	100

Appendix A

Table 2. List of macroinvertebrate taxa collected from stream sites in the Ipswich River watershed between 18 and 19 August 1995. The sampling sites were in: Fish Brook (FB01), Topsfield; Howlett Brook (HB02), Topsfield; Martins Brook (MB02), North Reading; Ipswich River (IP06), Middleton--all in Massachusetts.

TAXON	FFG	TV	FB01	HB02	MB02	IP06
Pisidiidae	FC	6		10		
Stylodrilus heringianus	GC	8				2
Gammarus sp.	GC	6	2	2	7	39
Baetis sp. 3	GC	6	1			
Heptageniidae	SC	4	2			1
Stenonema sp.	SC	3		1		
Hetaerina sp.	PR	5		2		
Perlidae	PR	1	1			
Acroneuria lycorias	PR	0	1	1		
Nigronia sp.	PR	6	16	2		
Chimarra sp.	FC	3	2	18		
Cheumatopsyche sp.	FC	7	23	17	61	5
Hydropsyche morosa gr.	FC	6	28	15	15	10
Glossosoma sp.	SC	2	2			
Lepidostoma sp.	SH	1				1
Nectopsyche sp.	PR	4		1		
Psephenus herricki	SC	3		2		1
Macronychus glabratus	SH	5				2
Optioservus sp.	SC	3	3	3		
Oulimnius sp.	SC	2	1			
Stenelmis sp.	SC	5	1	4	18	36
Conchapelopia sp.	PR	9		3		
Corynoneura sp.	GC	6		1		
Eukiefferiella devonica gr.	GC	4			1	
Krenosmittia sp.	GC	1	1			
Lopescladius sp.	GC	2	1			
Parametriocnemus sp.	GC	4	2			
Tvetenia vitracies gr.	GC	5			1	
Tvetenia bavarica gr.	GC	5		2		
Polypedilum aviceps	SH	4	2	1		
Polypedilum convictum	SH	5		6		
Micropsectra sp.	GC	1		1		
Rheotanytarsus distinctissimus gr.	GC	6		1	1	
Rheotanytarsus exiguus gr.	GC	6		1	1	1
Stempellinella sp.	GC	4	1			
Sublettea sp.	GC	4			1	
Tanytarsus sp.	FC	6			1	
Hemerodromia sp.	PR	6			1	
TOTAL			90	94	108	98

Appendix B

Table 1. Summary of RBP II data analysis for macroinvertebrate communites sampled at four stream sites (FB01, HB01, MB02, IP06) in the Ipswich River watershed and one stream site (MR03) in the Parker River watershed. Seven biological metrics were calculated and scored (in parentheses) for taxa collected at each station. Scores were totaled and compared to the regional reference station. The percent comparability to the reference station yields a final impairment score for each study site.

RBP II DATA SUMMARY FOR **IPSWICH RIVER** WATERSHED; DATE: **18-19 JULY 1995**

STATION #	FB01*	MB02	IP06		MR03**	HB02
STREAM	Fish Brook	Martins Brook	Ipswich River		Mill River	Howlett Brook
HABITAT SCORE	75	67	65		118	109
TAXA RICHNESS	10 (6)	5 (3)	8 (3)		16 (6)	12 (3)
BIOTIC INDEX	4.20 (6)	4.30 (6)	4.80 (6)		4.90 (6)	4.40 (6)
EPT INDEX	6 (6)	1 (0)	3 (0)		7 (6)	5 (3)
EPT/CHIRONOMIDAE	8.57 (6)	12.67 (6)	19 (6)		1.40 (6)	3.31 (6)
RIFFLE COMMUNITY: SCRAPERS/FILTERERS	0.17 (6)	0.24 (6)	2.35 (6)		0.45 (6)	0.17 (3)
% CONTRIBUTION (DOMINANT TAXA)	57% (0)	70% (0)	39% (3)		20% (6)	34% (3)
COMMUNITY SIMILARITY	100% (6)	71% (6)	27% (0)		100% (6)	76% (6)
TOTAL METRIC SCORE	36	27	24		42	30
% COMPARABILITY TO REFERENCE SITE		75%	67%			71%
BIOLOGICAL CONDITION -DEGREE IMPAIRED	REFERENCE	NON/ MODERATELY IMPAIRED	MODERATELY IMPAIRED		REFERENCE	MODERATELY IMPAIRED

* Reference station for MB02 and IP06

**Reference station for HB02 (MR03 is in the Parker River Watershed, sampled in 1994)

Appendix B

Table 2. Summary of RBP III data analysis for macroinvertebrate communites sampled at four stream sites (FB01, HB01, MB02, IP06) in the Ipswich River watershed and one stream site (MR03) in the Parker River watershed. Seven biological metrics were calculated and scored (in parentheses) for taxa collected at each station. Scores were totaled and compared to the regional reference station. The percent comparability to the reference station yields a final impairment score for each study site.

RBP III DATA SUMMARY FOR **IPSWICH RIVER** WATERSHED; DATE: **18-19 JULY 1995**

STATION #	FB01*	MB02	IP06		MR03**	HB02
STREAM	Fish Brook	Martins Brook	Ipswich River		Mill River	Howlett Brook
HABITAT SCORE	75	67	65		118	109
TAXA RICHNESS	18 (6)	11 (4)	10 (2)		26 (6)	21 (6)
BIOTIC INDEX	5.57 (6)	6.35 (6)	5.60 (6)		4.45 (6)	5.20 (6)
EPT INDEX	8 (6)	2 (0)	4 (0)		8 (6)	6 (2)
EPT/CHIRONOMIDAE	8.57 (6)	12.67 (6)	17 (6)		1.52 (6)	3.31 (6)
RIFFLE COMMUNITY: SCRAPERS/FILTERERS	0.17 (6)	0.24 (6)	2.67 (6)		0.49 (6)	0.17 (4)
% CONTRIBUTION (DOMINANT TAXA)	31% (2)	56% (0)	40% (2)		19% (6)	19% (6)
COMMUNITY SIMILARITY	100% (6)	43% (2)	20% (0)		100% (6)	52% (4)
TOTAL METRIC SCORE	38	24	22		42	34
% COMPARABILITY TO REFERENCE SITE		63%	58%			81%
BIOLOGICAL CONDITION -DEGREE IMPAIRED	REFERENCE	SLIGHTLY IMPAIRED	SLIGHTLY IMPAIRED		REFERENCE	NON/ SLIGHTLY IMPAIRED

* Reference station for MB02 and IP06

**Reference station for HB02 (MR03 is in the Parker River Watershed, sampled in 1994)

APPENDIX F
IPSWICH RIVER BASIN-2000 PERIPHYTON DATA AND RESULTS

During the summer of 2000, DEP personnel collected periphyton samples from stations in the Ipswich River Basin. Periphyton are described here as algae (either microscopic or macroscopic) attached to various substrates including rocks, vegetation, and sediments. Macroinvertebrate and habitat information were also gathered at the time of the periphyton sampling. The qualitative periphyton samples provide a record of the taxa that are found throughout Massachusetts and offer a means of comparing biological communities as well as documenting problem areas where prolific growth of nuisance species may be found. Nuisance growth of green macroalgae, such as *Spirogyra* sp., covers more than 40% of the riffle bottom (Barbour et al., 1999). Coverage of this magnitude could compromise the designated uses of the river as defined in the Massachusetts Surface Water Quality Standards (MA DEP, 1996). Both Aquatic Life uses and/or Aesthetics could be threatened by prolific growth of macroalgae, so the evaluation of this qualitative data focused on: 1) determination of percent cover by periphyton; and 2) identification of the dominant type and form of algae that are present.

Periphyton samples were typically collected in riffles or runs and were usually from scrapes of one substrate type, i.e. rock, cobble, aquatic vegetation etc. The samples collected indicate the presence of particular genera in one habitat.

MATERIALS and METHODS

Periphyton Identifications and Relative Abundance

Periphyton data were gathered along with the macroinvertebrate and habitat data using methods described in Barbour et al. (1999). Sampling was done by John Fiorentino and consisted of randomly scraping rocks and cobble substrates, typically within the riffle area, with a knife and collecting the material in a labeled glass vial. The samples were transported to the lab MA DEP-DWM-Worcester without refrigeration, but once at the lab they were refrigerated until identifications were completed.

The vial was shaken to get a uniform sample before subsampling. If filamentous algae comprised most of the sample they were removed first, identified separately and then the remainder of the sample was examined. An Olympus BH2 compound microscope with Nomarski optics was used for the identifications. Slides were typically examined under 200 power. A modified method for determining relative abundance developed by Bahls (1993) was used. The scheme developed by Bahls (1993) is as follows:

R (rare)	fewer than one cell per field of view at 200x, on the average;
C (common)	at least one, but fewer than five cells per field of view;
VC (very common)	between 5 and 25 cells per field;
A (abundant)	more than 25 cells per field, but countable;
VA (very abundant)	number of cells per field too numerous to count.

This determination of abundance provides a relative approximation of the taxa that contribute the most to the biomass in the riffle or pool habitats. Information obtained from the algal identifications and relative abundance is combined with information obtained in the habitat assessment, in particular, canopy cover and percent algal cover. Locations are noted where potential problem areas are found, based upon percent algal cover and abundance. The information can be used by assessment personnel to determine whether or not the aesthetics and aquatic life uses of the rivers are impaired.

Table 1 lists the stations that were included in this study and descriptions of their locations as well as the percent canopy cover and the percent algal cover.

Table 1. Ipswich River Watershed - 2000

Location	Station ID	Date	% Canopy Cover	% Algal Cover
Lubbers Brook upstream from Concord Street, Wilmington	LB02	19-Jul-2000	0	0
Ipswich River downstream from Mill Street, Reading/North Reading	IP01.5	19-Jul-2000	75	10
Ipswich River downstream from Route 28, Reading	IP02	07-Sep-2000	ND	ND
Martins Brook outlet Martins Pond, North Reading	MB01	07-Sep-2000	ND	ND
Martins Brook downstream from Park Street, North Reading	MB02	17-Jul-2000	40	*
		07-Sep-2000	ND	ND
Boston Brook upstream from Liberty Street, Middleton	BB01	17-Jul-2000	100	<5
Fish Brook upstream from Ipswich Road, Ipswich	FB00	17-Jul-2000	50	<5
Gravelly Brook upstream from Topsfield Road, Topsfield	GB01	19-Jul-2000	80	<1
Miles River downstream from Route 1A (near Lakeman Rd.) Ipswich	MR01	19-Jul-2000	40	<5
		07-Sep-2000	ND	ND
Ipswich River downstream from Main St., Middleton	IP06	17-Jul-2000	75	<5

* thin film, % not recorded ND-not determined

A subset of stations were re-sampled in the fall for identifications, no other data were collected. A list of the algal taxa found at the above stations is included in Appendix A.

RESULTS and DISCUSSION

The percent coverage or biomass of the periphyton community in the eight mainstem and tributary stations sampled during the 2000 biological sampling was found to be depauperate. The amount of algal cover was never more than the 10% that was found at IP01.5 (Table 1). This is much less than the 40% cover of the stream bottom which is considered to result in aesthetic as well as benthic habitat degradation through massive production of opportunistic species (Biggs, 1996) (Barbour et al., 1999) and eventual algal decay. Certainly the amount of algal cover as well as the genera present (Appendix A) indicate that neither Aesthetics nor Aquatic Life uses would be impaired due to excessive algal growth of green filamentous macroalgae (Barbour et al., 1999).

It is, however, difficult to know what is impacting the benthic algal community and keeping production suppressed throughout the Ipswich system. Grazing, disturbance and nutrients are important factors controlling algal biomass in areas where sufficient light levels are present. However, only three stations: LB02, MR01, MB02 had canopy cover of less than 50% indicating that light may be a common factor affecting community structure. In general, diatoms are found in areas of low light levels while the green filamentous algae have higher light requirements for photosynthesis, as well as having higher nutrient requirements. The tea-colored water found at several stations including IP01.5, MB02, BB01, FB00, GB01, and MR01 also would affect light levels received by the plants.

Nutrients can also affect algal growth especially if in limited supply or in excessive amounts. At the Ipswich River, nitrate-N, ammonia-N and total phosphorus were measured at most of the biological sampling stations during 2000 (MA DEP, 2003). In 2000, the EPA issued new recommended phosphorus criteria based on both aggregate nutrient ecoregions as well as Level III subecoregions (USEPA, 2000). These recommendations are intended to be starting points for states to develop more refined nutrient criteria. Reference condition for the *Northeast Coastal Zone* – the subecoregion most applicable to Massachusetts – was defined as the 25th percentile of data obtained from 59 reference streams that, for total phosphorus, was a value of 0.0237 mg/L based on data from all seasons. The highest total phosphorus value recorded during the 2000 summer survey (MA DEP, 2003) was 0.078 mg/L at MM01 (Maple Meadow Brook) on August 24. The lowest value for total phosphorus (0.038 mg/L) was recorded at MB01 (Martins Brook), the outlet of Martins Pond also on August 24. This sampling followed a rain event of greater than 0.2 inches on August 23 (MA DEP, 2003).

The algal sample collected at MB01 on September 7 followed a dry period extending from August 24. Unfortunately, no samples for nutrient analysis were collected on this date. The algae present, *Coelosphaerium* sp. and *Microcystis flos-aquae* (Appendix A), are both Cyanophyceae which respond to elevated phosphorus levels and were very abundant in the sample collected. They can cause aesthetic impacts resulting from their buoyancy and the development of large loosely collected colonies.

Chemical analyses were unavailable from station MR01 (Miles River) so nutrient enrichment could not be verified. However, upstream nonpoint sources, especially the horse farms and new local housing development, may have had some impact on the biological community at this sampling station, whether currently or in the recent past. The areas of open canopy within the reach (Table 1) and the lack of periphyton cover (<5%) were surprising. The sub-habitats sampled: i.e. riffle/cobble, run/*Sparganium* sp. and run/moss, contained few algal cells other than *Cocconeis* sp. on the *Sparganium* sp. leaves and adpressed (closely attached) *Coleochaete* sp. on the cobble (Appendix A). Nutrients do not appear to be controlling either the algal assemblage or the amount of growth. In areas with elevated nutrients and available light, the green filamentous algae e.g. *Cladophora* sp. are more likely to be abundant (Biggs, 1996).

Because the reach exhibited very stable cobble substrates, physical disturbance from sand abrasion is not a likely factor controlling the community assemblage unless, for example, silt barriers were not maintained during housing construction upstream resulting in intermittent periods of high turbidity. Other physical and biological factors must still be considered.

Upstream water withdrawals, by reducing the flow of the mainstem Ipswich River and its tributaries, could also be threatening the algal communities through both desiccation as well as by reduction of the dissemination of algal propagules. Stations potentially impacted include: MR01 (Miles River), BB01 (Boston Brook), and the mainstem Ipswich River stations IP01.5 and IP06. Secondary effects, such as temperature increases, that may also occur due to lack of flow can affect algal reproduction. While the sampling plan was not designed to directly determine the impacts resulting from reduced flow, the algal community may be altered in a characteristic manner where flood disturbance (e.g., scouring) frequency and resource (i.e., nutrients and light) supply is medium to low (Biggs, 1996). In these situations the communities tend to be dominated by cyanobacteria and red algae. The cyanobacteria, in particular, *Lyngbya* sp. (Appendix A) were found at several locations including IP01.5 (downstream Mill St., North Reading/Reading) where it was found in patches of heavy growth, but overall coverage was low (Table 1). Since this was the most upstream station sampled no indication of community change can be made.

No definitive statement can be made, at this time, regarding algal production at the sites assessed since many factors can have an impact. However, more work should be done to distinguish the causes of low algal biomass observed throughout the Ipswich River Watershed. There are some indications, at least, that this is not a reflection of resource availability, but rather physical and biological disturbances created by other factors which may include variable stream discharge and velocity, light levels and grazing pressures (Welch et al., 1988). Additional water quality sampling over the growing season, as well as at other times throughout the year, would help determine how representative the observed phosphorus values are for the Ipswich system and if the EPA criteria are being met.

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Appendix

Ipswich River Watershed 2000 Periphyton Data

Date	Habitat	Class	Genus	Abundance
Location: Lubbers Brook (LB02), upstream from Concord Street, Wilmington				
19 July 2000	pool/plankton	Cyanophyceae	*Microcystis* sp.	A
	pool/sediment	Bacillariophyceae	*Gyrosigma* sp.	R
		Bacillariophyceae	*Synedra* sp.	R
		Cyanophyceae	ui filamentous	A
		Cyanophyceae	*Lyngbya* sp	A
		Cyanophyceae	*Oscillatoria* sp.	C
			fungal mycelia	C
Location: Ipswich River (IP01.5) downstream from Mill Street, Reading/N. Reading				
19 July 2000	riffle/on *Sparganium* sp.		*Synedra berolinensis*	
		Bacillariophyceae	Lemmermann	VA
		Bacillariophyceae	*Navicula* spp.	VA
	rifle/cobble	Bacillariophyceae	*Fragilaria* sp.	VA
		Bacillariophyceae	*Gomphonema* sp.	C
		Bacillariophyceae	*Gyrosigma* sp.	R
		Bacillariophyceae	*Navicula* spp.	C
		Chlorophyceae	*Microspora* sp.	C
		Cyanophyceae	*Lyngbya* sp.	VA
		Cyanophyceae	*Oscillatoria* sp.	C
Location: Ipswich River (IP02), downstream from Route 28, Reading				
7 September 2000	riffle-moss	Bacillariophyceae	*Eunotia sp.*	R
		Bacillariophyceae	*Gyrosigma sp.*	R
		Bacillariophyceae	*Pinnularia* sp.	R
		Bacillariophyceae	*Synedra* sp.	R
		Cyanophyceae	*Lyngbya* sp.	R
		Cyanophyceae	*Spirulina* sp.	R
Location: Martins Brook (MB01), outlet of Martins Pond, North Reading				
7 September 2000	water column	Cyanophyceae	*Coelosphaerium* sp.	VA
		Cyanophyceae	*Microcystis flos-aquae*	VA
Location: Martins Brook (MB02), downstream from Park Street, North Reading				
17 July 2000	riffle/moss	Bacillariophyceae	*Meridion* sp.	R
		Chlorophyceae	green filament, branched	R
		Chlorophyceae	green parenchymatous	C
	riffle/cobble	Bacillariophyceae	*Fragilaria* sp.	C
		Bacillariophyceae	pennate diatoms	R
		Chlorophyceae	*Coleochaete* sp.	C
		Cyanophyceae	*Lyngbya* sp.	R
		Cyanophyceae	*Anabaena* sp.	R
	riffle/*Sparganium sp.*	Bacillariophyceae	*Gomphonema* sp.	VA
		Bacillariophyceae	pennate diatoms	A
7 September 2000	riffle/moss	Bacillariophyceae	*Cocconeis* sp.	R
		Bacillariophyceae	*Cymbella* sp.	R
		Bacillariophyceae	*Eunotia* sp.	R
		Bacillariophyceae	*Fragilaria* sp.	R
		Bacillariophyceae	*Navicula* spp.	R
		Chlorophyceae	*Coleochaete* sp.	C
Location: Boston Brook (BB01), upstream from Liberty Street, Middleton				
17 July 2000	riffle/cobble	Bacillariophyceae	*Fragilaria* sp.	R
		Bacillariophyceae	*Navicula* spp.	R

Date	Habitat	Class	Genus	Abundance
Location: Fish Brook (FB00), upstream from Ipswich Road, Ipswich				
17 July 2000	riffle/cobble	Bacillariophyceae	*Cocconeis* sp.	R
		Bacillariophyceae	*Navicula* sp.	R
		Bacillariophyceae	*Tabellaria* sp.	R
		Bacillariophyceae	ui pennate diatoms	C
		Chlorophyceae	*Closterium* sp.	R
		Cyanophyceae	ui blue green filaments	R
			fungal mycelia	C
	riffle/*Sparganium sp.*	Bacillariophyceae	*Amphipleura* sp.	R
		Bacillariophyceae	*Cocconeis* sp.	C
Location: Gravelly Brook (GB01), upstream from Topsfield Road, Ipswich				
19 July 2000	rifflecobble	Bacillariophyceae	*Eunotia* sp.	R
		Bacillariophyceae	*Synedra* sp.	R
		Bacillariophyceae	pennate diatoms	C
		Phycomycetes	fungal hyphae	
			ciliates	A
Location: Miles River (MR01), downstream from Route 1A (near Lakeman Road), Ipswich				
19 July 2000	riffle/moss	Bacillariophyceae	*Cocconeis* sp.	R
		Bacillariophyceae	*Cymbella*	R
		Bacillariophyceae	*Navicula*	R
		Bacillariophyceae	*Synedra* sp.	R
		Cyanophyceae	*Oscillatoria* sp.	R
	riffle/cobble	Chlorophyceae	*Coleochaete* sp.	A
	run/*Sparganium sp.*	Bacillariophyceae	*Cocconeis* sp.	C
		Bacillariophyceae	*Fragilaria* sp.	R
		Bacillariophyceae	*Gomphonema* sp.	C
7 September 2000	shady run/moss	Bacillariophyceae	*Amphipleura* sp.	R
		Bacillariophyceae	*Cocconeis* sp.	R
		Bacillariophyceae	*Cymbella* sp.	R
		Bacillariophyceae	*Gyrosigma* sp.	R
		Bacillariophyceae	*Meridion* sp.	R
		Bacillariophyceae	*Navicula* spp.	C
		Bacillariophyceae	*Surirella* sp.	R
		Bacillariophyceae	*Synedra* sp.	R
		Cyanophyceae	*Lyngbya* sp.	R
			sewage fungus	R
Location: Ipswich River (IP06), downstream from Main Street, Middleton				
17 July 2000	riffle/run	Bacillariophyceae	*Synedra* sp.	R
	scrape of wood snag	Cyanophyceae	*Microcystis* sp.	R
		Cyanophyceae	*Oscillatoria* sp.	R
			filamentous bacteria	VA
			fungal mycelia	VA
	riffle/run on *Sparganium sp.*	Bacillariophyceae	*Cocconeis* sp.	A
		Bacillariophyceae	*Nitzchia* sp.	R
		Bacillariophyceae	*Synedra* sp.	C

APPENDIX G - MA DEP OWM/DWM FISH TOXICS MONITORING IN THE IPSWICH RIVER WATERSHED 1995 AND 2000

INTRODUCTION

Fish toxics monitoring is a cooperative effort between three Massachusetts Department of Environmental Protection Offices/Divisions- Watershed Management, Research and Standards (ORS), and Environmental Analysis, the Massachusetts Department of Fisheries, Wildlife, and Environmental Law Enforcement, and the Massachusetts Department of Public Health (MDPH). Fish toxics monitoring is typically conducted to assess the concentrations of toxic contaminants in freshwater fish, identify waterbodies where those concentrations may pose a risk to human health, and identify waters where toxic contaminants may impact fish and other wildlife.

Between September 1995 and August 2000, fish were collected by the MA DEP Office of Watershed Management (OWM)/Division of Watershed Management (DWM) at four sites in the Ipswich Watershed: Martins Pond, North Reading in September 1995, Ipswich River, Middleton/ Peabody (near Bostik Company) in October 1995, Hood Pond, Ipswich/Topsfield in May 2000, and the Ipswich River, North Reading in August 2000. Additionally, Lowe Pond in Boxford and Towne Pond in Boxford/ North Andover were sampled by Normandeau and Associates in 1999 as part of an ORS mercury study.

PROJECT OBJECTIVES

Fish tissue monitoring is typically conducted to assess the levels of toxic contaminants in freshwater fish, identify waterbodies where those levels may impact human health, and identify waters where toxic chemicals may impact fish and other aquatic life. Nonetheless, human health concerns have received higher priority and, therefore, fish tissue analysis has been restricted to edible fillets. The fish toxics monitoring was designed to screen the edible fillets of several species of fish representing different feeding groups (i.e., bottom dwelling omnivores, top-level predators, etc.) for the presence of heavy metals, Polychlorinated biphenyls (PCBs) and chlorinated pesticides. In 2000, MA DEP DWM Fish Toxics Monitoring was conducted under an EPA-approved Fish Toxics Quality Assurance Project Plan (MA DEP 2002). Data Quality Objectives are presented in the above-mentioned QAPP. There were no deviations from the QAPP.

METHODS

Uniform protocols, designed to assure accuracy and prevent cross-contamination of samples, were followed for collecting, processing, and shipping fish collected for the fish toxics monitoring. In 1995 fish were collected on 15 September from Martins Pond, North Reading, on 4 October from Ipswich River, Middleton/ Peabody, and on 17 May 2000 from Hood Pond, Ipswich/Topsfield, and on 2 August 2000 from the Ipswich River, North Reading (Figure 1). All fish were collected using boat-mounted electroshocking gear and/or gill nets. Fish selected for analysis were placed in an ice filled cooler and brought back to the OWM/DWM laboratory for processing. Processing included measuring lengths and weights and visually inspecting fish for tumors, lesions, or other indications of stress or disease. Scales, spines, or pectoral fin ray samples were obtained from each sample to determine the approximate age of the fish. Fish were filleted (skin off) with stainless steel knives on glass cutting boards.

1995 FISH TOXICS

Details related to the collection, handling, and processing of samples were excerpted from the report entitled *1995 Public Request Fish Toxics Monitoring Surveys* (Maietta 1995).

Fillets targeted for metals analysis were placed in VWR high density polyethylene (HPDE) cups with covers. The opposite fillets were wrapped in aluminum foil for % lipids, PCB and organochlorine pesticide analysis. In the case of composite samples, two or three fillets from like-sized individuals of the same species were wrapped together in aluminum foil or stored in the single sample container. Samples were tagged and frozen for subsequent delivery to WES. All equipment used in the filleting and storage process was rinsed in accordance with USEPA procedures (1993). Methods used at WES for metals

analysis include a cold vapor method using a VGA hydride generator for mercury and Varian 1475 flame atomic absorption for all remaining metals. PCB/organochlorine pesticide analysis was performed on a gas chromatograph equipped with an electron capture detector.

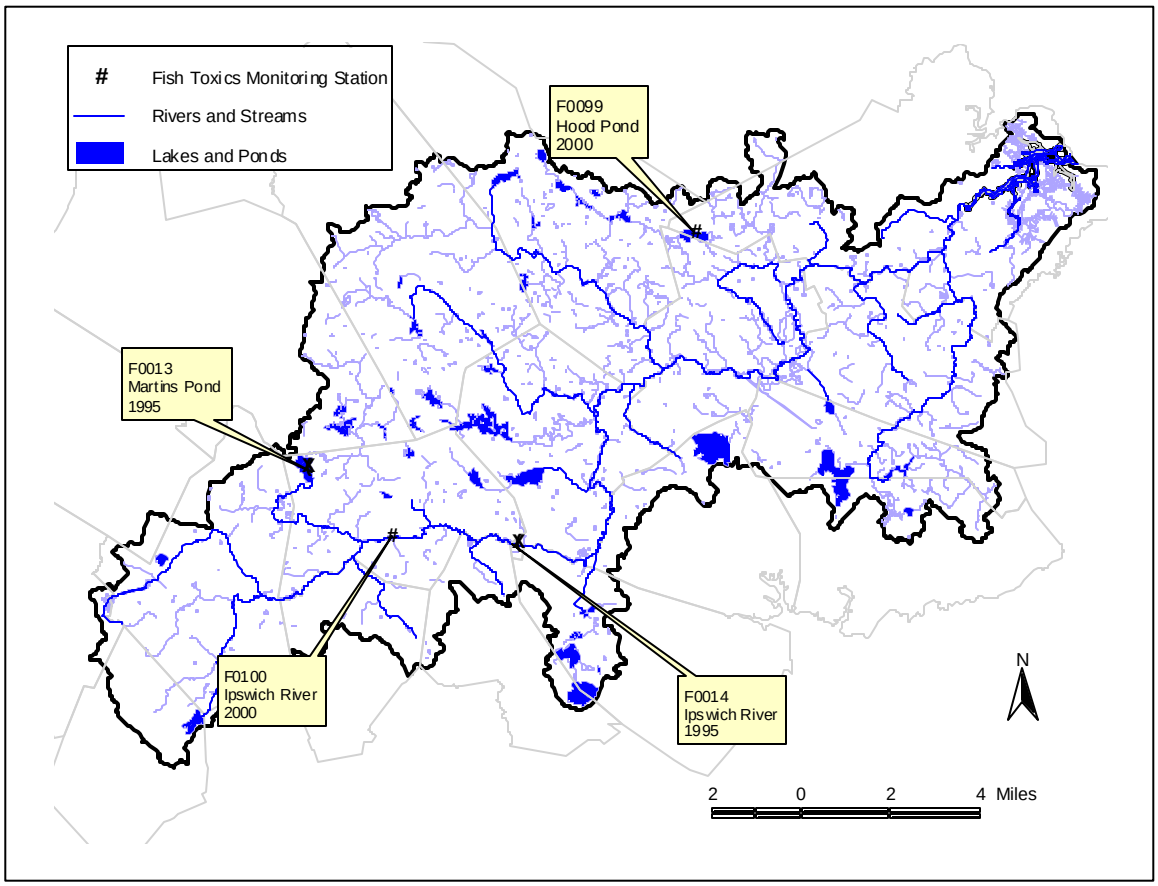

Figure 1. MA DEP OWM/DWM fish toxics monitoring locations in the Ipswich River Watershed 1995 and 2000.

1999 ORS FISH TOXICS

A directed study of fish in lakes in northeastern Massachusetts was performed by ORS during 1999 in order to examine possible spatial patterns in the occurrence of higher fish mercury concentrations and to compare the fish contamination situation in this localized geographic region to statewide and regional data. Fish were sampled with box nets, gill nets, trot lines, electroshocking, and rod and reel. Fish were removed from the water, rinsed with ambient water, wrapped individually in aluminum foil, placed in polyethylene Ziploc bags and placed on ice for delivery to the laboratory within 24 hours of collection. Methods for analysis of mercury in lateral muscle were in accordance with EPA procedures. A Perkin Elmer Flow Injection Mercury System was used for total mercury analysis (MA DEP 2000b).

2000 FISH TOXICS

Details related to the collection, handling, and processing of samples were excerpted from the report entitled *2000 Fish Toxics Monitoring Public Request and Year 2 Watershed Surveys* (Maietta and Colonna-Romano 2000).

> All equipment used in the filleting process was rinsed in tap water and then rinsed twice in de-ionized water before and or after each sample. Samples (individual or composite) targeted for % lipids, PCBs and organochlorine pesticide analysis were wrapped in aluminum foil. Samples targeted for metals analysis were placed in VWR 32-ounce high density polyethylene (HDPE) cups with covers. Composite samples ranged from two to five

fillets from like-sized individuals of the same species (occasionally the same genus). Samples were tagged and frozen for subsequent delivery to the Department's Wall Experiment Station (WES).

Methods used at WES for metals analysis include the following:
Mercury is analyzed by a cold vapor method using a Perkin Elmer, FIMS (Flow Injection Mercury System), which uses Flow Injection Atomic Absorption Spectroscopy. Cadmium and lead are analyzed using a Perkin Elmer, Optima 3000 XL ICP - Optical Emmission Spectrophotometer. Arsenic and selenium are analyzed using a Perkin Elmer, Zeeman 5100 PC, Platform Graphite Furnace, Atomic Absorption Spectrophotometer.

PCB Arochlor, PCB congener, and organochlorine pesticide analysis was performed on a gas chromatograph equipped with an electron capture detector "according to the modified AOAC 983.21 procedure for the analysis of PCB Arochlors, Congeners, and Organochlorine Pesticides."

According to standard practice, all laboratory analytical results were forwarded to the Massachusetts Department of Public Health.

RESULTS

The results of MA DEP Ipswich River Basin fish toxics monitoring surveys are described below for each sampling event (MA DEP 1995 and Maietta and Colonna-Romano 2000). Data for all surveys are presented in Tables 1 and 2. Sampling locations are depicted in Figure 1. All raw data files, field sheets, lab reports, chain of custody forms, and other metadata are maintained in databases at the MA DEP DWM office in Worcester. Quality assurance data are available in the *Data Validation Report for Year 2000 Project Data* (MA DEP 2003).

1995 FISH TOXICS

Ipswich River (Unique ID F0014)

Gill netting and trot lines placed in the Ipswich River near Bostik Company, Middleton/Peabody on 4 October 1995 resulted in the collection of chain pickerel, yellow perch, brown bullhead, creek chubsucker, and white sucker (Figure 1).

Mercury in the fish tissue from the Ipswich River ranged from 0.178 to 0.964 mg/kg wet weight (Table 1). Selenium levels ranged from below detection limit (BDL) to 0.104 mg/kg wet weight. Arsenic levels, with the exception of one sample (chain pickerel), were below detection limits. PCB arochlors and congeners, pesticides, cadmium, and lead were not detected in the edible fillets of all samples analyzed from the Ipswich River.

Martins Pond (Unique ID F0013)

Electroshocking in Martins Pond, North Reading on 15 September 1995 resulted in the collection of black crappie, pumpkinseed, bluegill, largemouth bass, yellow perch, white sucker, bullhead, and chain pickerel (Figure 1).

Mercury in the fish tissue from Martins Pond ranged from 0.132 to 0.898 mg/kg wet weight (Table 1). The mercury data triggered a site-specific advisory against the consumption of fish from Martins Pond (*"Children under 12, pregnant women and nursing mothers should refrain from consuming largemouth bass, black crappie and yellow perch from Martins Pond in order to prevent exposure of developing fetuses and young children to mercury. The general public should limit consumption of largemouth bass, black crappie, and yellow perch from Martins Pond to two meals per month"* MDPH 1996).

Selenium levels ranged from 0.164 to 0.315 mg/kg wet weight. PCB arochlors and congeners, pesticides, cadmium, arsenic, and lead were not detected in the edible fillets of all samples analyzed from Martins Pond (Table 1).

Table 1. Fish toxics monitoring data (mg/kg wet wt.) for Martins Pond, North Reading and Ipswich River, Middleton/Peabody.

Analysis #	Sample ID	Collecton Date	Species Code[1]	Sample Type[2]	Length (cm)	Weight (g)	Cd (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	As (mg/kg)	Se (mg/kg)	% Lipids	PCB (ug/g)	Pesticides (ug/g)
Martins Pond (F0013)														
95067	MPF95-1	09/15/95	LMB	C	43.1	1260	<0.20	<1.00	0.898	<0.040	0.164	0.070	ND[3]	ND
	MPF95-2	09/15/95	LMB	C	38.6	780								
	MPF95-3	09/15/95	LMB	C	39.1	870								
95068	MPF95-4	09/15/95	BC	C	22.8	130	<0.20	<1.00	0.538	<0.040	0.290	0.020	ND	ND
	MPF95-5	09/15/95	BC	C	22.1	130								
	MPF95-6	09/15/95	BC	C	21.8	130								
95069	MPF95-7	09/15/95	YP	C	22.1	100	<0.20	<1.00	0.538	<0.040	0.312	0.070	ND	ND
	MPF95-8	09/15/95	YP	C	22.1	100								
	MPF95-9	09/15/95	YP	C	23.6	110								
95070	MPF95-10	09/15/95	WS	C	39.1	630	<0.20	<1.00	0.132	<0.040	0.315	0.60	ND	ND
	MPF95-11	09/15/95	WS	C	42.8	800								
	MPF95-12	09/15/95	WS	C	42.1	860								
95071	MPF95-13	09/15/95	BB	C	23.8	130	<0.20	<1.00	0.260	<0.040	0.232	0.070	ND	ND
	MPF95-14	09/15/95	YB	C	25.2	240								
	MPF95-15	09/15/95	YB	C	22.3	140								
95072	MPF95-16	09/15/95	CP	C	43.6	560	<0.20	<1.00	0.379	<0.040	0.232	0.040	ND	ND
	MPF95-17	09/15/95	CP	C	39.5	370								
95073	MPF95-18	09/15/95	P	C	17.0	110	<0.20	<1.00	0.393	<0.040	0.276	0.050	ND	ND
	MPF95-19	09/15/95	B	C	16.9	110								
	MPF95-20	09/15/95	B	C	17.8	100								

[1]Species

bluegill (B) *Lepomis macrochirus*
brown bullhead (BB) *Ameiurus nebulosus*
black crappie (BC) *Pomoxis nigromaculatus*
creek chubsucker (CCS) *Erimyzon oblongus*
chain pickerel (CP) *Esox niger*
large mouth bass (LMB) *Micropterus salmoides*
pumkinseed (P) *Lepomis gibbosus*
white sucker (WS) *Castomus commersoni*
yellow bullhead (YB) *Ameiurus natalis*
yellow perch (YP) *Perca flavescens*

[2]Sample Type (All samples were fillets with skin off. Composite (C)
[3]ND = Not Detected

Table 1 (Continued.) Fish toxics monitoring data (mg/kg wet wt.) for Martins Pond, North Reading and Ipswich River, Middleton/Peabody.

Analysis #	Sample ID	Collecton Date	Species Code[1]	Sample Type[2]	Length (cm)	Weight (g)	Cd (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	As (mg/kg)	Se (mg/kg)	% Lipids	PCB (ug/g)	Pesticides (ug/g)
Ipswich River (F0014)														
95084	IRF95-1	10/04/95	CP	C	49.0	690	<0.20	<1.00	0.964	0.052	<0.040	0.10	ND[3]	ND
	IRF95-2	10/04/95	CP	C	41.2	410								
95085	IRF95-4	10/04/95	YP	C	21.9	140	<0.20	<1.00	0.237	<0.040	0.044	0.055	ND	ND
	IRF95-5	10/04/95	YP	C	21.5	130								
	IRF95-6	10/04/95	YP	C	24.5	190								
95086	IRF95-7	10/04/95	BB	C	25.7	190	<0.20	<1.00	0.223	<0.040	-0.040	0.20	ND	ND
	IRF95-8	10/04/95	BB	C	30.0	300								
	IRF95-9	10/04/95	BB	C	29.1	270								
95087	IRF95-10	10/04/95	CCS	C	25.6	240	<0.20	<1.00	0.178	<0.040	0.104	0.23	ND	ND
	IRF95-11	10/04/95	CCS	C	25.9	260								
	IRF95-12	10/04/95	CCS	C	26.5	230								
95088	IRF95-13	10/04/95	WS	C	44.0	910	<0.20	<1.00	0.405	<0.040	0.090	0.75	ND	ND
	IRF95-14	10/04/95	WS	C	41.5	800								
	IRF95-15	10/04/95	WS	C	43.5	840								

[1]Species

bluegill (B) *Lepomis macrochirus*
brown bullhead (BB) *Ameiurus nebulosus*
black crappie (BC) *Pomoxis nigromaculatus*
creek chubsucker (CCS) *Erimyzon oblongus*
chain pickerel (CP) *Esox niger*
large mouth bass (LMB) *Micropterus salmoides*
pumkinseed (P) *Lepomis gibbosus*
white sucker (WS) *Castomus commersoni*
yellow bullhead (YB) *Ameiurus natalis*
yellow perch (YP) *Perca flavescens*

[2]Sample Type (All samples were fillets with skin off. Composite (C)
[3]ND = Not Detected

1999 FISH TOXICS

Between 14 April and 26 May two lakes in the Ipswich River Watershed included in the ORS study were sampled by Normandeau and Associates (under contract to ORS in 1999): Lowe Pond (Boxford) and Towne Pond (Boxford/North Andover). Because of elevated mercury concentrations, MDPH issued a fish consumption advisory due to mercury contamination for Lowe Pond in Boxford (MDPH 2002). The advisory recommends the following:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody."
2. "The general public should not eat any largemouth bass from this waterbody."
3. "The general public should limit consumption of non-affected fish from this waterbody to two meals per month."

2000 FISH TOXICS

The results of MA DEP 2000 Ipswich Watershed fish toxics monitoring surveys described below are excerpted from *2000 Fish Toxics Monitoring Public Request and Year 2 Watershed Surveys* (Maietta and Colonna-Romano 2000). MDLs can also be found in Maietta and Colonna-Romano.

Hood Pond (Unique ID F0099)

This 67-acre mesotrophic pond is located within the Ipswich River watershed in Ipswich/Topsfield (Figure 1). The immediate watershed is relatively undeveloped with a large amount of contiguous wetlands. Electrofishing at Hood Pond in Ipswich resulted in the collection of three largemouth bass (*Mircropetus salmoides*), three black crappie (*Pomoxis nigromaculatus)*, three yellow perch *(Perca flavescens)*, three bluegill (*Lepomis macrochirus)*, and two brown bullhead (*Ameiurus nebulosus)*.

The analysis showed mercury exceeded the MDPH trigger level in four of the five samples analyzed; the mean mercury concentration in all samples from Hood Pond was 0.77mg/kg and the range was 0.25 to 1.1 mg/kg (Table 2). Potential sources of mercury include atmospheric deposition and geologic sources. The presence of contiguous wetlands may be enhancing mercury methylization and subsequently bioaccumulation of mercury in fishes within this waterbody. In light of elevated mercury concentrations, the MDPH issued the following fish consumption advisory in February of 2001:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat fish from this water body."
2. "The general public should not consume the largemouth bass, or yellow perch from this waterbody."
3. "The general public should limit consumption of other fish from this waterbody to two meals per month."

It should be noted that a trace amount (0.0030 mg/kg) of PCB congener BZ#77 was detected in a two fish composite of brown bullhead (Hpf00-13+14). All other PCBs and organochlorine pesticides were below MDLs in all samples analyzed from Hood Pond (Table 2).

Ipswich River (Unique ID F0100)

The Ipswich River in North Reading was sampled downstream of Central Street (Figure 1). Sampling was conducted in a small pool located just downstream of the road crossing and in a larger pooled area located a bit further downstream. There was no visible dam or other obstruction evident. The water was highly stained and there was some contiguous wetland located along the southern shore of the larger pool.

Electrofishing resulted in the collection of three chain pickerel, three yellow perch *(Perca flavesces)*, and three creek chubsuckers (*Erimyzon oblongus)*. Additional species observed included redfin pickerel (*Esox americana americana)*, American eel (*Anguilla rostrata)*, pumpkinseed (*Lepomis gibbosus)*, rainbow trout (*Oncorhynchus mykiss)*, largemouth bass *(Mircropetus salmoides)*, bluegill *(Lepomis macrochirus)*, white sucker (*Catostomus commersoni)*, and golden shiner (*Notemiginus crysoleucas)* (MA DEP 2000).

Mercury concentrations were below the MDPH "trigger level" of 0.5 mg/kg in all three composite samples; the mean concentration was 0.38 mg/kg (n=3) and the range was 0.27 to 0.47 mg/kg (Table 2). Arsenic was detected in each of the three samples analyzed. Concentrations ranged from 0.087 – 0.265 mg/Kg. PCBs and organochlorine pesticides were below MDLs in all samples analyzed from the Ipswich River (Table 2).

Table 2. Fish Toxics Monitoring Analytical Results from Hood Pond, Ipswich and the Ipswich River, North Reading (reported in wet weight from individual or composite samples with skin off).

Sample ID	Collection Date	Species Code[1]	Length (cm)	Weight (g)	Sample ID (laboratory sample #)	Cd (mg/kg	Pb (mg/kg)	Hg (mg/kg)	As (mg/kg)	Se (mg/kg)	% Lipids (%)	PCB Arochlors and Congeners (µg/g)	Pesticides (µg/g)
Hood Pond, Ipswich (F0099)													
HPF00-1	5/17/00	LMB	35.0	550	2000010 (L2000117-1)	<0.10	<1.0	1.1	<0.04	0.14	0.058	ND[2]	ND
HPF00-2	5/17/00	LMB	34.9	500									
HPF00-3	5/17/00	LMB	35.6	530									
HPF00-4	5/17/00	BC	27.0	270	2000011 (L2000117-2)	<0.10	<1.0	0.62	<0.04	0.15	0.074	ND	ND
HPF00-5	5/17/00	BC	28.1	300									
HPF00-6	5/17/00	BC	26.5	270									
HPF00-7	5/17/00	YP	25.0	180	2000012 (L2000117-3)	<0.10	<1.0	1.1	<0.04	0.20	0,13	ND	ND
HPF00-8	5/17/00	YP	25.4	200									
HPF00-9	5/17/00	YP	24.9	200									
HPF00-10	5/17/00	B	21.5	170	2000013 (L2000117-4)	<0.10	<1.0	0.80	<0.04	0.21	0.086	ND	ND
HPF00-11	5/17/00	B	20.2	160									
HPF00-12	5/17/00	B	21.4	180									
HPF00-13	5/17/00	BB	35.8	540	2000014[2] (L2000117-5)	<0.10	<1.0	0.25	<0.04	0.07	0.97	BZ#77 0.0030	ND
HPF00-14	5/17/00	BB	31.6	430									
Ipswich River, North Reading (F0100)													
IRF00-1	8/2/00	CP	29.0	150	2000018 (L2000256-1)	<0.02	<0.20	0.39	0.265	0.162	0.16	ND	ND
IRF00-2	8/2/00	CP	29.0	160									
IRF00-3	8/2/00	CP	26.4	110									
IRF00-4	8/2/00	YP	22.9	200	2000019 (L2000256-2)	<0.02	<0.20	0.47	0.260	0.410	0.17	ND	ND
IRF00-5	8/2/00	YP	19.6	100									
IRF00-6	8/2/00	YP	19.6	110									
IRF00-7	8/2/00	CCS	26.0	250	2000020 (L2000256-3)	<0.02	<0.20	0.27	0.087	0.131	0.43	ND	ND
IRF00-8	8/2/00	CCS	25.6	240									
IRF00-9	8/2/00	CCS	23.7	200									

[1]Species

bluegill (B) *Lepomis macrochirus*
brown bullhead (BB) *Ameiurus nebulosus*
black crappie (BC) *Pomoxis nigromaculatus*
creek chubsucker (CCS) *Erimyzon oblongus*
chain pickerel (CP) *Esox niger*
large mouth bass (LMB) *Micropterus salmoides*
yellow perch (YP) *Perca flavescens*

[2]ND = Not Detected

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APPENDIX H: SUMMARY OF NPDES AND WMA PERMITTING INFORMATION, IPSWICH RIVER WATERSHED

Table H1. Ipswich River Watershed municipal and sanitary wastewater surface discharges.

Permittee	NPDES #	Issuance	Flow (MGD)	Dilution Factor*	Special Conditions/notes	Receiving Water (Segment)
Town of Danvers, Vernon Russell Water Filtration Plant	MAG640062	December 2002	0.08	1.4:1	Treated filter backwash and sedimentation basin drainage via outfall #001	Unnamed tributary to Ipswich River (MA92-12)
Health and Education Services, Inc (formerly Topsfield Housing Sewage Plant, Topsfield)	MA0090808	Application filed in 1986	0.045	0	Facility is scheduled to tie into Danvers sewer (sewer connection to be initiated in the fall 2003), treatment at SESD.	Discharge to far west cove of Wenham Swamp, Ipswich River (MA92-06)
Town of Hamilton, Hamilton	MAR05C595				Stormwater	Miles River (MA92-03)
Town of Ipswich Sewer Department, Ipswich Wastewater Treatment Facility, Ipswich	MA0100609	February 2003	1.8	2.8:1	System upgrades: Chlorination to ultraviolet disinfection in 1998, mechanical aeration to a fine bubble diffuser system and cascade step aeration added to the outfall.	Unnamed tributary locally known as Greenwood Creek (MA92-23)
City of Peabody Department of Public Services, Winona Pond Water Treatment Facility	MAG640028	September 1995	0.12	NA*	City needs to reapply for a new permit.	Winona Pond (MA92077), (also mentioned in Norris Brook MA92-11)
Town of Reading Department of Public Works, Louanis Water Treatment Plant	MAG640038	April 2001	0.1	NA	Discharge on emergency basis only	Ipswich River (MA92-06)
Salem and Beverly Water Supply Board, Arlington Avenue Water Filtration Plant in Beverly, MA	MAG640059	January 2002	<1.0	NA		Wenham Lake Reservoir (MA92073) (also mentioned in Miles River MA92-03)
Turner Hill Preservation Associates, LLC, Ipswich (Conference center)	MA0021661	November 2002	0.01	no dilution	The facility (transferred from Missionaries of La Salette) now utilizes ultraviolet light for disinfection (use of chlorine discontinued in 1996). The new permit was issued for two years. Upgrades to treatment plant underway and the discharge will go to groundwater (expected November 2003).	Wetland tributary to Ipswich River (MA92-15)
Wenham Highway Garage, Wenham	MAR05C485				Stormwater	Miles River (MA92-03)
Town of Wilmington Water and Sewer Department, Butters Row Water Treatment Facility	MAG640024	June 2001	0.14	5.4:1	General permit (replaced individual permit MA00102636)	Maple Meadow Brook (MA92-04)
Wilmington Housing Authority, Wilmington	MA0102326	Tied into municipal sewer system, no longer discharges				Maple Meadow Brook (MA92-04)
Town of Wilmington Water and Sewer Department, E. H. Sargent Water Treatment Plant	MAG640020	August 2001	0.174	2.15:1		Martins Brook (MA92-08)

Dilution factor * = Qe +Qr/Qe where Qe is the average monthly effluent flow and Qr is the estimated 7Q10 of receiving stream, NA = not applicable

Table H2. Ipswich River Watershed NPDES industrial wastewater discharge facilities.

Permittee	NPDES #	Issuance	Flow (MGD)	Type(s) of discharge/special conditions/notes	Receiving Water (Segment)
Aggregate Industries Northeast, Peabody	MAR05C110	October 2001		Stormwater	Ipswich River (MA92-06)
Ametek Aerospace Products, Inc., Wilmington (formerly GE Co, Aerospace Instruments and Control Systems Department)	MAG250021	December 2002	0.009 MGD via outfall #001	NCCW	Ipswich River (MA92-06)
Analog Devices Inc., Wilmington	MAR05C391	September 2002		Stormwater	Maple Meadow Brook (MA92-04)
Avecia, Wilmington	MAR05B955	October 2001		Stormwater	Maple Meadow Brook (MA92-04)
Ballard Realty & Trust, Wilmington	MA0029823	Application filed in 1989	Discharge of stormwater to a 12" culvert. EPA determined that no permit is required for this stormwater discharge.		Ipswich River (MA92-06)
Benevento Sand & Gravel, Wilmington	MAR05B949			Stormwater	Martins Brook (MA92-08)
Bodycote, Ipswich	MAR05B925	October 2001		Stormwater	Howlett Brook (MA92-17)
Bostik, Inc., Middleton	MA0001180	July 1991	Need to determine	Facility installed a closed loop cooling tower system between 1998 and 2000 to eliminate CCW discharges. Still have NCCW discharge(s). Permit scheduled to be reissued.	Ipswich River (MA92-06)
Bursaw Oil Corp., Middleton	MA0033944	Application for NPDES permit; is an emergency exclusion for petroleum cleanup. Discharge to Ipswich River (MA92-06).			
Camp Curtis Guild in Reading	MAR05C074	October 2001		Stormwater	Bear Meadow Brook (MA92-07)
CYR Oil Company/Texaco Gas Station, Topsfield	MA0035912		In May 1998, EPA determined that no permit is required		Mile Brook (MA92-16)
Federal Express BED, Wilmington	MAR05C073	October 2001		Stormwater	Lubbers Brook (MA92-05)
FedEx Ground, Wilmington	MAR05B774	October 2001		Stormwater	Martins Brook (MA92-08)
Heffron Asphalt Corporation, Wilmington	MAR05B907	October 2001		Stormwater	Martins Brook (MA92-08)
Koch Membrane Systems, Wilmington	MAR05B672	October 2001		Stormwater	Maple Meadow Brook (MA92-04)
Laidlaw Transit, North Andover	MAR05C353			Stormwater	Boston Brook (MA92-13)
Morton International Inc., North Andover	MAR05C044	October 2001		Stormwater	Boston Brook (MA92-13)
MSM Industries, Inc., North Reading	MAG250899 and MA0027251	Facility installed a closed loop system in October 1995. EPA terminated these permits.			Ipswich River (MA92-06)
Neoresins, Inc., Wilmington	MAR05C328 MAR05C337 MAR05C345			Stormwater	Maple Meadow Brook (MA92-04)
Riverpark, North Reading	MAR05C200			Stormwater	Ipswich River (MA92-06)
Roadway Express Inc., North Reading	MAR05B805	October 2001		Stormwater	Ipswich River (MA92-06)
Shipley Co. LLC, North Andover	MAR05C390			Stormwater	Fish Brook (MA92-14)

Table H2 (cont'd). Ipswich River Watershed NPDES industrial wastewater discharge facilities.

Permittee	NPDES #	Issuance	Flow (MGD)	Type(s) of discharge/special conditions/notes	Receiving Water (Segment)
Sunoco Service Station, North Reading	MA0036749	Application for NPDES Permit is an Emergency Exclusion for Petroleum Cleanup.			Rapier Brook, a Tributary of Martins Brook (MA92-08)
Surface Coatings Inc., Wilmington	MAR05B952	October 2001		Stormwater	Maple Meadow Brook (MA92-04)
Textron Defense Systems, Wilmington	MAR05C305	September 2001		Stormwater (no longer discharges CCW and/or NCCW via MA0003468 issued in August 1995)	Maple Meadow Brook (MA92-04)
Yellow Transportation, Inc., North Reading	MAR05C566			Stormwater	Ipswich River (MA92-06)
Zeneca Resins (and/or Polyvinyl Chemical Industries, Wilmington)	MAG250902	Facility installed a closed loop system. EPA determined no permit is required for this facility in March/April 1999.			Maple Meadow Brook (MA92-04)

CCW = contact cooling water, NCCW = non-contact cooling water

Table H3. Ipswich River Watershed NPDES Phase II Stormwater Communities. All permits expire 1 May 2008.

TOWN	NPDES PERMIT NO.	PERMIT ISSUED	MAPPED REGULATED AREA IN COMMUNITY
Andover	MAR041178	09/24/03	Total
Beverly	MAR041181	09/29/03	Total
Billerica	MAR041182	02/24/04	Partial
Boxford	MAR041184	12/04/03	Partial
Burlington	MAR041030	09/18/03	Total
Danvers	MAR041188	09/26/03	Total
Essex	MAR041239	12/05/03	Partial
Georgetown	MAR041191	09/26/03	Partial
Hamilton	MAR041196	02/24/04	Partial
Ipswich	MAR041199	09/18/03	Partial
Lynnfield	MAR041045	09/25/03	Total
Middleton	MAR041211	10/09/03	Partial
North Andover	MAR041214	10/07/03	Partial
North Reading	MAR041215	08/18/03	Partial
Peabody	MAR041216	10/31/03	Total
Reading	MAR041056	08/26/03	Total
Rowley	MAR041218	08/22/03	Partial
Tewksbury	MAR041226	09/12/03	Total
Topsfield	MAR041227	01/20/04	Partial
Wenham	MAR041230	08/28/03	Partial
Wilmington	MAR041234	12/05/03	Total
Woburn	MAR041073	09/26/03	Total

Table H4: Ipswich River Watershed WMA User Data. (Note that the 20 year permitted volumes are in effect at least until the modified permit appeals are resolved.)

Permit	Registration	PWSID	System Name	Registered Volume (MGD)	20 Year Permitted Volume (MGD)	Modified (May 2003) 20 Year Permitted Volume (MGD)	Source (G = ground S = surface)	Well/Source Name	Withdrawal Location (Segment)
9P31707101	31707101	3071000	Danvers Water Department	3.14	0.81	0.58 (permit under appeal)	3071000-01S	Middleton Pond	Middleton (MA92039 and MA92-12)
							3071000-02S	Swan Pond	North Reading (MA92066 and MA92-12)
							3071000-03S	Emerson Brook Reservoir	Middleton (MA92021 and MA92-06)
							3071000-02G	Well #2	Danvers (MA92-06)
							3071000-01G	Well #1	Middleton (MA92-06)
9P31711901	31711901	3119000	Hamilton Water Department	0.92	0.24	0.11 (permit under appeal)	3119000-02G	School Street Well	Hamilton (MA92-03)
							3119000-03G	Patton Well	Hamilton (MA92-15)
							3119000-04G	Caisson Well	Hamilton (MA92-24)
							3119000-05G	Idlewood Well #1	Hamilton (MA92-24)
							3119000-06G	Idlewood Well #2	Hamilton (MA92-24)
							not assigned	Idlewood Well #3	Hamilton (MA92-24)
	31711902		Myopia Hunt Club	0.17	Not Applicable	Not Applicable		Miles River	Hamilton (MA92-03)
	31714401		Corliss Brothers, Inc.	0.22	Not Applicable	Not Applicable		Corliss Pond	Ipswich (MA92-15)
	31714402	3144000	Ipswich Water Department	0.2	Not Applicable	Not Applicable	3144000-03G	Winthrop Well #1	Ipswich (MA92-15)
							3144000-04G	Winthrop Well #2	Ipswich (MA92-03)
							3144000-05G	Winthrop Well #3	Ipswich (MA92-03)
							3144000-06G	Essex Road Well	Ipswich (MA92-15)
							3144000-07G	Fellows Road Well	Ipswich (MA92-15)
9P31716301	31716301	3163000	Lynn Water & Sewer Commission	5.31	1.28	0.33 (permit under appeal)	3163000-05S	Ipswich River	Lynnfield (MA92-06)
9P31716401	31716401	3164000	Lynnfield Center Water District	0.29	0	0 (permit under appeal)	3164000-05G to 3164000-08G	Glen Drive Wellfield	Lynnfield (MA92-10)
							3164000-02G	Station #2	

Table H4 (cont'd): Ipswich River Watershed User Data. (Note that the 20 year permitted volumes are in effect at least until the modified permit appeals are resolved.)

Permit	Registration	PWSID	System Name	Registered Volume (MGD)	20 Year Permitted Volume (MGD)	Modified (May 2003) 20 Year Permitted Volume (MGD)	Source (G = ground S = surface)	Well/Source Name	Withdrawal Location (segment)
	31716402		Sagamore Spring Golf Club, Inc.	0.12	Not Applicable	Not Applicable	3164003-01G 3164003-02G 3164003-03G S S	Well #1 Well #2 Well #3 Sagamore Spring #1 Sagamore Spring #2	Lynnfield (MA92-10)
	31718402		Bostik Division-Emhart Corporation	0.79	Not Applicable	Not Applicable		GW 1 GW 2 GW 3 GW 4 SW 1 SW 2 SW 3	Middleton (MA92-06)
	31721001		The Flatley Co. - Ferncroft C. C.	0.12	Not Applicable	Not Applicable		SW 1	Middleton (MA92-25)
9P31721301	31721301	3213000	North Reading Water Department	0.96	0.25	0.15 (permit under appeal)	3213000-04G 3213000-01G 3213000-07G 3213000-03G 3213000-05G 3213000-02G	Central Street Wellfield Railroad bed Wells Lakeside #4 Lakeside Boulevard #3 Route 125 Well Lakeside Boulevard #2	North Reading (MA92-08)
9P231721301	31721303		Thomson Club Inc.	0.15	0	0	S S G	inlet pond off Ipswich R. Mid- Iron Drive Pond Sutliff Well	North Reading (MA92-06)
9P31722901	31722901	3229000	Peabody Dept. of Public Services	3.89	0.82	0.58 (permit under appeal)	3229000-02S 3229000-04S 3229000-01G 3229000-02G 3229000-03S	Suntaug Lake Winona Pond Pine Street Well Johnson Street Well Ipswich River Pumping Station	Peabody (MA92065 and MA92-11) Peabody (MA92077 and MA92-11) Peabody (MA92-11) Peabody (MA92-06)

Table H4 (cont'd): Ipswich River Watershed User Data. (Note that the 20 year permitted volumes are in effect at least until the modified permit appeals are resolved.)

Permit	Registration	PWSID	System Name	Registered Volume (MGD)	20 Year Permitted Volume (MGD)	Modified (May 2003) 20 Year Permitted Volume (MGD)	Source (G = ground S = surface)	Well/Source Name	Withdrawal Location (segment)
	31724601	3246000	Reading DPW	2.57	Not Applicable	Not Applicable	3246000-09G	Gravel Well #66-8	Reading (MA92-06)
							3246000-10G	Gravel Well #13	
							3246000-04G	Gravel Well #2	
							3246000-05G	Gravel Well #3	
							3246000-03G	Gravel Well Revay	
							3246000-07G	Gravel Well Town Forest	
							3246000-06G	Gravel Well B-Line	
	31724602		Meadow Brook Golf Club	0.16	Not Applicable	Not Applicable	G	Grove Street Well	Reading (MA92-06)
							S	Meadow Brook Pond	
9P31725801	31725801	3030001	Salem & Beverly Water Supply Board	10.17	2.27	1.14 (permit under appeal)	3030001-03S	Putnamville Reservoir	Danvers (MA92052 and MA92-15)
							3030001-04S	Canal Pump Station-Ipswich River	Topsfield (MA92-15)
							3030001-01S	Wenham Lake	Beverly (MA92073 and MA92-03)
							3030001-02S	Longham Reservoir	Wenham (MA92030 and MA92-03)
9P31729801	31729801	3298000	Topsfield Water Department	0.43	0.26	0.17 (permit under appeal)	3298000-01G	North St. Pumping Sta.	Topsfield (MA92-17)
							3298000-02G	Perkins Row Pumping Sta.	Topsfield (MA92-16)
9P231732001	31732001	3320000	Wenham Water Department	0.29	0.11	0.10	3320000-01G	Pleasant St. Well #1	Wenham (MA92-24)
							3320000-02G	Pleasant St. Well #2	
9P31734201	31734201	3342000	Wilmington Water Department	2.91	0.8	0.45 (permit under appeal)	3342000-01G	Browns Crossing GP	Wilmington (MA92-08)
							3342000-02G	Barrows Wellfield	Wilmington (MA92-08)
							3342000-03G	Chestnut St. #1	Wilmington (MA92-04)
							3342000-04G	Town Park Well	Wilmington (MA92-04)
							3342000-05G	Shawsheen Ave Well	Wilmington (MA92-05)
							3342000-07G	Butter's Row #1	Wilmington (MA92-04)
							3342000-08G	Salem Street Well	Wilmington (MA92-08)
							3342000-09G	Butter's Row #2	Wilmington (MA92-04)
							3342000-10G	Chestnut St. #1A	Wilmington (MA92-04)

APPENDIX I – MA DEP GRANT AND LOAN PROGRAM PROJECTS IN THE IPSWICH RIVER WATERSHED

Excerpted from the DEP/DWM World Wide Web sites, http://www.mass.gov/dep/brp/mf/othergrt.htm http://www.mass.gov/dep/brp/wm/projsums.htm

104(b)(3) WETLANDS AND WATER QUALITY GRANT PROGRAM

This Grant Program is authorized under Wetlands and Clean Water Act Section 104(b)(3) of the federal Clean Water Act. The Water Quality proposals received by DEP under this National Environmental Performance Partnership Agreement (NEPPA) with the U.S. Environmental Protection Agency is a results oriented approach that will focus attention on environmental protection goals and the efforts to achieve them. The goals of the NEPPA are to: 1) achieve clean air, 2) achieve clean water, 3) protect wetlands, 4) reduce waste generation, and 5) clean up waste sites.

97-01/104 *Stormwater and Nonpoint Source Impacts to Wetlands: Transferring a New Assessment Methodology* This project will apply a recently developed Wetland Ecological Assessment method to selected wetland study sites in North Coastal and Ipswich basins by training targeted groups, identifying wetlands adversely impacted by stormwater, and initiating wetland restoration and stormwater mitigation efforts. The methodology will be used by watershed teams and CZM to evaluate Wetland Ecological Integrity.

97-07/104 *Hydrologic Model for the Ipswich River Basin* As a collaborative effort among DEM, DEP, USGS, this project will develop a water management (hydrologic) model to provide a scientific basis for water supply, water quality and aquatic habitat decisions in the Ipswich Basin. A methodology will be developed to couple groundwater and surface water flow. This integrated approach will allow the simulation of predevelopment conditions, current withdrawal conditions, and the prediction of future conditions such as changes in groundwater withdrawals or precipitation.

Assessment of Habitat, Fish Communities, and Streamflow Requirements for Habitat Protection, Ipswich River, Massachusetts, 1998–99 Water-Resources Investigations Report 01-4161 U.S. Department of the Interior, United States Geological Survey, Northborough, MA. Armstrong, D.S., Richards, T.A., and G.W. Parker. 2001 The relations among stream habitat, fish communities, and hydrologic conditions were investigated in the Ipswich River Basin in northeastern Massachusetts. Data were assessed from 27 sites on the mainstem of the Ipswich River from July to September 1998 and from 10 sites on 5 major tributaries in July and August 1999. Habitat assessments made in 1998 determined that in a year with sustained streamflow for most of the summer, the Ipswich River contains diverse, high-quality aquatic habitat. The mainstem and tributaries were sampled to determine fish species composition, relative abundance, and length frequency. Fish sampling indicates that the fish community in the Ipswich River is currently a warm-water fish community dominated by pond-type fish. However, historical temperature data, and survival of stocked trout in the mainstem Ipswich into late summer of 1998, indicate that the Ipswich River potentially could support cold-water fish species if adequate flows are maintained. In comparison to a nearby river (Lamprey River, N.H.), and a reference fish community developed for inland New England streams, the Ipswich fish community would be expected to have appreciably higher percentages of fluvial-dependent and fluvial-specialist species were streamflows restored.

Simulation of Reservoir Storage and Firm yields of Three Surface-Water Supplies, Ipswich river basin, Massachusetts USGS. Phillip J. Zarriello. 2002. A Hydrologic Simulation Program FORTAN (HSPF) model previously developed for the Ipswich River Basin was modified to simulate the hydrologic response and firm yields of the water-supply systems of Lynn, Peabody and Salem-Beverly. The purpose of this study was to evaluate the impact on the water-supply system of limiting surface water withdrawals so as to maintain water in the Ipswich River during the summer months when the river often dries up. The model indicated that even under current withdrawal rates the Peabody system failed whereas the Lynn and Salem-Beverly systems were able to meet demands. Under increased withdrawal limitations recommended by the Ipswich River Fisheries Restoration Task Groups, however, all three water supply systems failed.

A Precipitation-Runoff model for Analysis of the Effects of Water Withdrawals on Stream flow, Ipswich River Basin, Massachusetts. USGS. Philip J. Zarriello and Kernell F. Ries III. 2000. It has become commonplace for certain sections of the Ipswich River to become dry or nearly dry during the summer months. Water withdrawals from the River Basin affect aquatic habitat, water quality and recreational use of the river. The purpose of this study was to use the Hydrological Simulation Program – FORTRAN (HSPF) to model the effect of water withdrawals on stream flow. The study used six scenarios that tested different water – withdrawal operation and land use patterns: Three scenarios were simulated for the 1989-93 calibration period and three were simulated for the 1961-95 period to examine the effects of withdrawals and land use change over a wider range of climatic conditions. This study indicated that surface-water withdrawals have little effect on the duration and frequency of low flows, but the cumulative ground-water withdrawals substantially decrease low flows.

99-07/104 *Identifying Sources of Microbiological Contamination of Freshwater Beaches.* This project would field test a cooperative approach involving DEP, local officials, and local basin watershed associations to identify sources of bacterial contamination at freshwater beaches by sampling dry and wet weather discharges from stormwater outfalls. It will also involve using techniques such as comparing gutter sampling results versus outfall results to evaluate the contribution of microbiological contamination from illicit sewage connections versus contamination from street runoff.

319 NONPOINT SOURCE GRANT PROGRAM

This grant program is authorized under Section 319 of the CWA for implementation projects that address the prevention, control, and abatement of nonpoint source (NPS) pollution. In order to be considered eligible for funding projects must: implement measures that address the prevention, control, and abatement of NPS pollution; target the major source(s) of nonpoint source pollution within a watershed/subwatershed; have a 40 percent non-federal match of the total project cost (match funds must meet the same eligibility criteria as the federal funds); contain an appropriate method for evaluating the project results; address activities that are identified in the Massachusetts NPS Management Program Plan.

01-17/319 *North Green Stormwater Management Project.* Two studies prepared for the Town of Ipswich conclude that Urban Runoff is the largest contributing factor to stormwater pollution in the Ipswich River. The goal of this project is to treat stormwater from the North Green area, which is adjacent to the river, before it enters the river. This will be accomplished by constructing a closed drainage system in the area, consisting of deep sump catch basins, catch basins with outlet hoods, and Stormceptor/Vortechs units. It is anticipated that 80% of TSS will be removed from the stormwater prior to discharge into the river.

SOURCE WATER AND TECHNICAL ASSISTANCE/LAND MANAGEMENT GRANT PROGRAM

The Source Water Protection Technical Assistance/Land Management Grant Program provides funds to *third party* technical assistance organizations that assist public water suppliers in protecting local and regional ground and surface drinking water supplies.

00-12/SWT *Danvers/Middleton Source Water Protection Project.* This project will review known and potential drinking water supply threats and protection measures and recommend improvements for protection of the drinking water sources for the Towns of Danvers and Middleton; map stormwater infrastructure, non-point source threats to water quality, and update open space datalayers; identify outfalls and stormwater BMPs to facilitate improved stormwater management; review emergency response readiness; develop improved protocol for protection of water sources from stormwater contamination and spills of hazardous materials.

01-11/SWT *Ipswich Source Water Protection Project.* This project will develop a comprehensive Surface Water Supply Protection Plan for the Town of Ipswich's Dow and Bull Brook reservoirs. A comprehensive SWSPP will significantly enhance the protection of the Town's water supply by identifying the potential sources and pathways of contamination, and providing actions and a time-line to address them.

02-07/WHP *North Reading Wellhead Protection Project* This project will develop a comprehensive Wellhead Protection Plan including an Emergency Response Plan for the Town of North Reading. The project will inventory and create a GIS map of the sotrm water drainage systems and other potential contaminating land uses located within the Zone IIs.

APPENDIX J - DMF SHELLFISH DATA, IPSWICH RIVER WATERSHED

It is the mission of the Massachusetts Division of Marine Fisheries (DMF) to manage, develop, and protect the Commonwealth's renewable living marine resources to provide the greatest public benefit. DMF fosters protection of the marine environment by cooperating with other state and federal agencies on pollution abatement, coastal wetlands protection and other programs concerning coastal waters and marine life. DMF monitors coastal contaminant levels in fish and shellfish, operates a shellfish depuration facility, and evaluates the impacts of coastal development on marine fish and their habitats. DMF provides assistance to local shellfish officers on matters affecting the management of shellfish, and provides expertise on anadromous fish and construction assistance on fishways. Other DMF programs assist commercial and recreational fishermen and educate the public on marine resource issues and values.

The DMF Shellfish Management Program manages shellfish growing areas in compliance with the National Shellfish Sanitation Program (NSSP). The NSSP is a federal and state cooperative program recognized by the U.S. Food and Drug Administration and the Interstate Shellfish Sanitation Conference. One goal of this program is the sanitary control of shellfish harvested and sold for human consumption. Growing areas are managed with respect to shellfish harvesting 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 (six different classification types in all) with respect to shellfish harvesting (Table J1).

Table J1. DMF Shellfish Management Program Managed Shellfish Growing Area Classifications.

Classification Type	**Definition**
Approved	Open for harvest of shellfish for direct human consumption.
Conditionally Approved	During the time the area is approved, it is open for harvest of shellfish for direct human consumption subject to local rules and state regulations.
Conditionally Restricted	During the time the area is restricted, it is only open for the harvest of shellfish with depuration subject to local rules and state regulations.
Restricted	Open for harvest of shellfish with depuration subject to local rules and state regulations for the relay of shellfish.
Management Closure	Closed for the harvest of shellfish. Not enough testing has been done in the area to determine whether it is fit for shellfish harvest or not.
Prohibited	Closed for the harvest of shellfish.

Classification area codes and town names identify each DMF shellfish harvesting area (Table J2). The assessed region of a given shellfish harvesting area is defined in square miles within the MA DEP/DWM assessment segment. As of 2001 DMF classified a total of 387.427 acres in the Ipswich Watershed (Tables J2 and J3).

Table J2. DMF Shellfish Project Classification Area Information (DFWELE 2000 and Roach 2003).

Town	Classification Area Code	Classification Type	Area (acres)
Ipswich	N5.0	Conditionally Approved	214.061
Ipswich	N5.1	Prohibited	50.977
Ipswich	N5.2	Conditionally Approved	4.497
Ipswich	N5.3	Conditionally Approved	12.819
Ipswich	N5.4	Prohibited	29.610
Ipswich	N5.5	Prohibited	22.401
Ipswich	N5.6	Conditionally Approved	25.126
Ipswich	N5.7	Prohibited	27.937

Table J3. Summary of DMF Shellfish Project Classification Area Information (DFWELE 2000 and Roach 2003).

Classification Type	Area (Acres)
Approved	0
Conditionally Approved	256.503
Restricted	0
Conditionally Restricted	0
Prohibited	130.925
Management Closure	0
Total	**387.428**

REFERENCES

DFWELE. 2000. *Designated Shellfish Growing Areas Datalayer – July 2000.* Published by MassGIS (MA Office of Geographic and Environmental Information), Executive Office of Environmental Affairs, Department of Fisheries, Wildlife, and Environmental Law Enforcement, Division of Marine Fisheries. Boston, MA.

Roach, D. 2003. (David.Roach@state.ma.us). *Ipswich Questions.* MA Department of Fish and Game, Division of Marine Fisheries. Communication with Department of Environmental Protection. MA. E-mail to Laurie Kennedy, MA DEP dated 9 October 2003.