

DRAFT *Technical Memorandum*
Northeast Region Bacteria Source Tracking
2007 Results

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EXECUTIVE SUMMARY

The year 2007 marks the first year since the Bacteria Source Tracking (BST) program has been established at MassDEP's Northeast Regional Office (NERO). The goal of the program is to improve the water quality of pathogen impaired water bodies by locating sources of bacteria pollution and recommending appropriate remediation actions. A new laboratory was built in the NERO office space, facilitating in-house bacteria concentration quantification and use of several supplementary analytical techniques.

Over 215 samples were collected between May and November 2007 and analyzed for *E. coli* (freshwater conditions) or *Enterococcus* spp. (brackish/saline) concentrations. Samples were collected in twenty-five NERO municipalities in 8 different watersheds, ranging from small stream segments to specific storm drain outfall pipes. Based on the sampling data collected, a number of "hot spots" were identified, which warranted further MassDEP actions.

Of particular note among hot spots identified in 2007:

- Samples containing *E. coli* concentrations as high as approximately 20,000 Most Probable Numbers (MPN) per 100 milliliters (mL) were collected from four storm drain outfalls and a tributary discharging to Mill Brook in Arlington.
- Samples containing *E. coli* concentrations as high as approximately 24,000 MPN/100mL were collected from four instream sampling locations and one storm drain outfall in Wellington Brook and Winn's Brook in Belmont.
- Samples containing *E. coli* concentrations as high as approximately 241,000 MPN/100mL were collected from four Boston Water and Sewer Commission storm drain outfalls discharging to the Neponset River. Strong sewage odors and solids were observed at the outfalls.
- Samples containing *Enterococcus* spp. concentrations as high as approximately 27,000 MPN/100mL were collected from an unnamed stream flowing out to Stramski Beach in Marblehead.
- Samples containing *Enterococcus* spp. concentrations as high as approximately 10,000 MPN/100mL were collected from a storm drain outfall discharging near Derby Wharf in Salem.
- Samples containing *E. coli* concentrations as high as approximately 1,900 MPN/100mL were collected from a small tributary discharging to the Shawsheen River in Lawrence. A strong sewage odor was apparent and what appeared to be sewage fungus was observed in the benthos of the stream.

MassDEP utilized a range of response and enforcement actions, based on the severity of the violations, the identification of specific (pipe) sources, and the sensitivity of the water resource affected. Actions include six Notices of Noncompliance ("NON"), two "Section 303" requests

for information, and a letter to a municipality describing NERO sampling results. Each NON and Section 303 request included requirements for the municipality to provide maps of the storm drain and sewer systems, and a detailed plan to identify and eliminate any illegal wastewater connections to the storm drain system. Based on past experience, it is anticipated that it will take some time before municipal efforts to locate wastewater sources in the storm drain system are completed. NERO BST staff will continue to track progress of such efforts and conduct follow-up sampling when appropriate.

DISCLAIMER

References to trade names, commercial products, manufacturers, or distributors in this report constitute neither endorsement nor recommendations by MassDEP for use.

ACKNOWLEDGEMENTS

Data and information used during the 2007 field season of NERO's Bacteria Source Tracking program were provided in part by the following agencies and organizations:

State

- Massachusetts Department of Environmental Protection (MassDEP):
 - Division of Watershed Management (DWM)
 - Bureau of Resource Protection
 - Wall Experiment Station
- Massachusetts Department of Public Health (MDPH)

Federal

- United States Environmental Protection Agency (EPA)

Regional

- Charles River Watershed Association (CRWA)
- Hop Brook Protection Association (HBPA)
- Ipswich River Watershed Association (IRWA)
- Mystic River Watershed Association (MyRWA)
- Neponset River Watershed Association (NepRWA)
- Salem Sound Coastwatch (SSCW)
- Shawsheen River Watershed Association (SRWA)

The field investigation, sampling, and analyses for the 2007 BST program were carried out by Nihar Mohanty and Jenny Birnbaum, with essential support provided by staff from the NERO Wastewater Management Staff. Many thanks also go to the DWM staff who helped get the program up and running.

1.0 INTRODUCTION

A large number of Massachusetts waters appear on the State's 303(d) list of impaired water bodies due to violations of the water quality standards for bacteria (pathogens). Previous monitoring plans developed by the Division of Watershed Management (DWM) to evaluate surface water quality conditions in Massachusetts addressed a number of parameters, and were not designed to identify specific locations of sources of bacterial contamination or to implement remediation actions. To begin to rectify this situation, a Bacteria Source Tracking (BST) program has been initiated in the MassDEP northeast region ("NERO"), hereafter known as the "NERO BST program".

This year (2007) marks the first year of the NERO BST program. The overall goal of this program is to improve the water quality of rivers and streams in the northeast region that are impaired due to bacterial contamination. Steps towards achieving this goal were made by locating sources of bacteria contamination within targeted sub-watersheds and recommending appropriate action to initiate remediation. A secondary goal of this program was to focus on sensitive use areas, such as public swimming beaches. Where possible, effort was made to coordinate with DWM assessment work in NERO basins. In 2007, these basins were the Charles and North Coastal.

The main objectives of the NERO BST program in 2007 were as follows:

1. Identify watersheds in the northeast region with documented water quality impairment due to elevated bacteria;
2. Prioritize watersheds on which to perform source tracking;
3. Conduct screening level sampling for *E. coli* (freshwater) and Enterococci (brackish/saline water) in "targeted" watersheds, during dry weather conditions;
4. Review data from screening level (core) sites and the information collected during extensive watershed characterization. Refine sampling plan and implement iterative source tracking sampling using various techniques such as Colilert® (*E. coli*), Enterolert™ (*Enterococcus* spp.), optical brighteners, detergents, human marker analysis, and further field observation;
5. Identify sources of bacteria to MassDEP jurisdictional level;
6. Notify appropriate authorities of the suspected source(s);
7. Recommend appropriate action (e.g. further source tracking work, immediate clean up, municipal or MassDEP enforcement) to initiate remediation and coordinate with local authorities as needed;

One "targeted" sub-watershed from each basin in the northeast region was initially selected to undergo screening level sampling. These basins were: Boston Harbor (Neponset and Mystic), Charles, Shawsheen, SuAsCo, North Coastal, Merrimack, Ipswich, and Parker (see Figure 1). The Merrimack Basin was not sampled, but additional sub-basins in some of the other basins were sampled. This report summarizes results of sampling conducted May through November 2007.

Figure 1. 2007 Targeted Bacteria Source Tracking Basins



2.0 METHODS

Bacteria source tracking requires a well-defined set of protocols to direct activities, due to the high variability of bacteria concentrations in rivers and streams and the potential for the misinterpretation of results due to multiple bacteria sources. The recommended bacteria source tracking protocols used for the NERO BST program in 2007 are encompassed into a sampling process design which includes: 1) Identification, characterization and prioritization of contaminated watersheds, 2) screening level sampling and 3) source tracking monitoring. This design is fully described in *Bacteria Source Tracking in the Northeast Region, Sampling Analysis Plan 2007* (MassDEP 2007a). The foundations of this design are based on the DWM Bacteria Source Tracking “Toolbox” and lessons learned during the 2004 Bacteria Source Tracking Pilot Study (MassDEP 2005a and MassDEP 2004).

The fundamental methodology used to track bacteria sources involved the initial collection of water samples from selected river/stream sites and other sources (such as stormwater outfall pipes) using procedures described in *CN 1.21 - Sampling Collection Techniques for DWM Surface Water Quality Monitoring* (MassDEP 2005b) or *CN 1.5 – Stormwater Monitoring* (MassDEP 2005c).

These water samples were then analyzed in the NERO BST lab for total coliform and *Escherichia coli* (*E. coli*), or *Enterococcus* spp. using procedures described in *CN 198.0 - Analytical Quantification of Escherichia coli and Enterococci Bacteria in Ambient Surface Waters Using an Enzyme Substrate Test (Standard Methods 9223B)* (MassDEP 2006 as modified by NERO staff). These enzyme substrate tests, known as Colilert® and Enterolert™, can produce results in 18 or 24 hours. The rapid generation of results allowed for a quick focus or redirection of tracking activities.

A secondary method used to track bacteria sources involves the use of optical brightener pads. These pads were constructed and deployed using procedures described in *CN 58.0 – DWM Sampling Protocol for Optical Brightener Testing* (MassDEP 2005d). Optical brightener pads were used at select stream sites to determine if laundry detergents (an indicator of human waste) were present in the water. In addition, William X. Wall Experiment Station (WES) in Lawrence conducted Human Marker analyses (i.e., DNA by polymerase chain reaction techniques, caffeine, and fluorescent whitening agents) on a limited number of samples. Data on 2007 Human Marker results may be found in Appendix A.

Additional information regarding field and laboratory methods, method and reporting detection limits, data quality objectives, and data validation can be found in *Quality Assurance Program Plan, Surface Water Monitoring & Assessment, 2005-2009* (MassDEP 2005a).

3.0 Site Descriptions, Results, and Significant Findings

In order to make this report as user friendly as possible, sites have been grouped into sub-watersheds or relevant areas and organized by sub-basin. In all tables, multiple sites in a water body are generally arranged downstream (DS) to upstream (US). Sub-watershed descriptions, including a map depicting site locations, are followed by results, significant findings, and follow-up actions for each sub-watershed or relevant area. Data on antecedent rainfall may be found in Appendix B. The precipitation conditions for five days prior to sampling were determined by reviewing the National Oceanographic and Atmospheric Administration's (NOAA) data from their website (NOAA 2007). In rare instances, USGS gage stations where precipitation data were available were also consulted (USGS 2007). Sampling dates were considered wet weather if they did not meet dry weather conditions (dates that follow a minimum of 3 days with less than 0.1 inches of rain) and are shaded in tables in the body of the report and in Appendix B. Detailed site descriptions, including geographical coordinates, may be found in Appendix C.

3.1 BOSTON HARBOR - MYSTIC

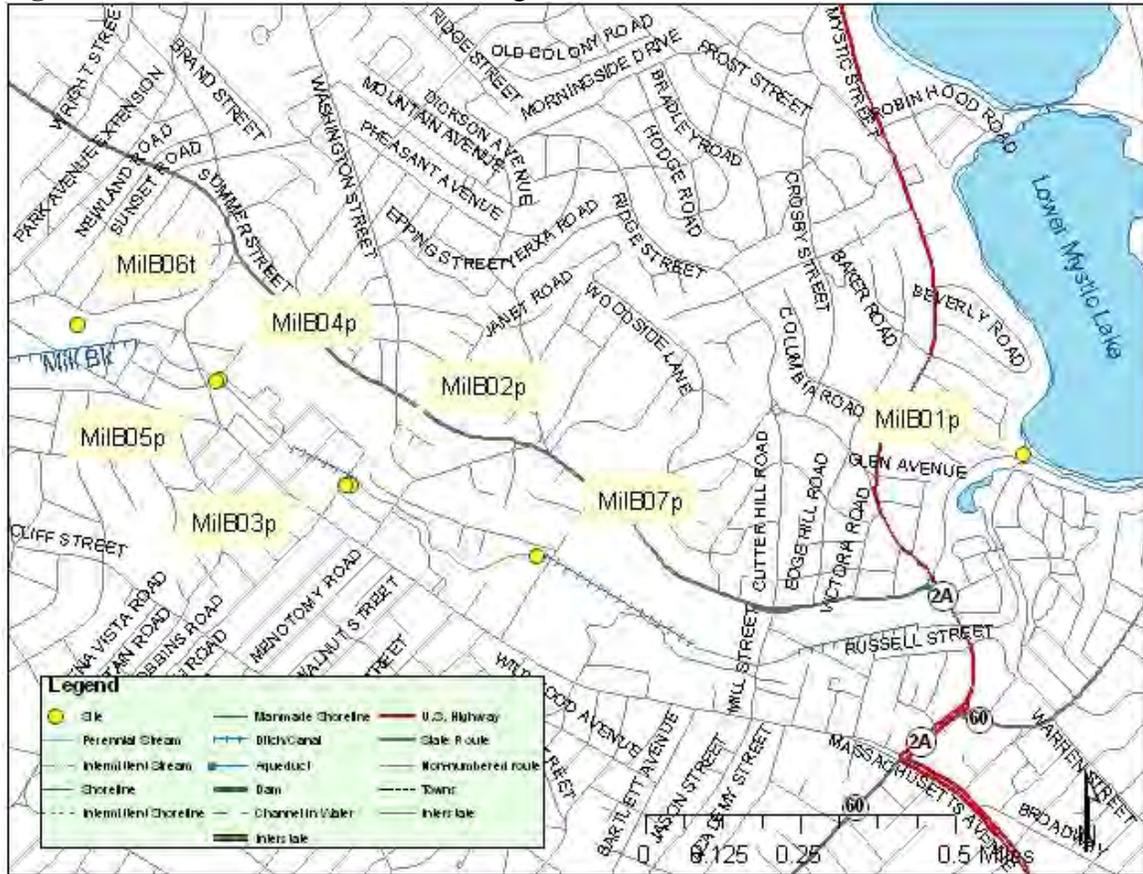
Mill Brook (Arlington)

Sampling locations were chosen based on historical data from the Mystic River Watershed Association.

Sub-watershed Description

- Mill Brook's source is in Lexington's Great Meadow, and from there it flows largely through Arlington into Lower Mystic Lake, from which the Mystic River flows.
- The Mill Brook sub-watershed is 5.5 square miles in area.
- Landuse in the Mill Brook sub-watershed is characterized as follows: Residential 65%, Forest 12%, Commercial 7%, Open Space 7%, Other 6%, Wetland 3%
- The sub-watershed is urban, with mixed residential and commercial use. The brook is culverted underground at multiple locations. The MilB06t site is on a tributary that runs along the North side of the Minuteman Commuter Bikeway, which is used for recreational purposes, including dog walking.
- Mill Brook is listed as impaired for pathogens on the 2006 303(d) list.
- Arlington is a NPDES Phase II community, with 100% of the population connected to the sewer system.

Figure 2. 2007 Bacteria Source Tracking Sites in the Mill Brook Sub-watershed



Results

Table 1. *E. coli* (EC) Concentrations (MPN/100mL) in the Mill Brook Sub-watershed

Site ID	Type	Water Body	Town	5/14/2007 (EC)	5/24/2007 (EC)	6/27/07 (EC)
MilB01p	pipe	Mill Brook	Arlington	1,723	2,282	1,607
MilB07p	pipe	Mill Brook	Arlington	ns	1,119	988
MilB02p	pipe	Mill Brook	Arlington	<10	<1	<1
MilB03p	pipe	Mill Brook	Arlington	84	108	697
MilB04p	pipe	Mill Brook	Arlington	6,131	63	19,863
MilB05p	pipe	Mill Brook	Arlington	10	10	20
MilB06t	tributary	unnamed brook	Arlington	798	1,354	4,352

ns = not sampled

Significant Findings

- Sampling in the Mill Brook sub-watershed revealed five sites (four of these were stormwater outfall pipes) with elevated bacteria levels in dry weather.
- Although MassDEP samples collected at a sixth site, MilB05p, had low bacteria levels, data from the Mystic River Watershed Association (MyRWA) indicates there may be intermittent elevated counts.
- **Actions to be taken:** 1) Review and comment on plans submitted by the Town of Arlington to investigate elevated bacteria levels and meet with Town officials as appropriate, 2) Communicate results to MyRWA and request monitoring of MilB05p, or if resources permit, include MilB05p in a NERO BST follow-up sampling plan for summer, 2008 conducted preferably in the peak summer months.

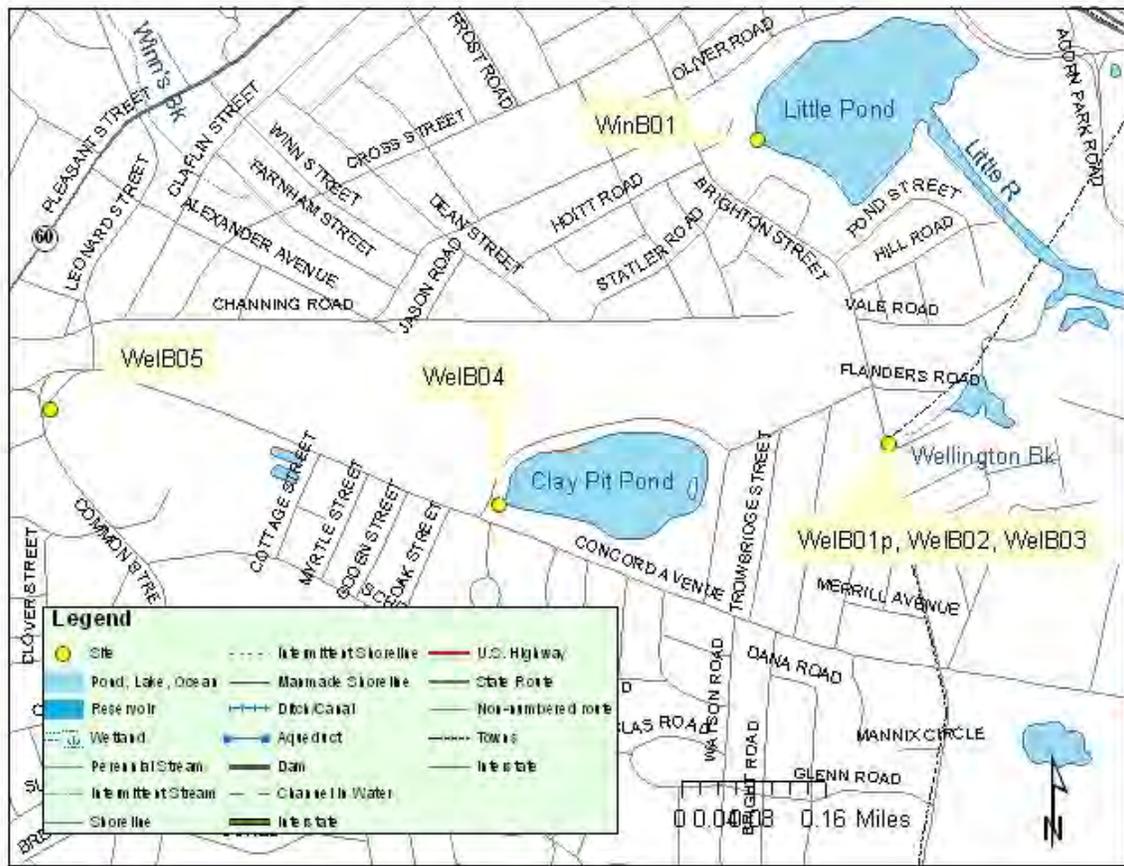
Winn's Brook and Wellington Brook (Belmont)

Sampling locations were chosen based on historical data from the Mystic River Watershed Association.

Sub-watershed Description

- Winn's Brook and Wellington Brook flow through a series of ponds and into the Little River, which becomes Alewife Brook. Alewife Brook is a tributary of the Mystic River.
- The combined Winn's Brook and Wellington Brook sub-watershed is 4.0 square miles in area.
- Landuse in the Winn's Brook and Wellington Brook sub-watershed is characterized as follows: Residential 67%, Other 11%, Commercial 8%, Forest 7%, Open Space 6%, Wetland 1%
- The sub-watershed is urban, with mixed residential and commercial use. Both brooks are culverted underground at multiple locations.
- The Alewife Brook watershed is listed as impaired for pathogens on the 2006 303(d) list.
- The Town of Belmont is a NPDES Phase II community, and is 100% sewerred.

Figure 3. 2007 Bacteria Source Tracking Sites in the Winn’s Brook and Wellington Brook Sub-watershed



Results

Table 2. *E. coli* (EC) Concentrations (MPN/100mL) in the Winn’s Brook and Wellington Brook Sub-watershed

Site ID	Type	Water Body	Town	5/14/2007 (EC)	5/24/2007 (EC)
WinB01	stream	Winn's Brook	Belmont	318	727
WelB01p	pipe	Wellington Brook	Belmont	>24,196	1,095
WelB02	stream	Wellington Brook	Belmont	5,172	1,376
WelB03	stream	Wellington Brook	Belmont	20	41
WelB04	stream	Wellington Brook	Belmont	4,884	6,131
WelB05	stream	Wellington Brook	Belmont	19,863	7,270

ns = not sampled

Significant Findings

- Sampling in the Winn's Brook and Wellington Brook sub-watersheds revealed five sites (one of these was a stormwater outfall pipe) with elevated bacteria levels in dry weather.
- WelB01p is a Cambridge outfall that carries a significant amount of contributing flow from Belmont pipes entering the Cambridge system (City of Cambridge 2007).
- **Actions to be taken:** 1) Review and comment on plans submitted by the Town of Belmont to investigate elevated bacteria levels and meet with Town officials as appropriate.

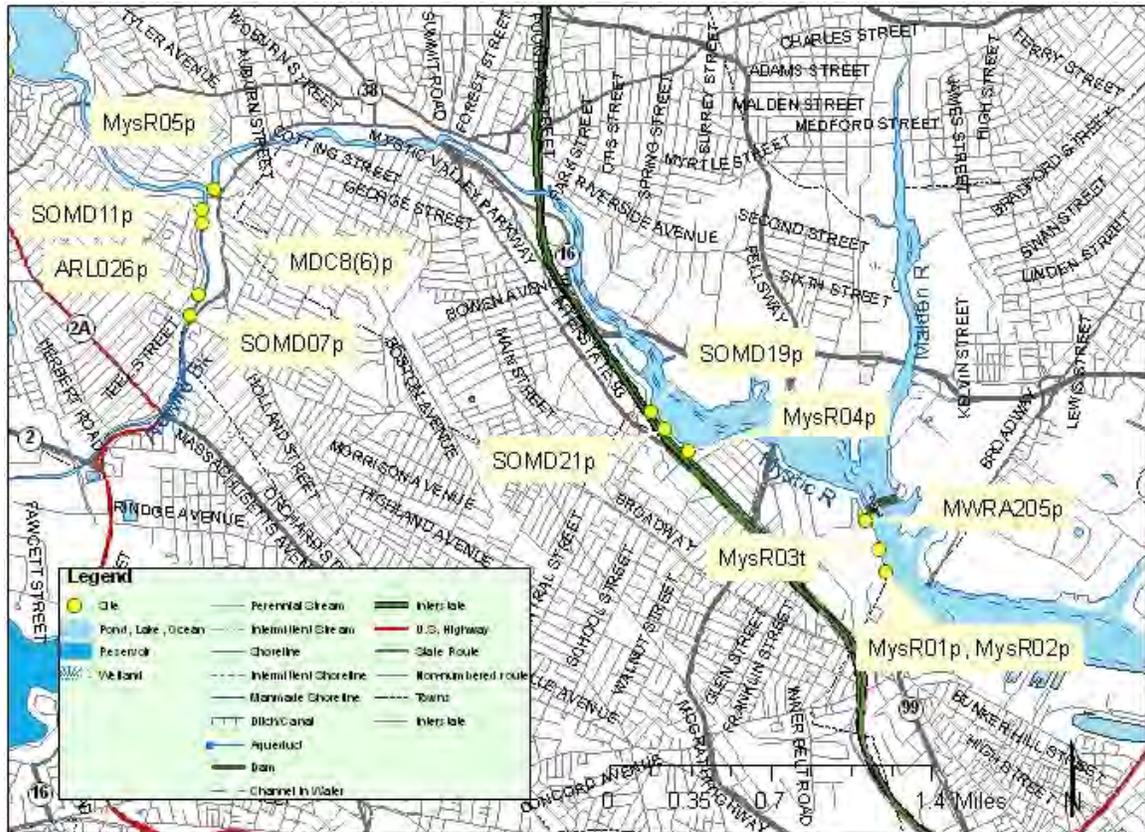
Mystic River and Alewife Brook pipes (Somerville/Arlington)

Some sites were chosen based on historical data from the Mystic River Watershed Association (MyRWA) and sampling was coordinated with a MyRWA volunteer.

Sub-watershed Description

- Alewife Brook is a tributary of the Mystic River.
- The Alewife Brook sub-watershed is 8.9 square miles in area and the Mystic River watershed (which includes Alewife Brook) upstream of MysR01p is 63 square miles.
- The study area is very urban, with mixed high density residential and commercial use. The Mystic River is dammed upstream of MWRA205p.
- The Alewife Brook and Mystic River watersheds are listed as impaired for pathogens on the 2006 303(d) list.
- The City of Somerville and the Town of Arlington are NPDES Phase II communities, and are 100% sewered.

Figure 4. 2007 Bacteria Source Tracking Sites in the Mystic River and Alewife Brook Sub-watershed



Results

Table 3. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in the Mystic River and Alewife Brook

Site ID	Type	Water Body	Town	10/31/2007 (ENT)
MysR01p	pipe	Mystic River	Somerville	<10
MysR02p	pipe	Mystic River	Somerville	10
MysR03t	stream/pipe	Mystic River	Somerville	<10
MWRA205p	pipe	Mystic River	Somerville	10
MysR04p	pipe	Mystic River	Somerville	122
SOMD21p	pipe	Mystic River	Somerville	<10
SOMD19p	pipe	Mystic River	Somerville	20
MysR05p	pipe	Mystic River	Somerville	<10
SOMD11p	pipe	Alewife Brook	Somerville	10
MDC8(6)p	pipe	Alewife Brook	Somerville	20
SOMD07p	pipe	Alewife Brook	Somerville	<10
ARL026p	pipe	Alewife Brook	Arlington	262

ns = not sampled

Significant Findings

- None of the samples collected at stormwater outfalls on the Mystic River and Alewife Brook yielded significantly elevated *Enterococcus* spp. concentrations.
- Toilet paper and a chlorine odor were observed at outfall MysR05p. A sample collected and analyzed for residual chlorine on January 7, 2008 had a chlorine concentration of 1.8 mg/L. The MWRA was contacted and staff identified a leak in a drinking water main in the area of the stormwater outfall. The leak was repaired. MyRWA was contacted and requested to continue sampling the outfall to determine bacteria concentration without chlorine in the system.
- **Actions to be taken:** 1) If resources permit, include locations in a NERO BST follow-up sampling plan for summer, 2008 and sample preferably in the peak summer months.

3.2 BOSTON HARBOR - NEPONSET

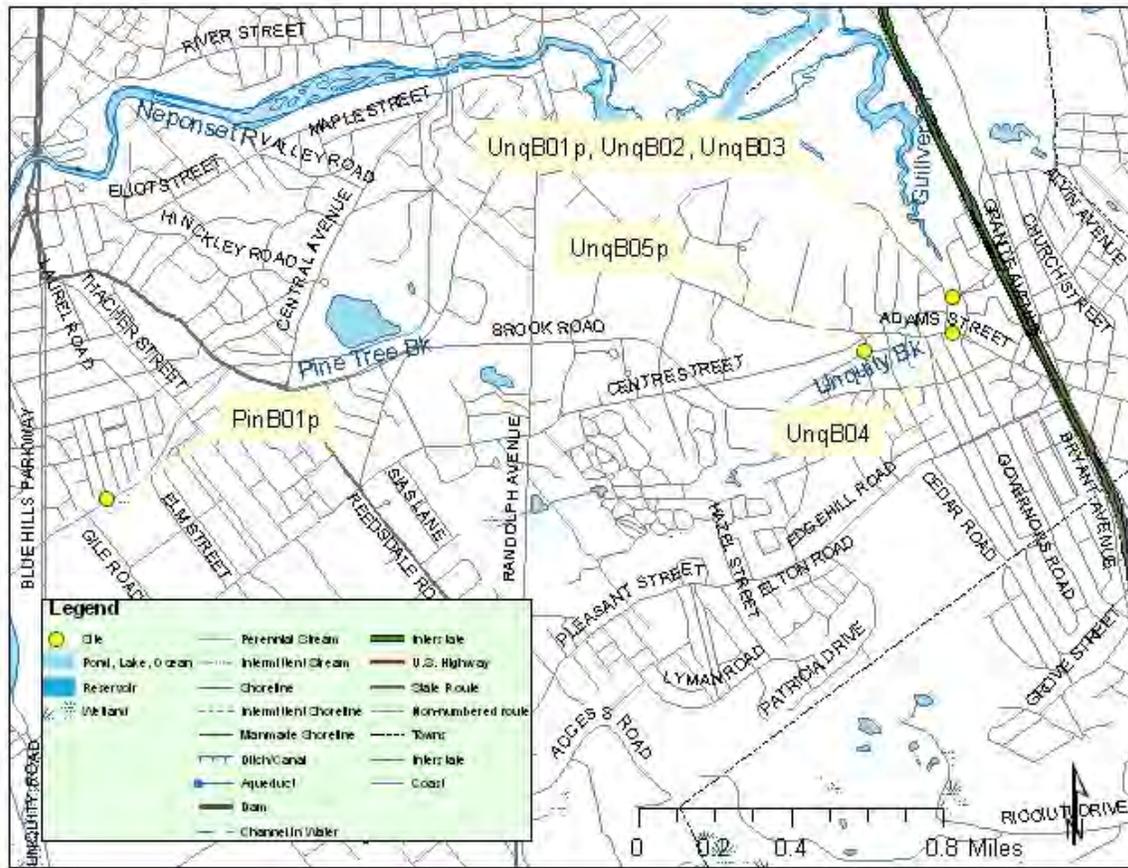
Unquity Brook and Pine Tree Brook (Milton)

Some sampling locations were chosen based on recommendations from the Neponset River Watershed Association.

Sub-watershed Description

- Pine Tree Brook is a tributary of the Neponset River, while Unquity Brook becomes Gulliver Creek, another tributary of the Neponset River.
- The Pine Tree Brook sub-watershed is 7.6 square miles in area and the Unquity Brook sub-watershed is 1.4 square miles.
- Landuse in the Pine Tree Brook sub-watershed is characterized as follows: Forest 46%, Residential 42%, Other 7%, Open Space 4%, Wetland 1%
- Landuse in the Unquity Brook sub-watershed is characterized as follows: Residential 68%, Open Space 16%, Forest 13%, Commercial 2%, Other 1%
- The section of the sub-watersheds near the study sites is generally residential. Unquity Brook is culverted underground at multiple locations.
- Pine Tree Brook and Unquity Brook are listed as impaired for pathogens on the 2006 303(d) list.
- The Town of Milton is a NPDES Phase II community, with 92% of the population on the sewer system and 8% on septic systems.

Figure 5. 2007 Bacteria Source Tracking Sites in the Unquity Brook and Pine Tree Brook Sub-watersheds



Results

Table 4. *E. coli* (EC) Concentrations (MPN/100mL) in the Unquity Brook and Pine Tree Brook Sub-watersheds

Site ID	Type	Water Body	Town	9/5/2007 (EC)
PinB01p	pipe	Pine Tree Brook	Milton	10
UnqB01p	pipe	Unquity Brook	Milton	74
UnqB02	stream	Unquity Brook	Milton	399
UnqB03	stream	Unquity Brook	Milton	218
UnqB04	stream	Unquity Brook	Milton	443
UnqB05p	pipe	Unquity Brook	Milton	31

ns = not sampled

Significant Findings

- Several instream samples collected in Unquity Brook had slightly elevated bacteria levels.
- Human Marker samples collected on September 25 at UnqB02 and UnqB04 indicated weak and inconclusive evidence of human bacteria sources, respectively.

- **Actions to be taken:** 1) Review data collected at these sites in 2007 by the Neponset River Watershed Association 2) If resources permit, include sampling locations in a NERO BST follow-up sampling plan for summer, 2008 to be sampled preferably in the peak summer months.

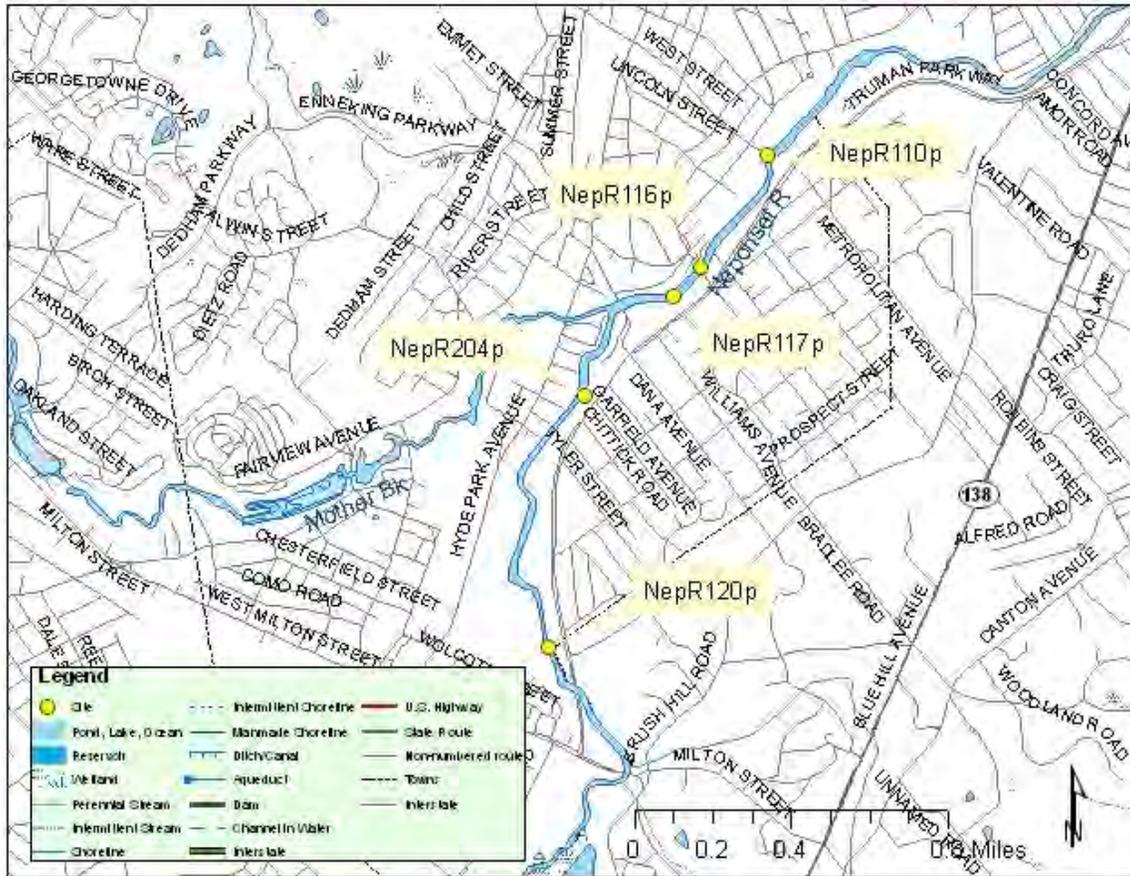
Neponset River (Boston)

Sampling locations were chosen based on data collected earlier in the summer by the Neponset River Watershed Association (NepRWA) and sampling was coordinated with NepRWA staff.

Sub-watershed Description

- The Neponset River watershed is 98 square miles in area upstream of NepR110p.
- This section of the watershed is urban, with mixed residential and commercial use. There are varying amounts of reservation land providing a buffer on either side of the river
- This section of the Neponset River is listed as impaired for pathogens on the 2006 303(d) list.
- Boston is a NPDES Phase I community, with more than 99% sewerage and less than 1% on septic systems.

Figure 6. 2007 Bacteria Source Tracking Sites in the Neponset River Sub-watershed



Results

Table 5. *E. coli* (EC) Concentrations (MPN/100mL) in the Neponset River

Site ID	Type	Water Body	Town	9/20/2007 (EC)
NepR110p	pipe	Neponset River	Boston	155,310
NepR116p	pipe	Neponset River	Boston	>241,960
NepR117p	pipe	Neponset River	Boston	496
NepR204p	pipe	Neponset River	Boston	>241,960
NepR120p	pipe	Neponset River	Boston	183

ns = not sampled

Significant Findings

- Samples collected from three Boston Water and Sewer Commission (BWSC) stormwater outfalls contained extremely elevated *E. coli* concentrations.
- **Actions to be taken:** 1) Review and comment on plans submitted by BWSC to investigate elevated bacteria levels and meet with BWSC staff as appropriate.

3.3 CHARLES

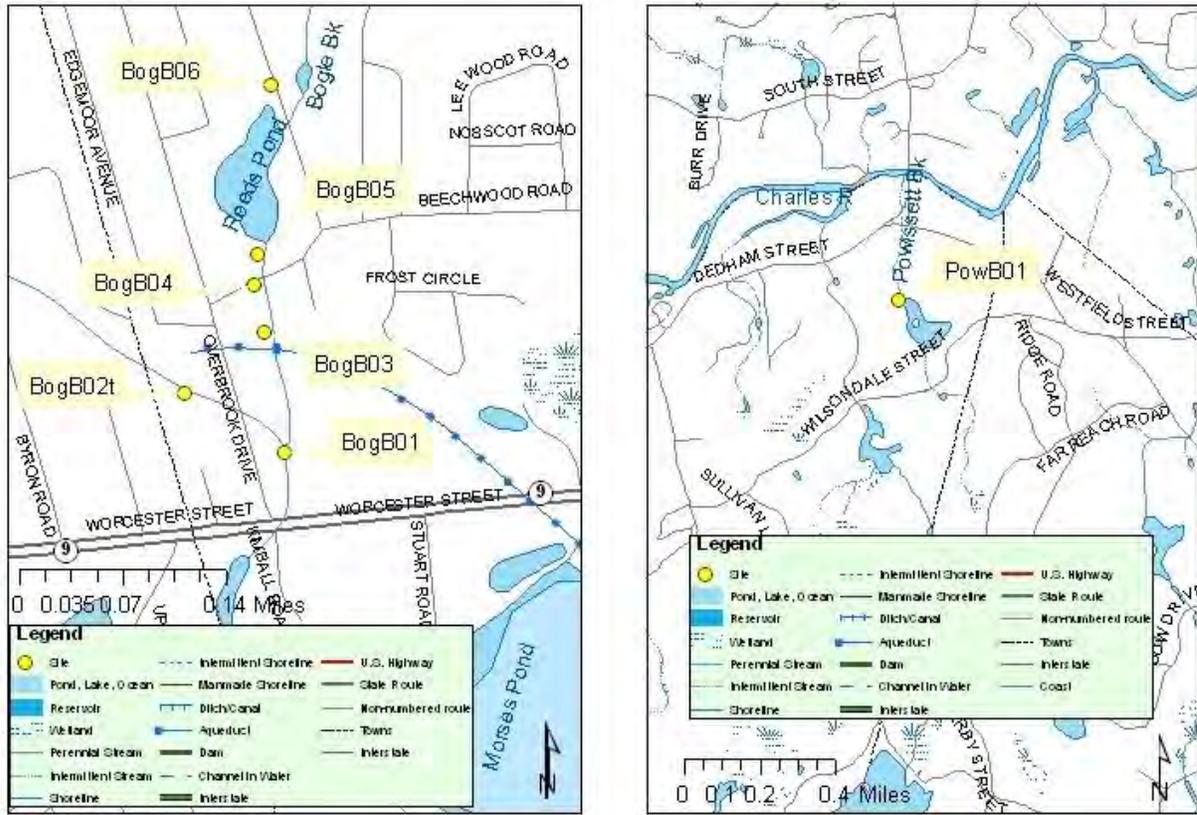
Bogle Brook (Wellesley) and Powissett Brook (Dover)

Bogle Brook and Powissett Brook were chosen to sample because of preliminary data collected earlier in the summer by DWM staff during the Charles River basin assessment work.

Sub-watershed Description

- Bogle Brook flows through a series of ponds/lakes, and then into Waban Brook, a tributary of the Charles River. Powissett Brook is a direct tributary of the Charles River.
- The Bogle Brook sub-watershed is 7.1 square miles in area upstream of BogB01 and the Powissett Brook sub-watershed is 1.3 square miles in area upstream of PowB01.
- Landuse in the Bogle Brook sub-watershed is characterized as follows: Residential 51%, Forest 31%, Commercial 6%, Open Space 6%, Wetland 3%, Other 3%
- Landuse in the Powissett sub-watershed is characterized as follows: Forest 76%, Residential 12%, Other 7%, Open Space, 4%, Wetland 1%
- The Bogle Brook sub-watershed is generally residential, while the Powissett Brook sub-watershed is low density residential with large pieces of undeveloped land.
- Bogle Brook is not listed in the 2006 Integrated List of Waters, while Powissett Brook is listed as attaining the primary contact and secondary contact uses.
- The towns of Wellesley and Dover are NPDES Phase II communities. Wellesley is 96% sewered and 4% of the Town is on septic systems, while 100% of Dover is on septic systems.

Figure 7. 2007 Bacteria Source Tracking Sites in the Bogle Brook and Powissett Brook Sub-watersheds



Results

Table 6. *E. coli* (EC) Concentrations (MPN/100mL) in Bogle Brook and Powissett Brook

Site ID	Type	Water Body	Town	8/1/2007 (EC)	8/15/2007 (EC)
BogB01	stream	Bogle Brook	Wellesley	160	156
BogB02t	tributary	unnamed brook	Wellesley	1,860	404
BogB03	stream	Bogle Brook	Wellesley	199	95.9
BogB04	stream	Bogle Brook	Wellesley	160	16.0
BogB05	stream	Bogle Brook	Wellesley	108	ns
BogB06	stream	Bogle Brook	Wellesley	341	41
PowB01	stream	Powissett Brook	Dover	84	10

ns = not sampled

= wet weather conditions

Significant Findings

- Samples collected at Powissett Brook and most Bogle Brook sampling locations were below the pathogen standard for class B water bodies or not significantly elevated.
- A wet weather sample collected at BogB02t, a small tributary to Bogle Brook, had an elevated *E. coli* concentration. A small marshy area is located upstream of the site, in between two townhouse/multifamily housing units. An optical brightener pad (the presence of optical brighteners indicates wash-water inputs) was placed partially in the water on September 20, but upon retrieval five days later, there was no flow. Results are inconclusive.
- **Actions to be taken: 1)** No actions are recommended at this time.

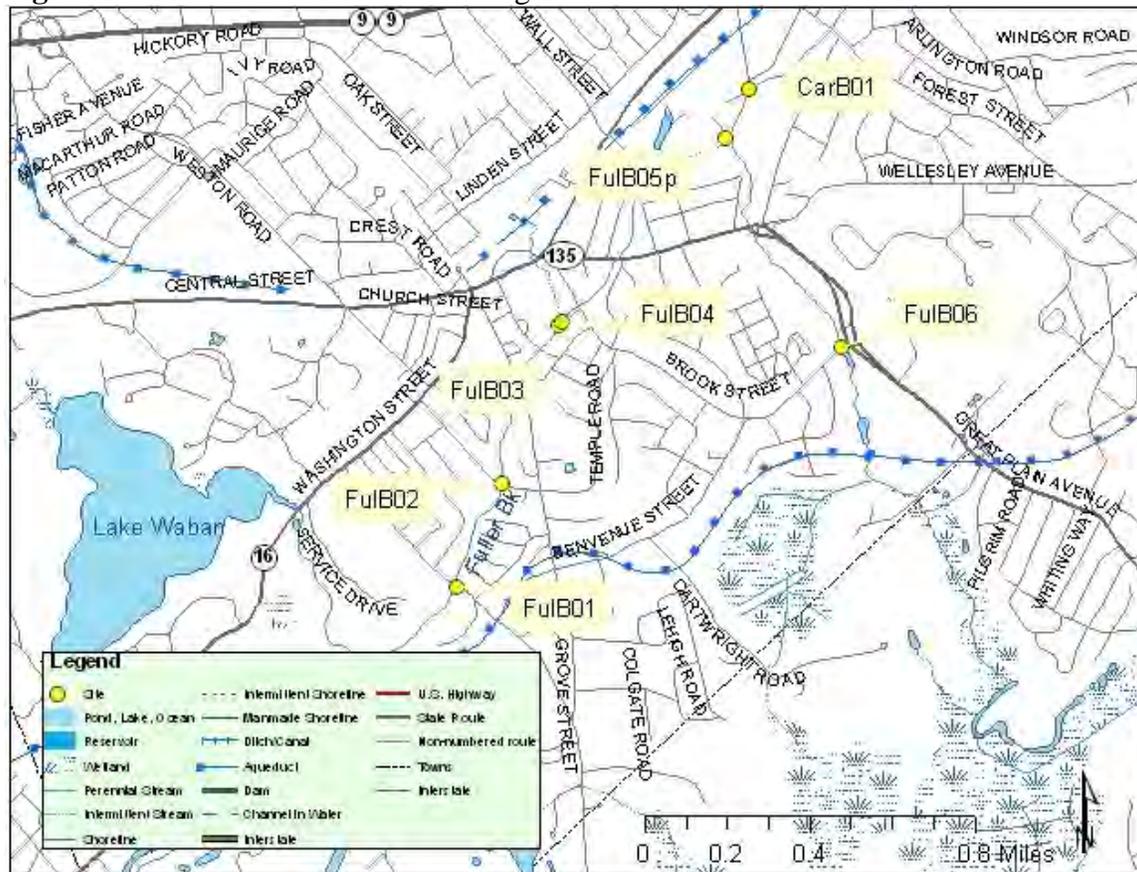
Fuller Brook (Wellesley)

Fuller Brook was chosen as a study segment through consultation with the Charles River Watershed Association.

Sub-watershed Description

- Fuller Brook flows into Waban Brook, a tributary of the Charles River.
- The Fuller Brook sub-watershed is 5.5 square miles in area upstream of FulB01.
- Landuse in the Fuller Brook sub-watershed is characterized as follows: Residential 54%, Forest 24%, Open Space 9%, Other 6%, Commercial 4%, Wetland 3%
- The Fuller Brook sub-watershed upstream of Wellesley (in Needham) is mainly conservation area with some residential use, while in Wellesley, the sub-watershed is mainly residential. Between FulB05p and FulB04, the brook runs through the town center, which contains denser commercial use. A paved recreational trail runs along the brook, approximately from FulB04 to the most downstream site.
- Fuller Brook is listed as impaired for pathogens on the 2006 303(d) list.
- The Town of Wellesley is a NPDES Phase II community, with 96% of the town sewerred and 4% on septic systems.

Figure 8. 2007 Bacteria Source Tracking Sites in the Fuller Brook Sub-watershed



Results

Table 7. *E. coli* (EC) Concentrations (MPN/100mL) in the Fuller Brook Sub-watershed

Site ID	Type	Water Body	Town	8/1/2007 (EC)	8/15/2007 (EC)	9/20/07 (EC)
FulB01	stream	Fuller Brook	Wellesley	2,382	2,014	3,609
FulB02	stream	Fuller Brook	Wellesley	1,081	1,439	1,860
FulB03	stream	Fuller Brook	Wellesley	820	181	ns
FulB04	stream	Fuller Brook	Wellesley	650	156	ns
FulB05p	pipe	Fuller Brook	Wellesley	292	20	ns
CarB01	tributary	Caroline Brook	Wellesley	2,014	345	ns
FulB06	stream	Fuller Brook	Wellesley	441	613	ns

ns = not sampled

= wet weather conditions

Significant Findings

- Instream samples collected at the two downstream sites in Fuller Brook contained elevated bacteria concentrations. Human Marker samples collected at these sites on September 25 were inconclusive.

- Staff from the Town of Wellesley indicated that the Dana Hall School, which is located in the watershed of FulB01 and FulB02, maintains horse stables on its property.
- **Actions to be taken:** 1) Review and comment on plans submitted by the Town of Wellesley to investigate elevated bacteria levels and meet with Town staff as appropriate.

3.4 IPSWICH

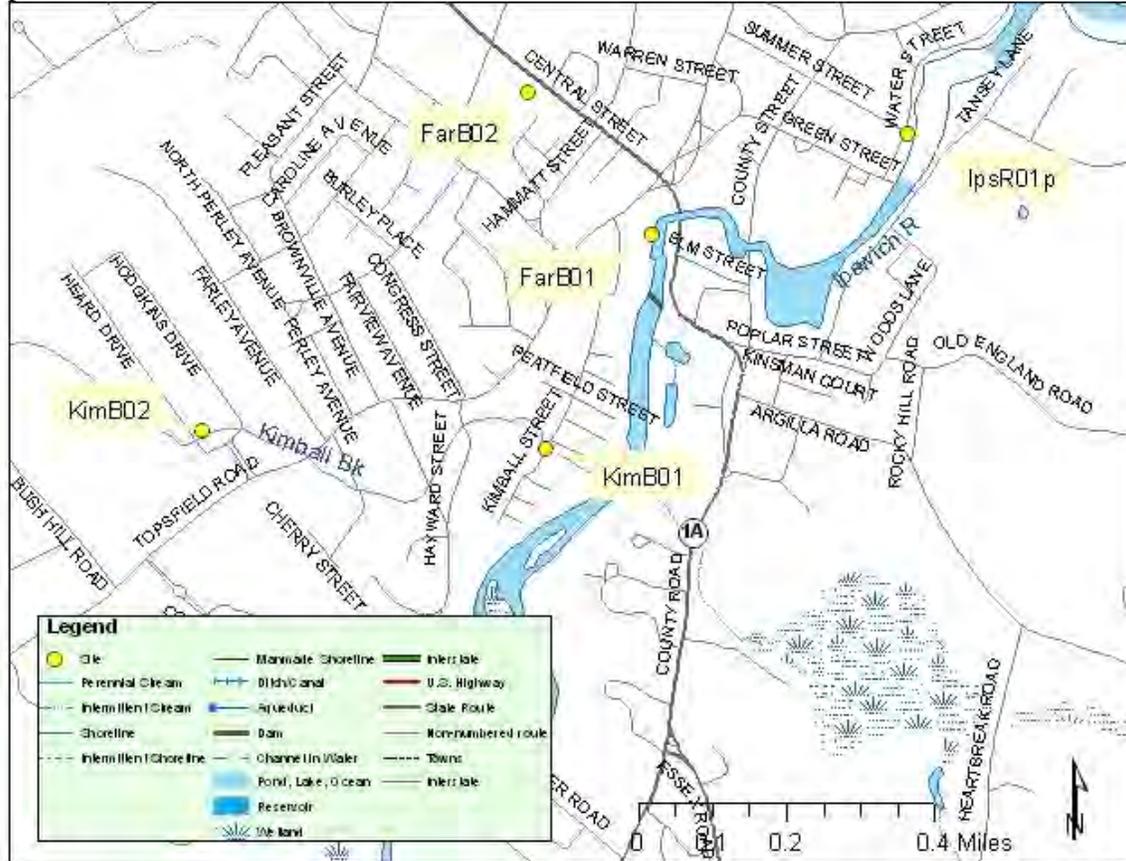
Farley Brook, Kimball Brook, and Ipswich River Pipe (Ipswich)

Farley Brook was chosen as a study segment through consultation with the Ipswich River Watershed Association.

Sub-watershed Description

- Farley Brook and Kimball Brook are tributaries of the Ipswich River.
- Farley Brook is a very small sub-watershed, while the Kimball Brook sub-watershed is 1.0 square miles in area. The Ipswich River watershed upstream of IpsR01p is 150 square miles.
- Landuse in the Kimball Brook sub-watershed is characterized as follows: Residential 47%, Forest 23%, Commercial 11%, Open Space 8%, Other 7%, Wetland 4%
- Farley Brook and Kimball Brook run through the Ipswich town center, which contains dense commercial and residential use. The upstream sampling location on Kimball Brook is located where the brook daylights in a residential area. The stormwater outfall on the Ipswich River is located in a dense residential area.
- Farley Brook is not listed as a segment in the 2006 Integrated List of Waters, while Kimball Brook and this section of the Ipswich River are listed as impaired for pathogens on the 2006 303(d) list.
- Ipswich is a NPDES Phase II community, with 50% of the town sewered and 50% on septic systems.

Figure 9. 2007 Bacteria Source Tracking Sites in the Farley Brook, Kimball Brook, and Ipswich River Sub-watersheds



Results

Table 8. *Enterococcus* spp. (ENT) and *E. coli* (EC) Concentrations (MPN/100mL) in Farley Brook, Kimball Brook, and an Ipswich River Pipe

Site ID	Type	Water Body	Town	10/16/2007 (ENT)	10/18/2007 (ENT)	10/23/07 (EC)
IpsR01p	pipe	Ipswich River	Ipswich	20	<10	ns
FarB01	stream	Farley Brook	Ipswich	197	663	ns
FarB02	stream	Farley Brook	Ipswich	52	20	ns
KimB01	stream	Kimball Brook	Ipswich	98	ns	226
KimB02	stream	Kimball Brook	Ipswich	74	ns	1,281

ns = not sampled

= wet weather conditions

Significant Findings

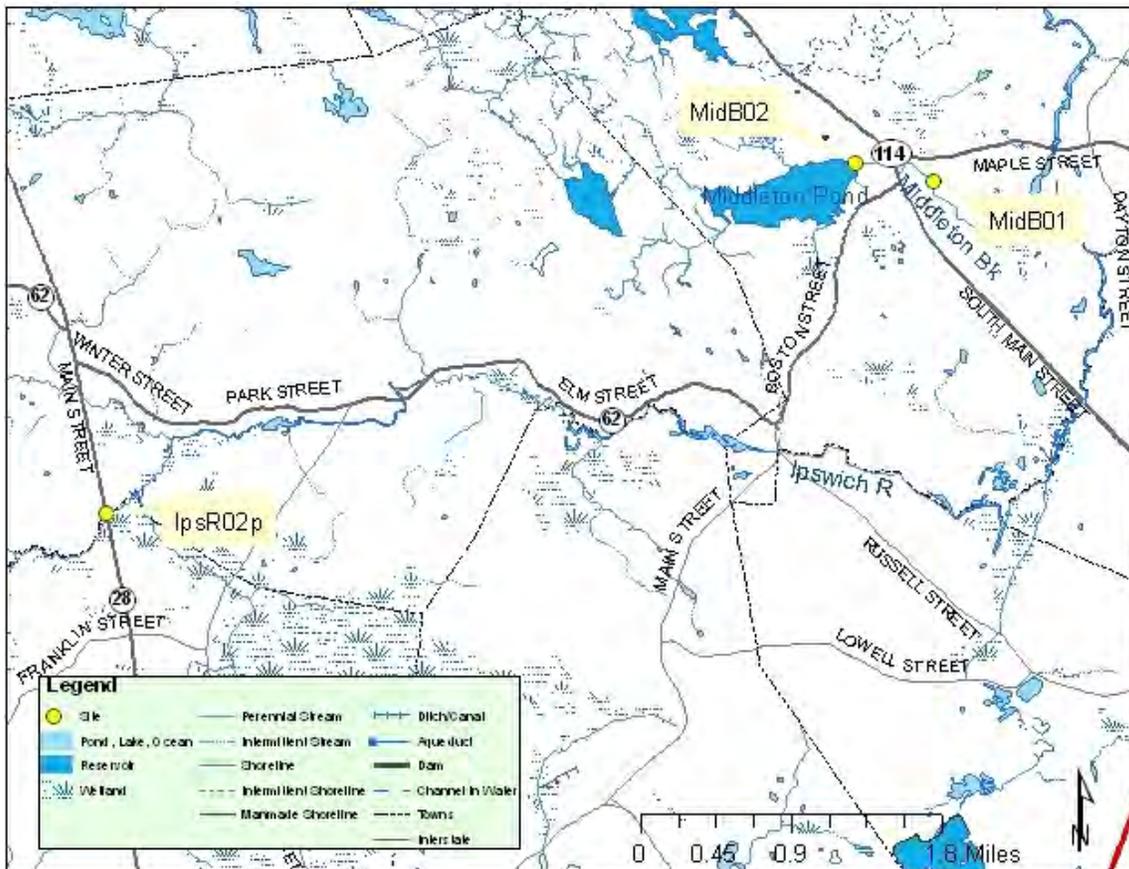
- The downstream bacteria sample collected in Farley Brook, FarB01, was slightly elevated, while the upstream sample collected in Kimball Brook, KimB02, was elevated (however, this was a wet weather sample).
- **Actions to be taken: 1)** If resources permit, include the sampling location in a NERO BST follow-up sampling plan for summer, 2008 conducted preferably in the peak summer months.

Miscellaneous Sites (Middleton, North Reading)

Sub-watershed Description

- Middleton Brook is fed by Middleton Pond and flows into the Ipswich River.
- The Middleton Brook sub-watershed is 2.9 square miles in area upstream of MidB01, while the Ipswich River watershed is 18.8 square miles upstream of IpsR02p.
- Landuse in the Middleton Brook sub-watershed is characterized as follows: Forest 70%, Residential 14%, Other 12%, Open Space 3%, Wetland 1%
- The Middleton Brook sub-watershed is mixed residential use and conservation area. The section of the Ipswich River watershed near IpsR02p is mixed commercial, low density residential, and conservation land.
- Middleton Brook is listed as impaired for pathogens on the 2006 303(d) list. This section of the Ipswich River is not listed as impaired for pathogens.
- Middleton and North Reading are NPDES Phase II communities. The Town of Middleton is 2% sewerred and 98% septic, while the Town of North Reading is 1% sewerred and 99% septic.

Figure 10. 2007 Bacteria Source Tracking Sites in the Middleton Brook and Ipswich River Sub-watersheds



Results

Table 9. *Enterococcus* spp. (ENT) and *E. coli* (EC) Concentrations (MPN/100mL) in the Middleton Brook and Ipswich River Sub-watersheds

Site ID	Type	Water Body	Town	10/16/2007 (ENT)	10/23/2007 (EC)
MidB01	stream	Middleton Brook	Middleton	175	833
MidB02	stream	Middleton Brook	Middleton	41	20
IpsR02p	pipe	Ipswich River	N. Reading	120	84

ns = not sampled

= wet weather conditions

Significant Findings

- All samples were collected in conditions that did not meet the definition of dry weather.

- Bacteria concentrations were not significantly high for marginally wet weather conditions.
- **Actions to be taken:** 1) If resources permit, include MidB01 in a NERO BST follow-up sampling plan for summer 2008, sampled preferably in the peak summer months.

3.5 NORTH COASTAL

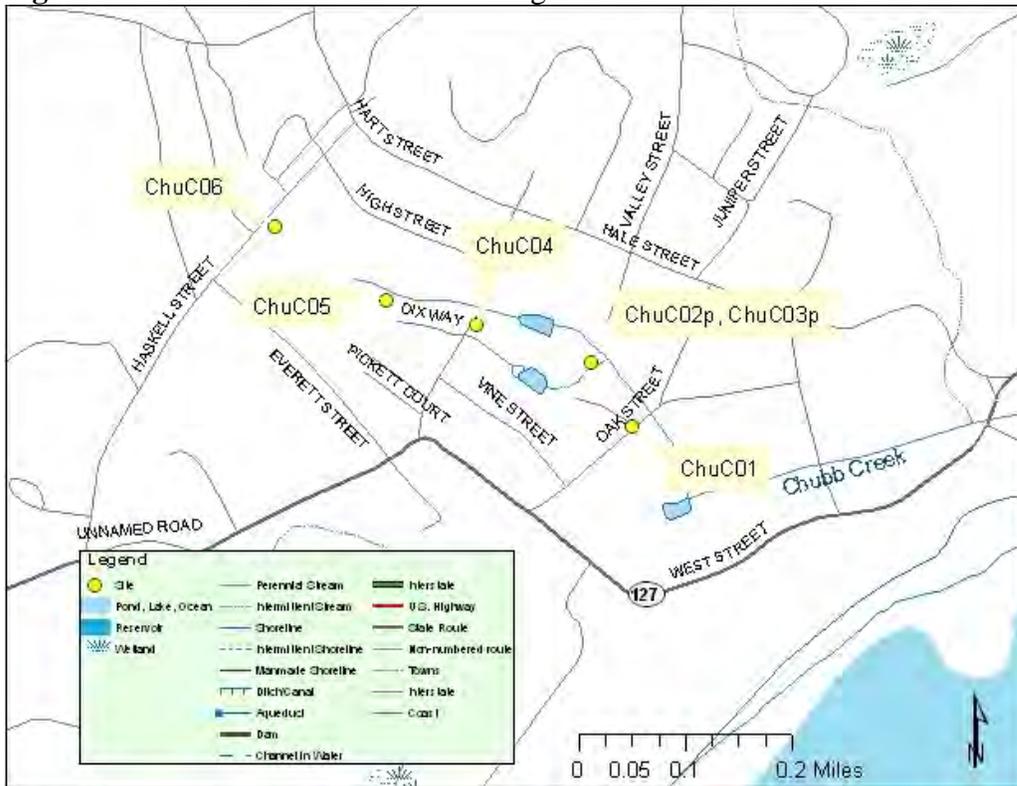
Chubb Creek (Beverly)

Chubb Creek was chosen to sample because of preliminary data collected earlier in the summer by DWM staff during the North Coastal basin assessment work.

Sub-watershed Description

- Chubb Creek flows directly out to Beverly Harbor.
- The Chubb Creek sub-watershed is 1.5 square miles in area upstream of ChuC01.
- Landuse in the Chubb Creek sub-watershed is characterized as follows: Forest 60%, Residential 27%, Open Space 6%, Other 3%, Commercial 2%, Wetland 2%
- The Chubb Creek sub-watershed is generally residential in the area around the sampling locations, but is undeveloped in most of the sub-watershed. The ChuC05 site is located adjacent to a construction site.
- Chubb Creek is not listed as a segment in the 2006 Integrated List of Waters.
- Beverly is a NPDES Phase II community, with 92% of the City sewerred and 8% on septic systems.

Figure 11. 2007 Bacteria Source Tracking Sites in the Chubb Creek Sub-watershed



Results

Table 10. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in the Chubb Creek Sub-watershed

Site ID	Type	Water Body	Town	9/18/2007 (ENT)
ChuC01	stream	Chubb Creek	Beverly	161
ChuC02p	pipe	Chubb Creek	Beverly	<10
ChuC03p	pipe	Chubb Creek	Beverly	31
ChuC04	stream	Chubb Creek	Beverly	86
ChuC05	stream	Chubb Creek	Beverly	428
ChuC06	stream	Chubb Creek	Beverly	41

ns = not sampled

= wet weather conditions

Significant Findings

- Sample collection was conducted during a stream walk. Samples were collected in conditions that did not meet the definition of dry weather.
- Bacteria concentrations were not significantly elevated for marginally wet weather conditions.
- A Human Marker sample collected at ChuC05 on September 25 indicated no human sources of bacteria.
- **Actions to be taken:** 1) No actions are recommended at this time.

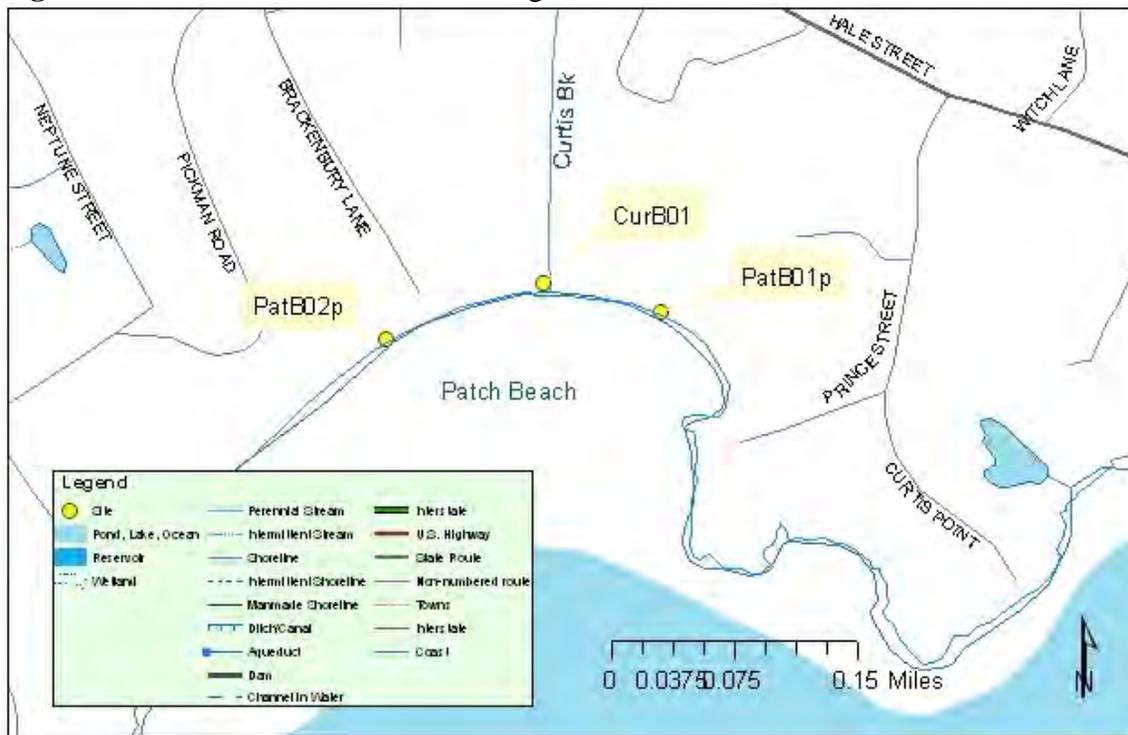
Patch Beach (Beverly)

Patch Beach was chosen as a study area based on historical data from Salem Sound Coastwatch.

Sub-watershed Description

- Curtis Brook is culverted over much of its length and flows onto Patch Beach. PatB02p is also partially fed by a wetland/stream area.
- The Curtis Brook sub-watershed (CurB01) is 1.6 square miles in area.
- Landuse in the Curtis Brook sub-watershed is characterized as follows: Forest 59%, Residential 28%, Other 5%, Commercial 3%, Open Space 3%, Wetland 2%
- The Curtis Brook sub-watershed is mixed residential and undeveloped land.
- Curtis Brook is not listed as a segment in the 2006 Integrated List of Waters.
- The City of Beverly is a NPDES Phase II community, with 92% sewered and 8% on septic systems.

Figure 12. 2007 Bacteria Source Tracking Sites at Patch Beach



Results

Table 11. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) at Patch Beach Sites

Site ID	Type	Water Body	Town	6/21/2007 (ENT)	7/2/2007 (ENT)	7/17/07 (ENT)
PatB01p	pipe	Beverly Cove	Beverly	2,382	1,046	235

Site ID	Type	Water Body	Town	6/21/2007 (ENT)	7/2/2007 (ENT)	7/17/07 (ENT)
CurB01	stream	Curtis Brook	Beverly	529	908	538
PatB02p	pipe	Beverly Cove	Beverly	161	74	197
ns = not sampled						

 = wet weather conditions

Significant Findings

- CurB01 is a culverted brook that emerges at Patch Beach (also known as Brackenbury Beach). Bacteria levels were slightly elevated on both sampling dates. However, there is a pond north of Hale Street where a large number of ducks and other birds have been observed.
- PatB01p is a pipe whose visible portion is broken and misaligned. Bacteria concentrations in samples collected there ranged from slightly elevated to significantly elevated. Potential for human contact, particularly children, is high. Human marker sampling was attempted at this pipe, but tidal conditions on the sampling date prevented access.
- Salem Sound Coastwatch (2007) indicates that this area is part of a project to restore tidal flushing in the saltmarsh, which may lead to decreased bacteria concentrations.
- **Actions to be taken:** 1) Maintain communication with Salem Sound Coastwatch and obtain updates on marsh restoration project.

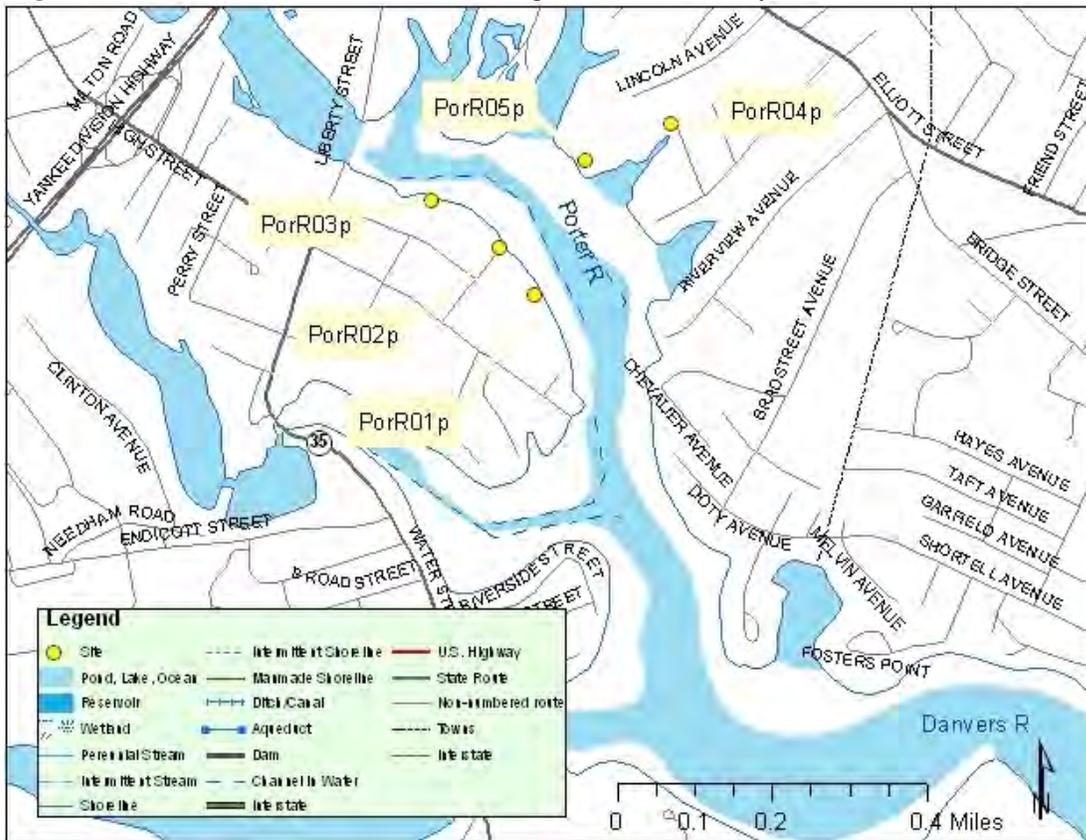
Sandy Beach (Danvers)

Sandy Beach was chosen for BST investigation because of beach closures listed on the Massachusetts Department of Public Health website.

Sub-watershed Description

- Sandy Beach is located on the Porter River, which is a tidal river that joins with several other rivers to form the Danvers River.
- The Porter River sub-watershed is 4.1 square miles in area upstream of PorR01p.
- The section of the sub-watershed around the sites is mainly residential with some aquatic recreational facilities.
- The Porter River is listed as impaired for pathogens on the 2006 303(d) list.
- The Town of Danvers is a NPDES Phase II community, with 99% sewerage and 1% on septic systems.

Figure 13. 2007 Bacteria Source Tracking Sites Near Sandy Beach



Results

Table 12. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) at Pipes Near Sandy Beach

Site ID	Type	Water Body	Town	6/21/2007 (ENT)	7/2/2007 (ENT)
PorR01p	pipe	Porter River	Danvers	52	173
PorR02p	pipe	Porter River	Danvers	30	ns
PorR03p	pipe	Porter River	Danvers	<10	<10
PorR04p	pipe	Porter River	Danvers	7,701	>24,196
PorR05p	pipe	Porter River	Danvers	31	41

ns = not sampled

= wet weather conditions

Significant Findings

- Sample collection was conducted after a pipe survey of the intertidal zone upstream of Sandy Beach on both sides of the Porter River. The second sampling date was considered a wet weather event.
- Only one of the pipes, PorR04p, had an elevated bacteria concentration. The outfall is located across the Porter River from the beach, at the head of a small

- inlet. BST staff returned to the site with the Board of Health agent from the Town of Danvers, but there was no flow at that time.
- A Human Marker sample collected at Sandy Beach on September 25 indicated no human sources of bacteria. Many geese were observed near the beach on each visit, and may contribute significant bacteria loadings to the area.
 - **Actions to be taken: 1)** No actions are recommended at this time.

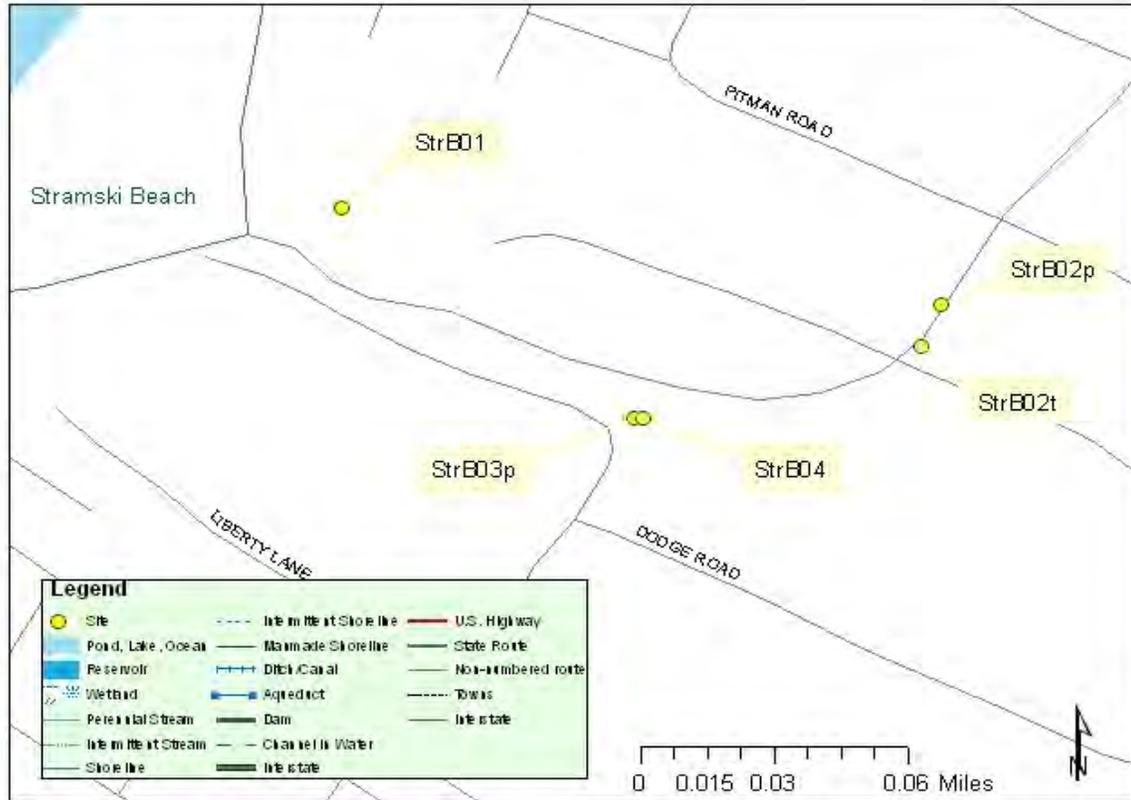
Stramski Beach (Marblehead)

Stramski Beach was chosen for BST investigation because of historical beach closures listed on the Massachusetts Department of Public Health website.

Sub-watershed Description

- Stramski Beach is a marine beach on the Salem Harbor side of Marblehead. An unnamed stream flows onto the beach.
- The contributing area of the stream flowing to Stramski Beach is approximately 0.2 square miles.
- Landuse in the Stramski Beach sub-watershed is characterized as follows:
Residential 64%, Open Space 23%, Forest 13%
- The sub-watershed is mainly residential.
- The unnamed stream is not listed as a segment on the 2006 Integrated List of Waters.
- The Town of Marblehead is a NPDES Phase II community, with 100% sewer.

Figure 14. 2007 Bacteria Source Tracking Sites in a Tributary to Stramski Beach



Results

Table 13. *Enterococcus* spp. (ENT) and *E. coli* (EC) Concentrations (MPN/100mL) in a Tributary to Stramski Beach

Site ID	Type	Water Body	Town	5/8/2007 (ENT)	7/17/2007 (ENT)	7/23/2007 (ENT)	8/2/2007 (EC)	8/13/2007 (ENT)
StrB01	stream	unnamed brook	Marblehead	52	1,722	1,989	691	ns
StrB03p	pipe	unnamed brook	Marblehead	10	>24,196	183	201	ns
StrB04	stream	unnamed brook	Marblehead	63	3,448	1,296	4,611	ns
StrB02t	stream	unnamed brook	Marblehead	<10	24,196	ns	2,909	ns
StrB02p*	pipe	unnamed brook	Marblehead	ns	ns	27,230	15,531	1,439

ns = not sampled, * = upstream source of StrB02t

= wet weather conditions

Significant Findings

- Samples were collected at multiple sites on an unnamed stream flowing out to Stramski Beach.

- Significantly elevated levels of bacteria were found in samples collected at the two upstream sites, StrB02t and StrB02p, located where the stream daylighted from under Pitman Road.
- Although a strongly elevated bacteria concentration was identified at StrB03p (a downstream stormwater outfall) on July 17, a small sampling hole was dug in the sediment (allowing time for the sediment to settle) in front of the pipe. On later dates, samples were collected by sandbagging (sandbags were placed in the mouth of the pipe and a sample was collected after enough water had pooled behind the sandbag), and those results likely give a more accurate representation of bacteria levels in the water column.
- **Actions to be taken:** 1) Review and comment on plans submitted by the Town of Marblehead to investigate elevated bacteria levels- meet with Town staff as appropriate.

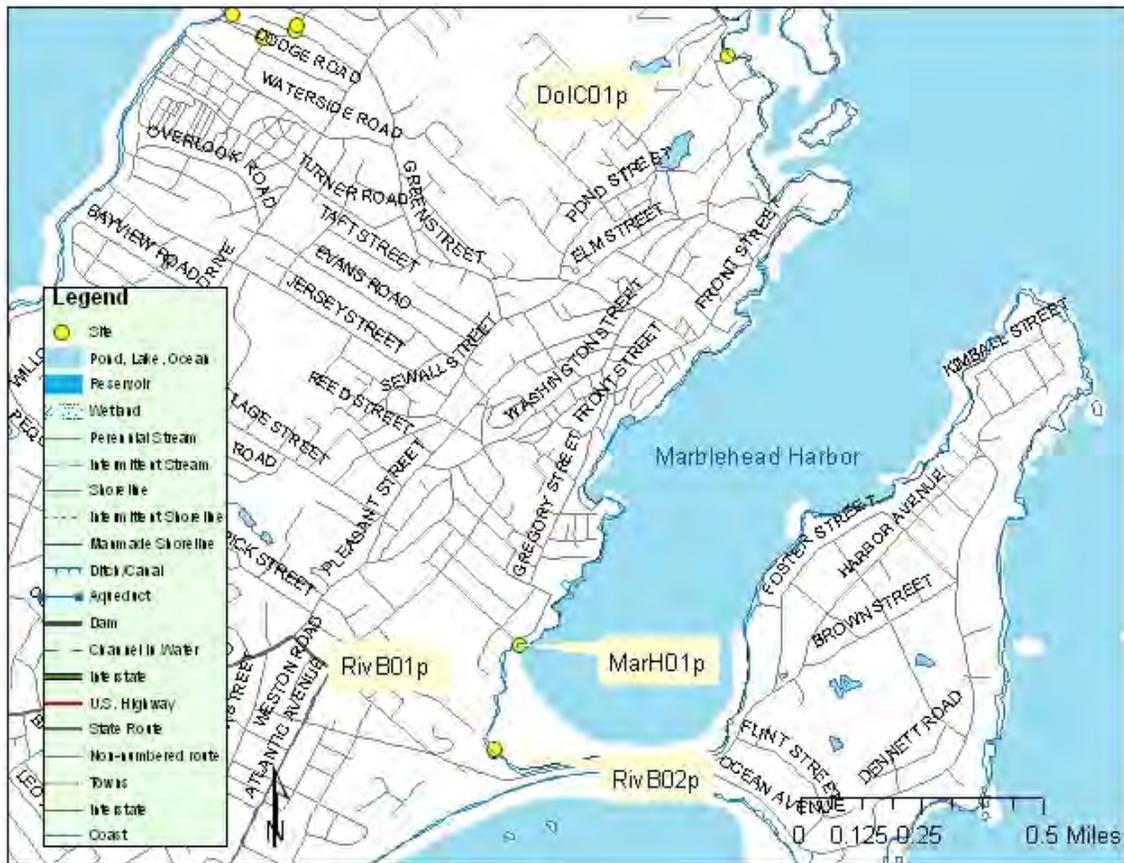
Miscellaneous Sites (Marblehead)

The Riverhead Beach sites (RivB01p and RivB02p) were chosen based on historical data from Salem Sound Coastwatch. The remaining two sites were chosen based on observations during reconnaissance.

Sub-watershed Description

- These sites are stormwater outfalls that drain to Marblehead Harbor or Doliber Cove.
- This section of the sub-watershed is mainly residential with some aquatic recreation facilities.
- The Town of Marblehead is a NPDES Phase II community, with 100% sewer.

Figure 15. 2007 Bacteria Source Tracking Sites in Marblehead Harbor and Doliber Cove



Results

Table 14. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in Marblehead Harbor and Doliber Cove

Site ID	Type	Water Body	Town	7/17/2007 (ENT)	7/23/2007 ^{a*} (ENT)
RivB01p	pipe	Marblehead Harbor	Marblehead	231	173
RivB02p	pipe	Marblehead Harbor	Marblehead	134	86
MarH01p	pipe	Marblehead Harbor	Marblehead	41	74
DolC01p	pipe	Doliber Cove	Marblehead	213	521

ns = not sampled, ^{a*} = approximately 0.03 inches precipitation occurred before Mar---- and Dol---- sample collection, while significant precipitation occurred before Riv---- sample collection

☐ = wet weather conditions

Significant Findings

- None of the samples contained significantly elevated bacteria concentrations.
- **Actions to be taken:** 1) No actions are recommended at this time.

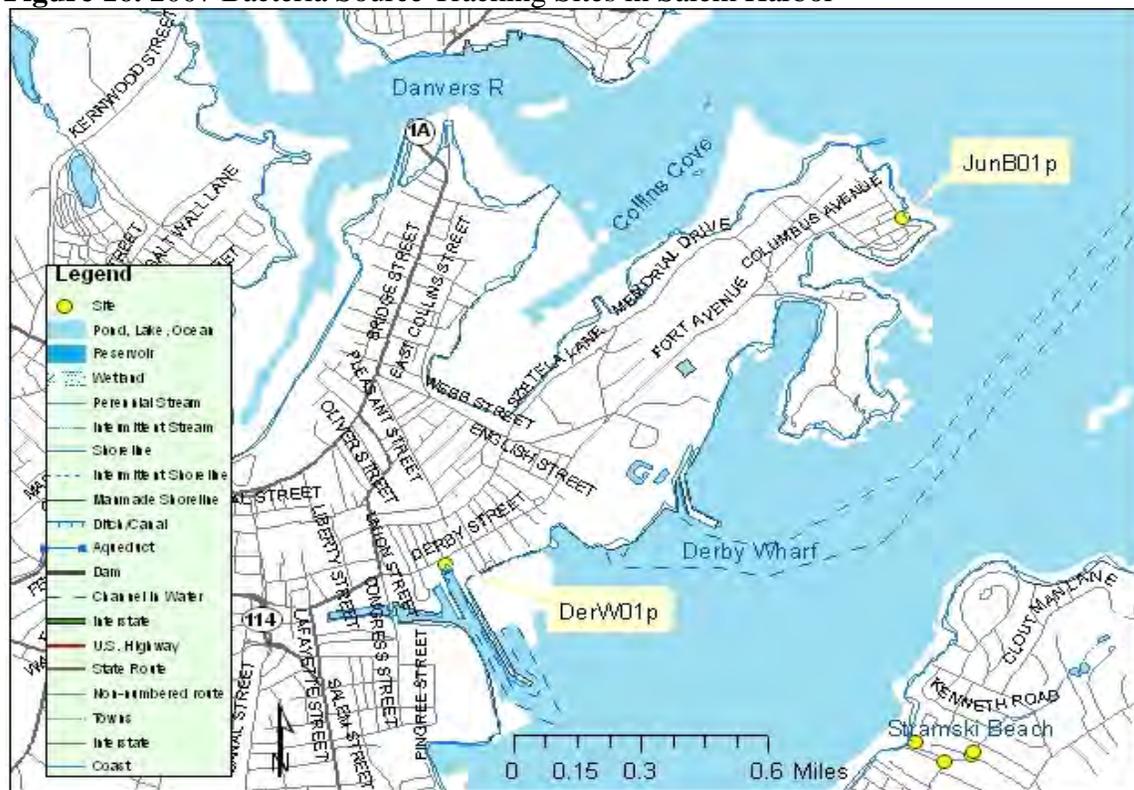
Miscellaneous Sites (Salem)

These sites were chosen based on historical data from Salem Sound Coastwatch.

Sub-watershed Description

- These sites are stormwater outfalls that drain to Salem Harbor.
- The Derby Wharf outfall (DerW01p) is located in a highly dense mixed residential/commercial area, while the Juniper Beach outfall (JunB01p) is in a residential area.
- The City of Salem is a NPDES Phase II community, with 100% sewered.

Figure 16. 2007 Bacteria Source Tracking Sites in Salem Harbor



Results

Table 15. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in Salem Harbor

Site ID	Type	Water Body	Town	6/21/2007 (ENT)	7/2/2007 (ENT)	7/17/07 (ENT)
DerW01p	pipe	Salem Harbor	Salem	7,701	5,172	10,462
JunB01p	pipe	Salem Harbor	Salem	84	129.6	ns

ns = not sampled

= wet weather conditions

Significant Findings

- Samples collected at a stormwater outfall (DerW01p) on the northwest side of Derby Wharf had significantly elevated bacteria concentrations.
- **Actions to be taken: 1)** Review and comment on plans submitted by the City of Salem to investigate elevated bacteria levels and meet with City staff as appropriate.

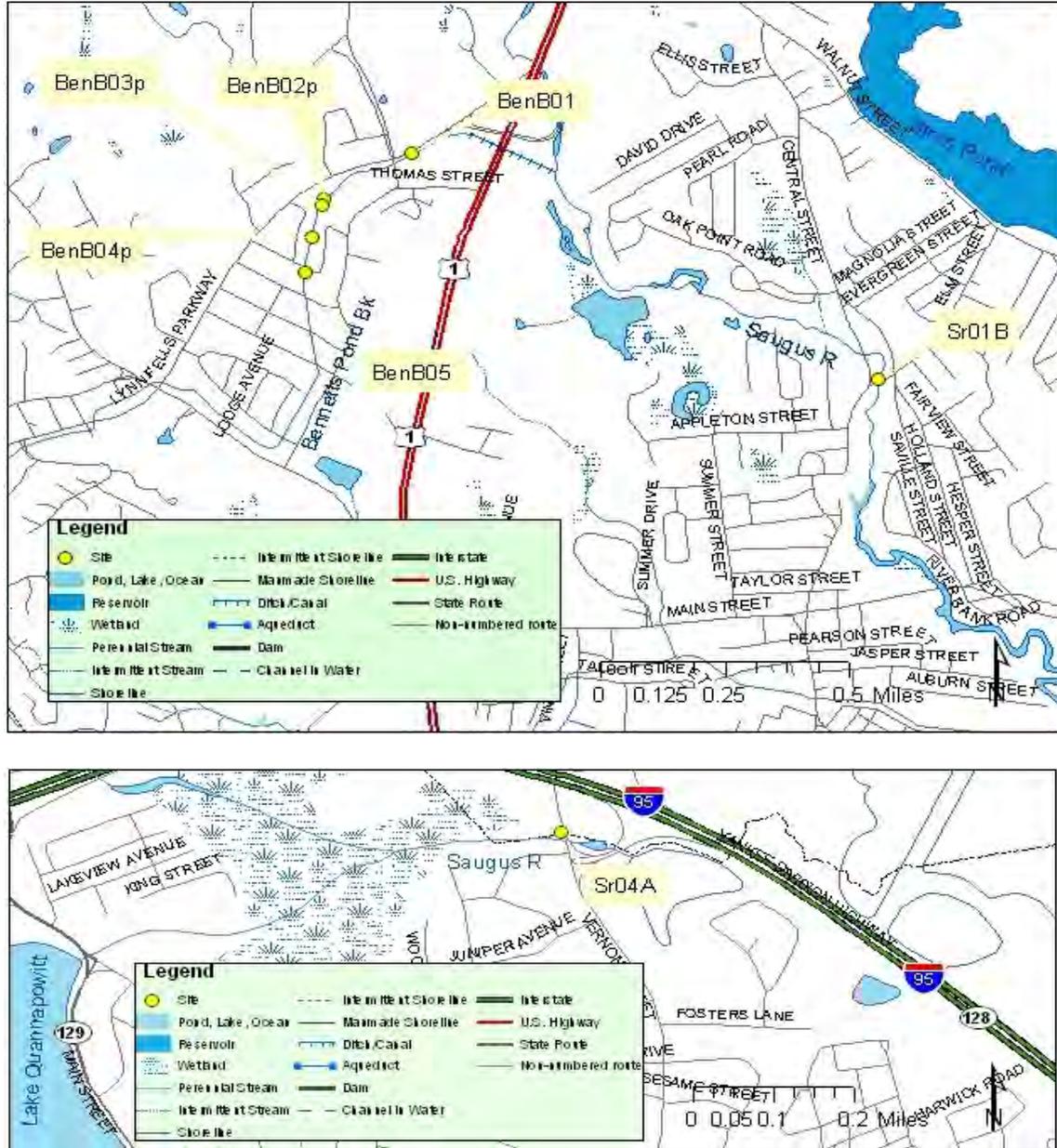
Bennetts Pond Brook and Saugus River (Saugus/Wakefield)

Bennetts Pond Brook and the Saugus River were chosen to sample because of preliminary data collected earlier in the summer by DWM staff during the North Coastal basin assessment work.

Sub-watershed Description

- Bennetts Pond Brook is a tributary of the Saugus River.
- The Bennetts Pond Brook sub-watershed is 3.1 square miles in area upstream of BenB01 and the Saugus River watershed upstream of Sr01B is 24.8 square miles.
- Landuse in the Bennetts Pond Brook sub-watershed is characterized as follows: Residential 56%, Forest 28%, Open Space 6%, Commercial 4%, Other 4%, Wetland 2%
- Landuse in the Saugus River sub-watershed is characterized as follows: Residential 46%, Forest 28%, Commercial 8%, Other 8%, Open Space, 5%, Wetland 5%
- The Bennetts Pond Brook sub-watershed is mainly residential, with the most downstream section (BenB01) in a commercial area.
- Bennetts Pond Brook is not listed as a segment on the 2006 Integrated List of Waters, while these segments of the Saugus River are listed as impaired for pathogens on the 2006 303(d) list.
- The Town of Saugus is a NPDES Phase II community, with 91% sewerred and 9% on septic systems.

Figure 17. 2007 Bacteria Source Tracking Sites in the Bennetts Pond Brook and Saugus River Sub-watersheds



Results

Table 16. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in Bennetts Pond Brook and the Saugus River

Site ID	Type	Water Body	Town	9/19/2007 (ENT)
Sr01B	stream	Saugus River	Saugus	185
BenB01	stream	Bennetts Pond Brook	Saugus	331
BenB02p	pipe	Bennetts Pond Brook	Saugus	75

Site ID	Type	Water Body	Town	9/19/2007 (ENT)
BenB03p	pipe	Bennetts Pond Brook	Saugus	<10
BenB04p	pipe	Bennetts Pond Brook	Saugus	134
BenB05	stream	Bennetts Pond Brook	Saugus	1,145
Sr04A	stream	Saugus River	Wakefield	109
ns = not sampled				

Significant Findings

- The downstream (BenB01) and upstream (BenB05) sites on Bennetts Pond Brook had slightly elevated and significantly elevated bacteria concentrations, respectively. Samples from stormwater outfalls located between the two instream sampling locations all had low bacteria concentrations.
- Human Marker samples collected at BenB01 and BenB05 on September 25 indicated inconclusive or no human sources of bacteria.
- **Actions to be taken: 1)** No actions are recommended at this time.

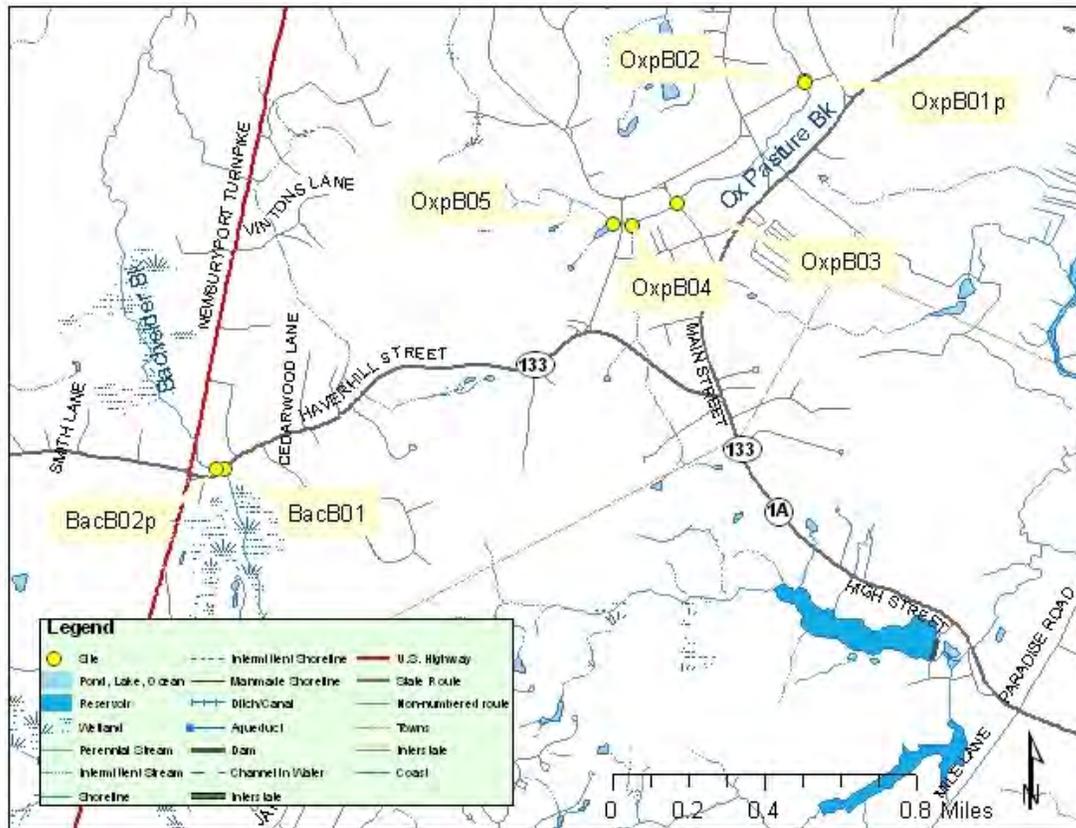
3.6 PARKER

Ox Pasture Brook and Bachelder Brook (Rowley)

Sub-watershed Description

- Ox Pasture Brook and Bachelder Brook are tributaries of the Mill River, which flows into the Parker River.
- The Ox Pasture Brook sub-watershed upstream of OxpB01p is 0.7 square miles and the Bachelder Brook sub-watershed upstream of BacB01 is 0.9 square miles.
- Landuse in the Ox-Pasture Brook sub-watershed is characterized as follows: Residential 39%, Forest 38%, Open Space 14%, Commercial 4%, Other 4%, Wetland 1%
- Landuse in the Bachelder Brook sub-watershed is characterized as follows: Forest 46%, Residential 27%, Other 10%, Wetland 9%, Commercial 6%, Open Space 2%
- There is some residential use in the Ox Pasture Brook sub-watershed, but there is also a large amount of open space and undeveloped land.
- Ox Pasture Brook is listed as not assessed for primary and secondary contact in the 2006 Integrated List of Waters, while Bachelder Brook is not listed as a segment.
- The Town of Rowley is a NPDES Phase II community, with 100% of the town on septic systems.

Figure 18. 2007 Bacteria Source Tracking Sites in the Ox Pasture Brook and Bachelder Brook Sub-watersheds



Results

Table 17. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in Ox Pasture Brook and Bachelder Brook

Site ID	Type	Water Body	Town	10/16/2007 (ENT)	10/18/2007 (ENT)
OxpB01p	pipe	Ox Pasture Brook	Rowley	<10	<10
OxpB02	stream	Ox Pasture Brook	Rowley	298	1,723
OxpB03	stream	Ox Pasture Brook	Rowley	2,909	798
OxpB04	stream	Ox Pasture Brook	Rowley	ns	121
OxpB05	stream	Ox Pasture Brook	Rowley	ns	41
BacB01	stream	Bachelder Brook	Rowley	<10	<10
BacB02p	pipe	Bachelder Brook	Rowley	<10	<10

ns = not sampled

= wet weather conditions

Significant Findings

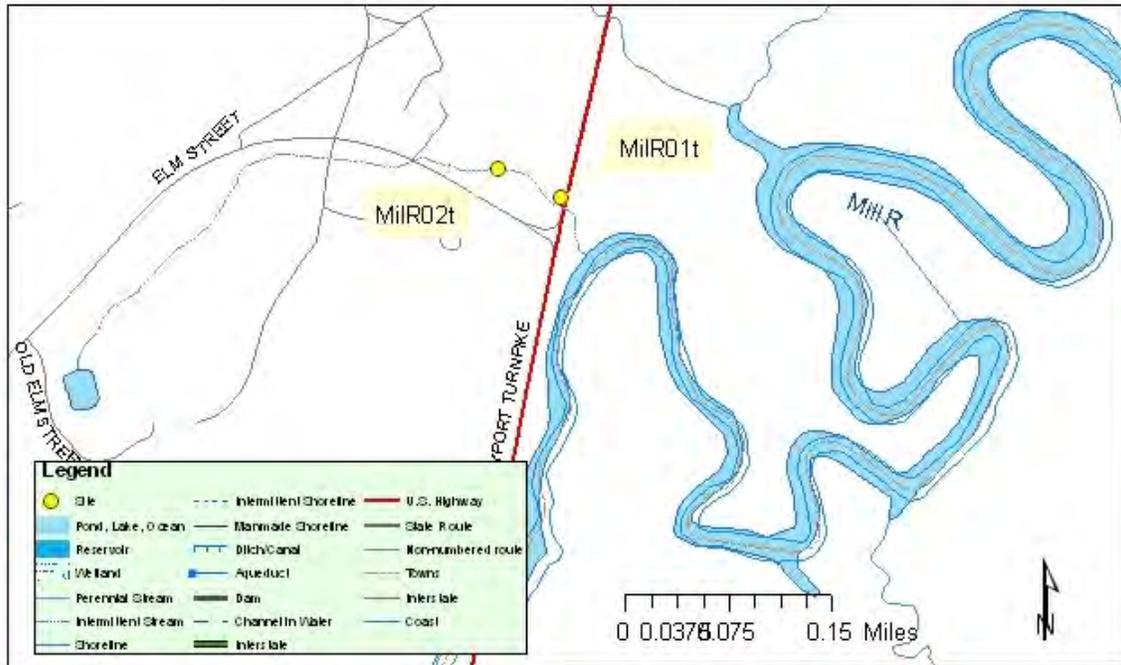
- The OxpB02 and OxpB03 sites had elevated to strongly elevated bacteria concentrations.
- Additional sites (OxpB04 and OxpB05) were chosen on the second sampling date to bracket a pond where a large number of ducks and duck droppings were observed. These samples had low bacteria concentrations; however, given the density of droppings, this is a likely source of pollution in wet weather.
- It appeared that a property downstream of the duck pond contained a corral for horses (though none were observed).
- **Actions to be taken: 1)** The Town of Rowley should be contacted and given sources of information on best management practices for non-point sources of bacteria pollution.

Tributary to Mill River (Newbury)

Sub-watershed Description

- The sites are located on an unnamed tributary of the Mill River, near the Newbury–Rowley border.
- The contributing area of the tributary is 0.1 square miles.
- Landuse in the Mill River tributary sub-watershed is characterized as follows: Forest 47%, Residential 28%, Open Space 25%
- The sub-watershed of this tributary contains the Governor Dummer Academy campus, including a wastewater treatment plant discharge, and also a large amount of undeveloped land.
- This unnamed tributary is not listed as a segment in the 2006 Integrated List of Waters.
- The Town of Newbury is a Phase II community, with 5% sewerred and 95% on septic systems.

Figure 19. 2007 Bacteria Source Tracking Sites in a Mill River Tributary



Results

Table 18. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in a Mill River Tributary

Site ID	Type	Water Body	Town	10/16/2007 (ENT)	10/18/2007 (ENT)
MilR01t	tributary	Mill River	Newbury	20	<10
MilR02t	tributary	Mill River	Newbury	51	20

ns = not sampled

= wet weather conditions

Significant Findings

- Sites were chosen to bracket the Governor Dummer Academy Wastewater Treatment Plant discharge.
- On the October 18 sampling date, bubbles and a detergent odor were observed at the site downstream of the WWTP discharge. A Chemetrics MBAS detergent test kit was used to analyze duplicate samples collected at the site, and both samples yielded a detergent concentration of 0.75 ppm (or mg/L). Surfactants will be included among the monitoring requirements in the next NPDES discharge permit for this facility.
- **Actions to be taken:** 1) No actions are recommended at this time.

Results

Table 19. *E. coli* (EC) Concentrations (MPN/100mL) at Sites in the Lower Shawsheen Sub-watershed

Site ID	Type	Water Body	Town	8/22/2007 (EC)	8/28/2007 (EC)	10/23/2007 (EC)	11/29/07 (EC)
ShaR01t	tributary	unnamed brook	Lawrence	ns	ns	512	98
ShaR02t	tributary	unnamed brook	Lawrence	ns	ns	1,904	52
NA19	pipe	Shawsheen River	Lawrence	73 ^d	110	ns	ns
AN64	pipe	Shawsheen River	Andover	10 ^d	<10	ns	ns
AN59	pipe	Shawsheen River	Andover	10 ^d & <10 ^d	<10	ns	ns

ns = not sampled, ^d = precision of field or laboratory duplicates did not meet data quality objectives

 = wet weather conditions

Significant Findings

- On both dates when samples were collected at ShaR01t and ShaR02t, a very strong sewage odor was present over several hundred feet from the point of daylighting to the confluence with the Shawsheen River. Additionally, a growth, which appeared to be sewage fungus, was apparent in the benthos.
- **Actions to be taken:** 1) Review and comment on plans submitted by the City of Lawrence to investigate elevated bacteria levels and meet with City staff as appropriate.

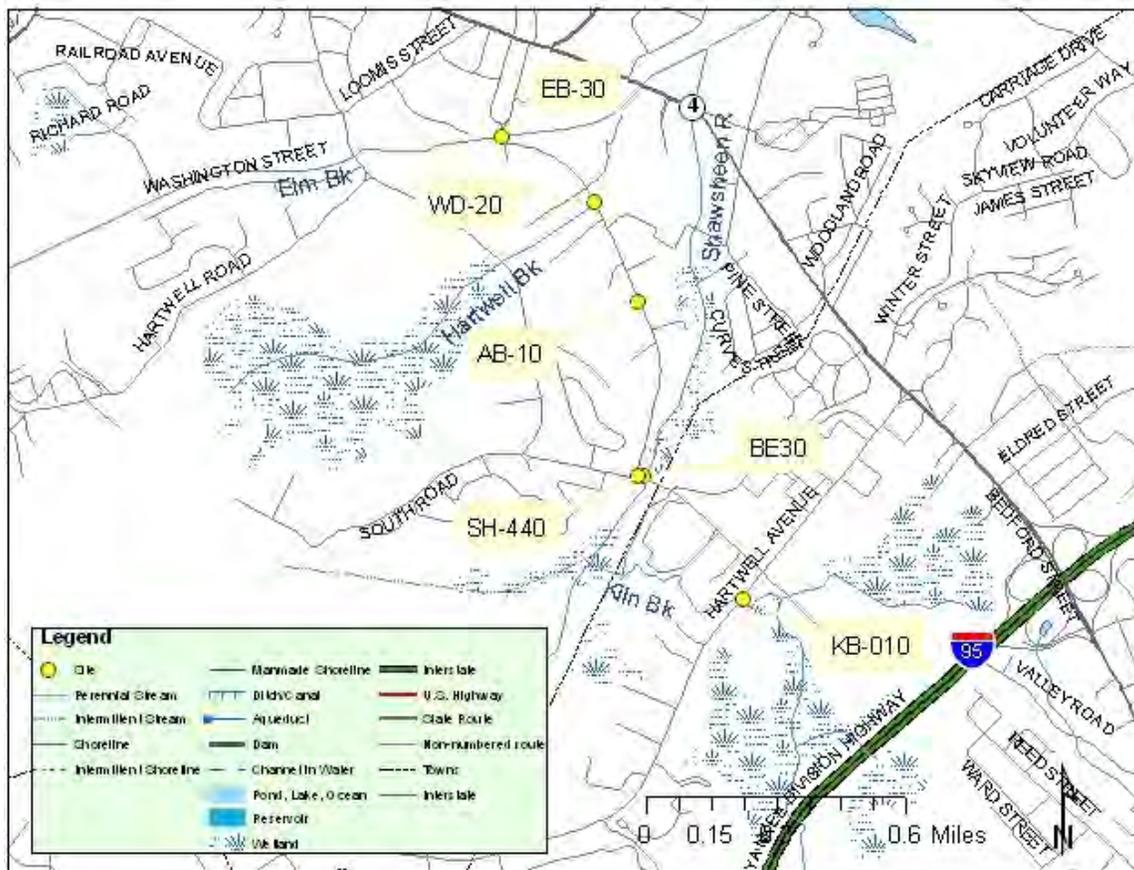
Upper Shawsheen River (Bedford, Lexington)

Sub-watershed Description

- Hartwell Brook, Elm Brook, and Kiln Brook are tributaries of the Shawsheen River.
- The area of the Hartwell Brook sub-watershed upstream of WD-20 is 0.4 square miles, while that of Elm Brook upstream of EB-30 is 5.3 square miles, the Shawsheen River upstream of SH-440 is 6.6 square miles, and Kiln Brook upstream of KB-010 is 4.1 square miles.
- Landuse in the Hartwell Brook sub-watershed is characterized as follows: Forest 55%, Commercial 17%, Residential 13%, Open Space 11%, Wetland 4%
- Landuse in the Elm Brook sub-watershed is characterized as follows: Forest 45%, Residential 31%, Commercial 12%, Open Space 7%, Other 3%, Wetland 2%
- Landuse in the Shawsheen River sub-watershed is characterized as follows: Residential 36%, Forest 21%, Commercial 21%, Open Space 15%, Other 4%, Wetland 3%

- Landuse in the Kiln Brook sub-watershed is characterized as follows: Residential 47%, Forest 23%, Commercial 11%, Open Space 8%, Other 7%, Wetland 4%
- These sites are located in areas of mixed undeveloped land, and low density commercial and residential use. The Shawsheen River site is downstream of Hanscom Air Force Base.
- Hartwell Brook is not listed as a segment in the 2006 Integrated List of Waters, but Elm Brook is listed as impaired for pathogens, Kiln Brook has had a pathogen TMDL created, and this segment of the Shawsheen River is also listed as impaired for pathogens in the 2006 303(d) list.
- The towns of Bedford and Lexington are NPDES Phase II communities. Bedford is 92% sewered and 8% is on septic systems, while Lexington is more than 90% sewered and less than 10% septic.

Figure 21. 2007 Bacteria Source Tracking Sites in the Upper Shawsheen River Sub-watershed



Results

Table 20. *E. coli* (EC) Concentrations (MPN/100mL) in the Upper Shawsheen Sub-watershed

Site ID	Type	Water Body	Town	8/22/2007 (EC)	8/28/2007 (EC)
EB-30	stream	Elm Brook	Bedford	122 ^d	158
WD-20	stream	Hartwell Brook	Bedford	98 ^d	1,022
AB-10	tributary	unnamed brook	Bedford	341 ^d	331
BE30	pipe	Shawsheen River	Bedford	<10 ^d	<10
SH-440	stream	Shawsheen River	Bedford	309 ^d	122
KB-010	stream	Kiln Brook	Lexington	110 ^d	309

ns = not sampled, ^d = precision of field or laboratory duplicates did not meet data quality objectives

Significant Findings

- One of the samples collected at WD-20 (Hartwell Brook) contained an elevated *E. coli* level. However, this sampling location was stagnant, which may explain the elevated concentration.
- Samples from other sampling locations were not significantly elevated.
- **Actions to be taken:** 1) No actions are recommended at this time.

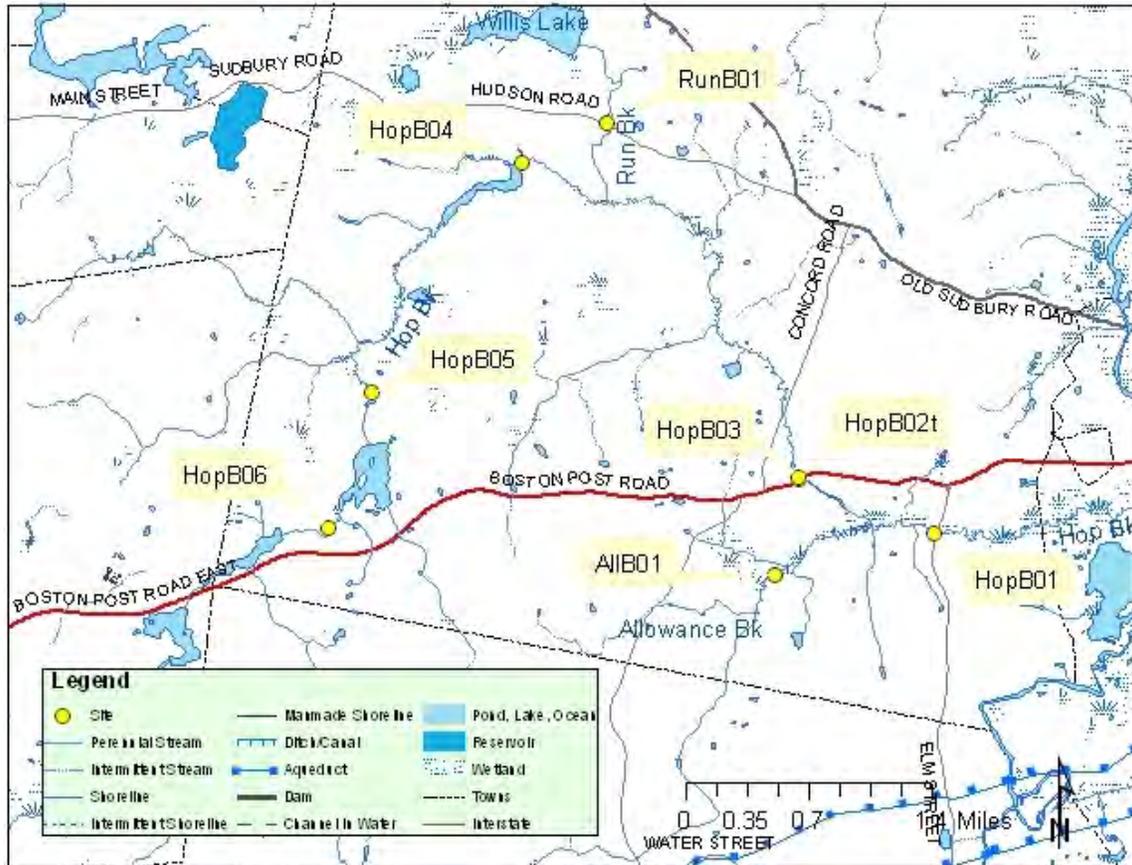
3.8 SuAsCo

Hop Brook (Sudbury)

Sub-watershed Description

- Hop Brook is a tributary of the Sudbury River.
- The area of the Hop Brook sub-watershed upstream of HopB01 is 21.2 square miles.
- Landuse in the Hop Brook sub-watershed is characterized as follows: Forest 45%, Residential 41%, Open Space 6%, Wetland 3%, Commercial 3%, Other 2%
- The upstream sites are in low density residential areas, while HopB02t and HopB03 are in commercial areas, RunB01 is in a residential area, and AllB01 and HopB01 are in wetland areas.
- Most of the section of Hop Brook studied is listed as impaired for pathogens on the 2006 303(d) list; the most upstream site is in an area that is not listed as impaired for pathogens.
- The Town of Sudbury is a NPDES Phase II community, with 99.9% of the town on septic systems and 0.1% sewerred.

Figure 22. 2007 Bacteria Source Tracking Sites in the Hop Brook Sub-watershed



Results

Table 21. *E. coli* (EC) Concentrations (MPN/100mL) in the Hop Brook Sub-watershed

Site ID	Type	Water Body	Town	9/13/2007 (EC)	10/2/2007 (EC)
HopB01	stream	Hop Brook	Sudbury	663	203 ^d
HopB02t	tributary	Hop Brook	Sudbury	>24,196	ns
HopB03	stream	Hop Brook	Sudbury	697	175 ^d
AIB01	stream	Allowance Brook	Sudbury	145	145 ^d
RunB01	stream	Run Brook	Sudbury	717	246 ^d
HopB04	stream	Hop Brook	Sudbury	110	31 ^d
HopB05	stream	Hop Brook	Sudbury	30	10 ^d
HopB06	stream	Hop Brook	Sudbury	63	86 ^d

ns = not sampled, ^d = precision of field or laboratory duplicates did not meet data quality objectives

= wet weather conditions

Significant Findings

- On the September sampling date, which was also a wet weather date (over an inch of rain fell on the second day prior to sampling), samples from several sites

- (HopB01, HopB03, and RunB01) were elevated, although not significantly given the amount of rainfall.
- A sample collected on the September sampling date at HopB02t, an unnamed tributary to Hop Brook, had an *E. coli* concentration >24,196 MPN/100mL. It is likely that stormwater is the main water source for this stream, as it was dry on the October sampling date. Human exposure is unlikely at this site because it is located in a commercial area.
 - Human Marker samples were collected on September 25 from HopB01, HopB02t, and HopB03. There was no evidence of human sources of bacteria in any of the samples.
 - **Actions to be taken:** 1) No actions are recommended at this time.

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Appendix A MassDEP Wall Experiment Station Human Marker and *Enterococcus* spp. Results

The Wall Experiment Station (WES) performed Human Marker (HM) analysis on thirteen samples, one duplicate, and one blank collected by NERO staff on September 25, 2007. Analyses performed included *Enterococcus* spp. concentration, *Enterococcus* spp. DNA analysis by polymerase chain reaction (PCR), Bacteroidetes DNA analysis by PCR, fluorescent whitening agent concentration, and caffeine concentration. The weight of evidence of human sources of bacteria could be ranked as “none,” “inconclusive,” “weak,” or “strong.” None of the samples indicated strong evidence of human sources, while only two were ranked as weak. One of these was the site on Unquity Brook at Squantum Street in Milton. A pipe on the Shawsheen River in Andover was also ranked as weak, but with a qualifier. All other sites either had no evidence of human sources of bacteria, or results were inconclusive.

Table 1. September 25, 2007 Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Boston	Boston	Boston	Boston	Boston	Boston
25 September	0	0	0	0	0	0
MFR-Missing from record, T= trace amounts, NOAA/NWS precipitation stations: = Boston, *= USGS Muddy River gage data, ^a = rainfall on day of sampling occurred after sampling Precipitation data reported in inches.						

Note: Conditions at the Boston Logan gage were representative of those throughout the Northeast Region.

Table 2. *Enterococcus* spp. Concentration (MPN/100mL) and Human Marker (HM) Analysis for September 25, 2007

Site ID	Type	Basin	Water Body	Town	<i>Enterococcus</i> spp.	HM Analysis	Site Description
UnqB04	stream	Boston Harbor - Neponset	Unquity Brook	Milton	620	Inconclusive	Unquity Brook: US of Adams St.
UnqB02	stream	Boston Harbor - Neponset	Unquity Brook	Milton	540	Weak	Unquity Brook: E round culvert DS of Squantum St.
FulB01	stream	Charles	Fuller Brook	Wellesley	1,100	Inconclusive	Fuller Brook: DS of Dover Rd.
FulB02	stream	Charles	Fuller Brook	Wellesley	840	Inconclusive	Fuller Brook: DS of Cottage St.
HopB01	stream	SuAsCo	Hop Brook	Sudbury	170	None	Hop Brook: US of Landham Rd.

HopB02t	tributary	SuAsCo	Hop Brook	Sudbury	150	None	Hop Brook: tributary DS of Station Rd. (near Rt. 20)
HopB03	stream	SuAsCo	Hop Brook	Sudbury	66	None	Hop Brook: US of tributary & Rt. 20 (near Station Rd.)
485-87	blank	na	na	na	<3	None	na
PorR01	beach	North Coastal	Porter River	Danvers	43	Inconclusive	Sandy Beach: off River St, Lat/Long 42.55511N, 70.91854W
PorR01	beach/duplicate	North Coastal	Porter River	Danvers	17	None	Sandy Beach: off River St, Lat/Long 42.55511N, 70.91854W
ChuC05	stream	North Coastal	Chubb Creek	Beverly	1,400	None	Chubb Creek: coming above ground, DS of Dix Park
BenB01	stream	North Coastal	Bennetts Pond Brook	Saugus	940	Inconclusive J	Bennetts Pond Brook: US of culvert between Marshall's store and Fells Prkwy
BenB05	stream	North Coastal	Bennetts Pond Brook	Saugus	2,000	None	Bennetts Pond Brook: US of Laurine Rd.
RB-030	stream	Shawsheen	Roger's Brook	Andover	200	Inconclusive	Roger's Brook: US of Morton St.
AN35	pipe	Shawsheen	Shawsheen River	Andover	120	Weak J	Shawsheen River: 30" concrete pipe on SE side of river, accessed by wading into river from left bank
J = Evidence strength may be overestimated due to bias high recovery in the analysis of caffeine							

APPENDIX B 2007 Precipitation Data

Charles River Basin 2007 Survey Day Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Boston	Boston	Boston	Boston	Boston	Boston
	Norwood	Norwood	Norwood	Norwood	Norwood	Norwood
1 August	T	2.32	0	1.72	0	0
	0	0.67	0.01	1.02	0	0.01
15 August	0.09	0	0	T	0	0
	0.16	0	0	0.01	0	0.01
20 September	0.34	0	0	0	0	0
	0.33	0	0	0	0	0

MFR-Missing from record, T= trace amounts, NOAA/NWS precipitation stations: = Boston, *= USGS Muddy River gage data, ^a = rainfall on day of sampling occurred after sampling
Precipitation data reported in inches.

Ipswich River Basin 2007 Survey Day Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Beverly	Beverly	Beverly	Beverly	Beverly	Beverly
16 October	0.04	0.52	0.41	0	0	0
18 October	0.41	0	0	0	0	0
23 October	0	0.56	.1	0	0	0.02

MFR-Missing from record, T= trace amounts, NOAA/NWS precipitation stations: = Boston, *= USGS Muddy River gage data, ^a = rainfall on day of sampling occurred after sampling
Precipitation data reported in inches.

Mystic Watershed 2007 Survey Day Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Boston	Boston	Boston	Boston	Boston	Boston
14 May	0	T	0.07	0	0	0
24 May	0.59*	0.24*	T	T	0	0*
27 June	0.03	0	0	0	0	0

31 October	0.02	0.44	0	0	0	0
MFR-Missing from record, T= trace amounts, NOAA/NWS precipitation stations: = Boston, *= USGS Muddy River gage data, ^a = rainfall on day of sampling occurred after sampling Precipitation data reported in inches.						

North Coastal 2007 Survey Day Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Beverly	Beverly	Beverly	Beverly	Beverly	Beverly
8 May	0	0	T	MFR	0	0
21 June	T	T	0	0	0.06	0.20 ^a
2 July	T	0	0	0	0.22	T
17 July	T	0	T	0.03	0	0
23 July	0.13	0.12	0.02	0	0	0.14 ^{a*}
2 August	1.15	0.01	0.18	0	0	0
13 August	0.26	0	0.04	0	0	0.13 ^{a**}
18 September	0	0.01	0.38	0	0	0
19 September ⁺	0	0.34	0	0	0	0
MFR= Missing from record, T= trace amounts, NOAA/NWS precipitation stations: = Boston, = USGS Muddy River gage data, ^a = rainfall on day of sampling occurred after sampling, ^{a*} = approximately 0.03 inches occurred before Mar----, Dol----, and Str---- sample collection, ^{a**} = precipitation occurred after sampling, with partial daily total derived from NOAA hourly data (record only available until 16:15), ⁺ =data collected from the Boston station Precipitation data reported in inches.						

Neponset Watershed Survey Day Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Boston	Boston	Boston	Boston	Boston	Boston
	Norwood	Norwood	Norwood	Norwood	Norwood	Norwood
5 Sept	0.01	0	0	0	0	0
	T	0	0	0	0	0
20 Sept	na	na	na	na	na	na
	0.33	0	0	0	0	0
MFR-Missing from record, T= trace amounts, NOAA/NWS precipitation stations: = Boston, *= USGS Muddy River gage data, ^a = rainfall on day of sampling occurred after sampling Precipitation data reported in inches.						

Parker River Basin Survey Day Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Beverly	Beverly	Beverly	Beverly	Beverly	Beverly
16 October	0.04	0.52	0.41	0	0	0
18 October	0.41	0	0	0	0	0

MFR-Missing from record, T= trace amounts, NOAA/NWS precipitation stations: = Boston, *= USGS Muddy River gage data, ^a = rainfall on day of sampling occurred after sampling
Precipitation data reported in inches.

Shawsheen River Basin 2007 Survey Day Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Bedford	Bedford	Bedford	Bedford	Bedford	Bedford
	Lawrence	Lawrence	Lawrence	Lawrence	Lawrence	Lawrence
22 August	MFR	MFR	MFR	0	0	0.01
	T	0.1	0	0	0.01	0.01
28 August	0	T	0	T	0	0
	0	T	0	T	0	0
23 October	na	na	na	na	na	na
	0	0.89	0.23	0	0	0.09 ^a
29 November	na	na	na	na	na	na
	0	0	0.43	0.03	0	T

MFR-Missing from record, T= trace amounts, NOAA/NWS precipitation stations: = Boston, *= USGS Muddy River gage data, ^a = rainfall on day of sampling occurred after sampling
Precipitation data reported in inches.

SuAsCo River Basin 2007 Survey Day Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Bedford	Bedford	Bedford	Bedford	Bedford	Bedford
13 September	0.31	0.01	0.08	1.1	0	0
2 October	0.09	0.01	0	T	0	0

MFR-Missing from record, T= trace amounts, NOAA/NWS precipitation stations: = Boston, *= USGS Muddy River gage data, ^a = rainfall on day of sampling occurred after sampling
Precipitation data reported in inches.

= wet weather conditions

APPENDIX C Site ID Key

Note: DS = downstream, US = upstream

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
Boston-Mystic	Arlington	MilB01p	pipe	Mill Brook	Mill Brook: 24" outfall DS of Mystic Valley Parkway, on NW bank, same as MyRWA ARL043	42.422595	-71.149268
Boston-Mystic	Arlington	MilB07p	pipe	Mill Brook	Mill Brook: one of two 36" concrete pipes (the one at slightly higher elevation) in the N wall behind the Dudley St. Apts, ~100ft US of Grove St., same as MyRWA ARL203	42.420259	-71.164625
Boston-Mystic	Arlington	MilB02p	pipe	Mill Brook	Mill Brook: 6" iron outfall on N bank ~20-30ft DS of culvert exit where brook emerges at MWRA facility (end of Brattle Ct.), need ladder to access	42.421938	-71.170473
Boston-Mystic	Arlington	MilB03p	pipe	Mill Brook	Mill Brook: 12" clay outfall on S bank just inside culvert exit where brook emerges at MWRA facility (end of Brattle Ct.), need ladder to access, same as MyRWA ARL205	42.421939	-71.170642
Boston-Mystic	Arlington	MilB04p	pipe	Mill Brook	Mill Brook: 24" concrete outfall on N bank, ~15ft DS of Ryder St., need ladder to access, same as MyRWA ARL206	42.424409	-71.174602
Boston-Mystic	Arlington	MilB05p	pipe	Mill Brook	Mill Brook: 36" concrete outfall under Ryder St., in S bank (E of 2 pipes), need ladder to access, same as MyRWA ARL207	42.424366	-71.174714
Boston-Mystic	Arlington	MilB06t	tributary	unnamed brook	Mill Brook tributary: park @ Gold's Gym on Park Ave, walk E along bike path until brook on N side goes underground @ circular structure (~100 yards DS of the first bridge), same as MyRWA ARL211	42.425717	-71.179042
Boston-Mystic	Belmont	WinB01	stream	Winn's Brook	Winn's Brook: outlet to Little Pond, access via path between Larch Circle & Sandrick Rd. off Brighton St., same as MyRWA WIB001	42.399368	-71.161068
Boston-Mystic	Belmont	WelB01p	pipe	Wellington Brook	Wellington Brook: outfall to Blair Pond where Wellington Br. emerges fr Blanchard Rd/Brighton St, S rectangular outfall, same as MyRWA CAMD34	42.394520	-71.158283
Boston-Mystic	Belmont	WelB02	stream	Wellington Brook	Wellington Brook: inflow to Blair Pond where Wellington Br. emerges fr Blanchard Rd/Brighton St, S & middle circular 48" pipe, same as MyRWA BEL08S	42.394520	-71.158283

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
Boston-Mystic	Belmont	WelB03	stream	Wellington Brook	Wellington Brook: inflow to Blair Pond where Wellington Br. emerges fr Blanchard Rd/Brighton St, N & side circular 48" pipe, same as MyRWA BEL08N	42.394520	-71.158283
Boston-Mystic	Belmont	WelB04	stream	Wellington Brook	Wellington Brook: inflow to Claypit Pond @ SW corner by Concord Ave where brook emerges from underground, sample @ lip above dropoff, same as MyRWA WEB007	42.393568	-71.166703
Boston-Mystic	Belmont	WelB05	stream	Wellington Brook	Wellington Brook: emerging from under Common St., same as MyRWA WEB013	42.395133	-71.176420
Boston-Mystic	Somerville	MysR01p	pipe	Mystic River	Mystic River: 24" metal pipe w/ flapgate on right bank between commuter rail bridge and Rt. 99 (US of Charlestown bus depot), immediately DS of MysR02p	42.39071	-71.07437
Boston-Mystic	Somerville	MysR02p	pipe	Mystic River	Mystic River: pipe welling up from square opening in ground on right bank between commuter rail bridge and Rt. 99 (US of Charlestown bus depot), immediately US of MysR01p	42.39074	-71.07441
Boston-Mystic	Somerville	MysR03t	stream/pipe	Mystic River	Mystic River: unknown flow ~100ft DS of commuter rail bridge (right bank) in line w/ fence	42.39216	-71.07498
Boston-Mystic	Somerville	MWRA205p	pipe	Mystic River	Mystic River: CSO #205 DS of Amelia Earhart Dam, right bank	42.39402	-71.07608
Boston-Mystic	Somerville	MysR04p	pipe	Mystic River	Mystic River: 36" concrete pipe ~200ft US of Blessing of the Bay Boathouse, right bank	42.39847	-71.09117
Boston-Mystic	Somerville	SOMD21p	pipe	Mystic River	Mystic River: 48" concrete pipe several hundred feet US of MysR04p & even w/ Rt 93 exit sign, right bank	42.39981	-71.09320
Boston-Mystic	Somerville	SOMD19p	pipe	Mystic River	Mystic River: 48" concrete pipe ~200 feet DS of N-bound entrance ramp bridge over I-93 (US of SOMD21p), former CSO SOM006, right bank	42.40095	-71.09433
Boston-Mystic	Somerville	MysR05p	pipe	Mystic River	Mystic River: 24" wide wooden outfall off Rt. 16, opposite MWRA drinking water building, right bank, may be a joint Somerville/DCR pipe, same as MyRWA MDCMYT	42.41518	-71.13161
Boston-Mystic	Somerville	SOMD11p	pipe	Alewife Brook	Alewife Brook: 12" iron pipe @ DS corner of Dilboy Field parking lot, right bank, used to be CSO #4	42.41381	-71.13256

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
Boston-Mystic	Somerville	MDC8(6)p	pipe	Alewife Brook	Alewife Brook: 36" flared concrete pipe @ US end of Dilboy Field parking lot, right bank	42.41296	-71.13259
Boston-Mystic	Somerville	SOMD07p	pipe	Alewife Brook	Alewife Brook: 24" clay pipe ~25ft DS of Broadway, right bank	42.40717	-71.13370
Boston-Mystic	Arlington	ARL026p	pipe	Alewife Brook	Alewife Brook: 12" concrete pipe @ US end of Sunnyside Ave alley, access thru gate in fence, right bank	42.40842	-71.13289
Boston-Neponset	Milton	PinB01p	pipe	Pine Tree Brook	Pine Tree Brook: pipe at end of Harold St ~200ft DS of pedestrian bridge; marked w/ yellow caution tape	42.25417	-71.09028
Boston-Neponset	Milton	UnqB01p	pipe	Unquity Brook	Unquity Brook: rectangular CSO pipe DS of Squantum St (E of 2 circular pipes)	42.26167	-71.04694
Boston-Neponset	Milton	UnqB02	stream	Unquity Brook	Unquity Brook: E culvert DS of Squantum St (middle of 3 culverts/pipes)	42.26167	-71.04694
Boston-Neponset	Milton	UnqB03	stream	Unquity Brook	Unquity Brook: W culvert DS of Squantum St (W of 3 culverts/pipes)	42.26167	-71.04694
Boston-Neponset	Milton	UnqB04	stream	Unquity Brook	Unquity Brook: US of Adams St	42.26028	71.04694
Boston-Neponset	Milton	UnqB05p	pipe	Unquity Brook	Unquity Brook: pipe under Pleasant St	42.259608	-71.051515
Boston-Neponset	Boston	NepR110p	pipe	Neponset River	Neponset River	42.25738	-71.11550
Boston-Neponset	Boston	NepR116p	pipe	Neponset River	Neponset River	42.25327	-71.11882
Boston-Neponset	Boston	NepR117p	pipe	Neponset River	Neponset River	42.25216	-71.12021
Boston-Neponset	Boston	NepR204p	pipe	Neponset River	Neponset River	42.24854	-71.12462
Boston-Neponset	Boston	NepR120p	pipe	Neponset River	Neponset River	42.23922	-71.12645
Charles	Wellesley	BogB01	stream	Bogle Brook	Bogle Brook: US of fabric store parking lot off of Overbrook Dr.	42.305143	-71.325166

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
Charles	Wellesley	BogB02t	tributary	unnamed brook	Bogle Brook: tributary DS of upper part of Edgemoor Circle)	42.305731	-71.326474
Charles	Wellesley	BogB03	stream	Bogle Brook	Bogle Brook: DS of water main right of way (~150ft DS of # 7 Cedar Brook Rd.)	42.306334	-71.325419
Charles	Wellesley	BogB04	stream	Bogle Brook	Bogle Brook: DS of Cedar Brook Rd., next to 7 Cedar Brook Rd.	42.306802	-71.325565
Charles	Wellesley	BogB05	stream	Bogle Brook	Bogle Brook: DS of Reeds Pond dam	42.307091	-71.325504
Charles	Wellesley	BogB06	stream	Bogle Brook	Bogle Brook: US of Reeds Pond (DS of Woodside Ave)	42.308761	-71.325324
Charles	Wellesley	FulB01	stream	Fuller Brook	Fuller Brook: DS of Dover Rd.	42.28613	-71.29375
Charles	Wellesley	FulB02	stream	Fuller Brook	Fuller Brook: DS of Cottage St.	42.289772	-71.291534
Charles	Wellesley	FulB03	stream	Fuller Brook	Fuller Brook: 100m US of Cameron St. (DS of Duck Pond tributary)	42.295286	-71.288848
Charles	Wellesley	FulB04	stream	Fuller Brook	Fuller Brook: 102m US of Cameron St. (US of Duck Pond tributary)	42.295407	-71.288700
Charles	Wellesley	FulB05p	pipe	Fuller Brook	Fuller Brook: 30" concrete outfall DS of Smith St.	42.301845	-71.280914
Charles	Wellesley	CarB01	tributary	Caroline Brook	Caroline Brook: US of Smith St. (just S of Paine St.), tributary to Fuller Brook	42.303608	-71.279785
Charles	Wellesley	FulB06	stream	Fuller Brook	Fuller Brook: US of Brook St.	42.294530	-71.275494
Charles	Dover	PowB01	stream	Powissett Brook	Powissett Brook: DS of Wilsondale St.	42.255049	-71.237601
Ipswich	Ipswich	IpsR01p	pipe	Ipswich River	Ipswich River: approx. 18" pvc outfall w/ duckbill tide-gate located @ end of Summer St, sample collected in flow 12-15 ft DS of pipe	42.68089	-70.83095
Ipswich	Ipswich	FarB01	stream	Farley Brook	Ipswich River: Farley Brook conduit to Ipswich River ~200-250ft US of Choate Bridge	42.67893	-70.83780
Ipswich	Ipswich	FarB02	stream	Farley Brook	Farley Brook: near "Back to Normal Chiropractic" at 78 Central St	42.68173	-70.84102
Ipswich	Ipswich	KimB01	stream	Kimball Brook	Kimball Brook: DS of Kimball St	42.67478	-70.84062
Ipswich	Ipswich	KimB02	stream	Kimball Brook	Kimball Brook: DS of Heard Dr	42.67516	-70.84977
Ipswich	Middleton	MidB01	stream	Middleton Brook	Middleton Brook: DS of King St	42.59312	-71.01073
Ipswich	Middleton	MidB02	stream	Middleton Brook	Middleton Brook: DS of Middleton Pond culvert	42.59458	-71.01972

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
Ipswich	N. Reading, Reading	IpsR02p	pipe	Ipswich River	Ipswich River: 30" concrete pipe DS of Rt. 28 on N side of river	42.56467	-71.10764
N.Coastal	Beverly	ChuC01	stream	Chubb Creek	Chubb Creek: US of Oak St	42.56270	-70.81051
N.Coastal	Beverly	ChuC02p	pipe	Chubb Creek	Chubb Creek: 12" concrete pipe on right bank ~200 feet US of Oak St	42.56357	-70.81127
N.Coastal	Beverly	ChuC03p	pipe	Chubb Creek	Chubb Creek: 6" metal pipe on right bank ~200 feet US of Oak St	42.56357	-70.81127
N.Coastal	Beverly	ChuC04	stream	Chubb Creek	Chubb Creek: DS of Hale St ~20 feet DS of bridge	42.56408	-70.81335
N.Coastal	Beverly	ChuC05	stream	Chubb Creek	Chubb Creek: DS of Dix Park & adjacent to Save A Tree construction site, @ point where stream flows belowground	42.56443	-70.81502
N.Coastal	Beverly	ChuC06	stream	Chubb Creek	Chubb Creek: culverted stream at Dix Park, access through grate by Haskell St	42.56544	-70.81706
N.Coastal	Beverly	PatB01p	pipe	Beverly Cove	Patch Beach: 18" broken concrete pipe E of 4'X4' culvert, access via Brackenbury Lane, same as SSC 213A	42.550818	-70.848875
N.Coastal	Beverly	CurB01	stream	Curtis Brook	Curtis Brook: emerging @ 4'X4' culvert on Patch Beach, access via Brackenbury Lane, same as SSC 213	42.551066	-70.850292
N.Coastal	Beverly	PatB02p	pipe	Beverly Cove	Patch Beach: 18" rcp W of 4'X4' culvert & Brackenbury Lane, same as SSC 222	42.550596	-70.852159
N.Coastal	Danvers	PorR01p	pipe	Porter River	Porter River: 12" flared concrete outfall @ Sandy Beach (beach entrance off River St)	42.554727	-70.918575
N.Coastal	Danvers	PorR02p	pipe	Porter River	Porter River: 12" cmp at Mead St access point to river US of Sandy Beach (US pipe- one of two)	42.555618	-70.919444
N.Coastal	Danvers	PorR03p	pipe	Porter River	Porter River: 6" plastic pipe in retaining wall of Pope's Landing Marine-access via Harbor St & woods on DS side of marina (US of PorR02p)	42.556502	-70.921156
N.Coastal	Danvers	PorR04p	pipe	Porter River	Porter River: 12" corrugated metal pipe at head of inlet DS of Danversport Yacht Club (access via DYC driveway fr. Rt. 62)- DS of PorR05p	42.557908	-70.915079

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
N.Coastal	Danvers	PorR05p	pipe	Porter River	Porter River: 4" pvc pipe located in ~1'x1' swale DS of Danversport Yacht Club (access via DYC driveway fr. Rt. 62)- US of PorR04p	42.557242	-70.917257
N.Coastal	Marblehead	RivB01p	pipe	Marblehead Harbor	Riverhead Beach: left pipe when facing opening of 54" double concrete culvert near Ocean Ave boat launch, same as SSC 701A	42.492262	-70.855124
N.Coastal	Marblehead	RivB02p	pipe	Marblehead Harbor	Riverhead Beach: right pipe when facing opening of 54" double concrete culvert near Ocean Ave boat launch, same as SSC 701B	42.492287	-70.855130
N.Coastal	Marblehead	MarH01p	pipe	Marblehead Harbor	Marblehead Harbor: 48" concrete pipe at end of Chestnut St & downstairs to the left when facing water	42.495423	-70.854125
N.Coastal	Marblehead	DolC01p	pipe	Doliber Cove	Doliber Cove: 24" pipe near Doliber Landing off Beacon St	42.512943	-70.845533
N.Coastal	Marblehead	StrB01	stream	unnamed brook	Stramski Beach stream: end of Stramski Way DS of last culvert before beach	42.514287	-70.865509
N.Coastal	Marblehead	StrB02t	stream	unnamed brook	Stramski Beach stream: ~20' US of Stramski Way culvert & ~50' DS of pipe draining Pitman Rd, similar to SSC 722B	42.513786	-70.862966
N.Coastal	Marblehead	StrB02p	pipe	unnamed brook	Stramski Beach stream: pipe draining Pitman Rd accessed US of Stramski Way culvert (N side), same as SSC 722B	42.513932	-70.862876
N.Coastal	Marblehead	StrB03p	pipe	unnamed brook	Stramski Beach stream: pipe draining Dodge Rd, access behind 23 Dodge Rd, same as SSC 722A	42.513541	-70.864235
N.Coastal	Marblehead	StrB04	stream	unnamed brook	Stramski Beach stream: ~6' US of StrB03p (pipe behind 23 Dodge Rd)	42.513537	-70.864194
N.Coastal	Salem	DerW01p	pipe	Salem Harbor	Derby Wharf: 18" rcp on NW side, same as SSC 630	42.521091	-70.887103
N.Coastal	Salem	JunB01p	pipe	Salem Harbor	Juniper Beach: 18" ductile iron pipe w/ duckbill tide-gate, access via Cheval Ave., same as SSC 620	42.533995	-70.865886
N.Coastal	Lynn	NahB01p	pipe	Nahant Bay	King's Beach: 20'x8' Lynn CSO box culvert in seawall; to the left of NahB02p when facing outfalls	42.466809	-70.922049
N.Coastal	Lynn	NahB02p	pipe	Nahant Bay	King's Beach: 11'x5' Swampscott chlorinated box culvert in seawall; to the right of NahB01p when facing outfalls	42.466831	-70.922020
N.Coastal	Saugus	Sr01B	stream	Saugus River	Saugus River: US of Elm St	42.47234	-71.00682
N.Coastal	Saugus	BenB01	stream	Bennetts Pond Brook	Bennetts Pond Brook: US of culvert between Marshalls store & Fells Pkwy	42.47969	-71.02510

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
N.Coastal	Saugus	BenB02p	pipe	Bennetts Pond Brook	Bennetts Pond Brook: 18" cmp on left bank, several hundred feet US of Marshalls	42.47826	-71.02854
N.Coastal	Saugus	BenB03p	pipe	Bennetts Pond Brook	Bennetts Pond Brook: cpp on left bank, several hundred feet US of Marshalls & ~20ft US of BenB02p	42.47807	-71.02862
N.Coastal	Saugus	BenB04p	pipe	Bennetts Pond Brook	Bennetts Pond Brook: US of BenB03p	42.47704	-71.02902
N.Coastal	Saugus	BenB05	stream	Bennetts Pond Brook	Bennetts Pond Brook: US of Laurine Rd	42.47589	-71.02929
N.Coastal	Wakefield	Sr04A	stream	Saugus River	Saugus River: US of Vernon St	42.52488	-71.06589
Parker	Rowley	OxpB01p	pipe	Ox Pasture Brook	Ox Pasture Brook: 4" plastic pipe 12-15 ft DS of School St. on left bank	42.71994	-70.87722
Parker	Rowley	OxpB02	stream	Ox Pasture Brook	Ox Pasture Brook: DS of School St	42.71988	-70.87719
Parker	Rowley	OxpB03	stream	Ox Pasture Brook	Ox Pasture Brook: DS of Independent St	42.71533	-70.88382
Parker	Rowley	OxpB04	stream	Ox Pasture Brook	Ox Pasture Brook: DS of pond on DS side of Bradford St	42.714475	-70.886125
Parker	Rowley	OxpB05	stream	Ox Pasture Brook	Ox Pasture Brook: US of pond on US side of Bradford St (~30ft US of road)	42.714549	-70.887095
Parker	Newbury	MilR01t	tributary	Mill River	Mill River: unnamed tributary DS of Governor Dummer Academy WWTP outfall, ~100ft US of Elm St., West of Rt.1	42.74782	-70.89628
Parker	Newbury	MilR02t	stream	Mill River	Mill River: unnamed tributary US of Governor Dummer Academy WWTP outfall	42.74813	-70.89718
Parker	Rowley	BacB01	stream	Bachelor Brook	Bachelor Brook: US of Rt. 133 (near intersection with Rt. 1)	42.70534	-70.90722
Parker	Rowley	BacB02p	pipe	Bachelor Brook	Bachelor Brook: 18" concrete outfall DS of Rt. 133 (left bank)	42.70529	-70.90766

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
Shawsheen	Lawrence	ShaR01t	tributary	unnamed brook	Shawsheen River: tributary E of S Lawrence E Elem. School, ~50ft US of confluence w/ Shawsheen R.	42.69629	-71.14550
Shawsheen	Lawrence	ShaR02t	tributary	unnamed brook	Shawsheen River: conduit at upper end of tributary E of S Lawrence E Elem. School	42.69553	-71.14606
Shawsheen	Lawrence	NA19	pipe	Shawsheen River	Shawsheen River: 48" N. Andover cmp ~200ft DS of Rt 114 (E bank)	42.68444	-71.13833
Shawsheen	Andover	AN64	pipe	Shawsheen River	Shawsheen River: 18" iron pipe on SW (US) side of Haverhill St bridge	42.67222	-71.14944
Shawsheen	Andover	AN59	pipe	Shawsheen River	Shawsheen River: 12" rcp ~30ft US of Haverhill St bridge (E side)	42.67222	-71.14944
Shawsheen	Bedford	EB-30	stream	Elm Brook	Elm Brook: ~15ft DS of Ashby Rd next to Wiggins Ave stop sign	42.48528	-71.27028
Shawsheen	Bedford	WD-20	stream	Hartwell Brook	Hartwell Brook: DS of Wiggins Ave (SW of Summit Health Fitness)	42.48306	-71.26611
Shawsheen	Bedford	AB-10	tributary	unnamed brook	Shawsheen River: tributary running N to S in front of Applied Biosystems (E side of Wiggins Ave), ~2ft US of dry double 36" culvert	42.47972	-71.26417
Shawsheen	Bedford	BE30	pipe	Shawsheen River	Shawsheen River: 12" concrete pipe DS of Summer St. bridge on NE bank	42.47389	-71.26389
Shawsheen	Bedford	SH-440	stream	Shawsheen River	Shawsheen River: DS of Summer St.	42.47389	-71.26417
Shawsheen	Lexington	KB-010	stream	Kiln Brook	Kiln Brook: US of Hartwell Ave.	42.46972	-71.25944
SuAsCo	Sudbury	HopB01	stream	Hop Brook	Hop Brook: US of Landham Rd	42.35722	-71.40306
SuAsCo	Sudbury	HopB02t	tributary	Hop Brook	Hop Brook: tributary DS of Station Rd (near Rt 20)	42.36167	-71.41806
SuAsCo	Sudbury	HopB03	stream	Hop Brook	Hop Brook: ~100ft US of Rt. 20 (and Station Rd tributary)	42.36194	-71.41806
SuAsCo	Sudbury	AlIB01	stream	Allowance Brook	Allowance Brook: US of Raymond Rd	42.35389	-71.42083
SuAsCo	Sudbury	RunB01	stream	Run Brook	Run Brook: US of Hudson Rd	42.39111	-71.43944
SuAsCo	Sudbury	HopB04	stream	Hop Brook	Hop Brook: DS of Dutton Rd and Stearns Mill Pond	42.38778	-71.44889
SuAsCo	Sudbury	HopB05	stream	Hop Brook	Hop Brook: DS of French Pond and Dutton Rd	42.36889	-71.46556
SuAsCo	Sudbury	HopB06	stream	Hop Brook	Hop Brook: DS of Wayside Inn Rd	42.35778	-71.47028

