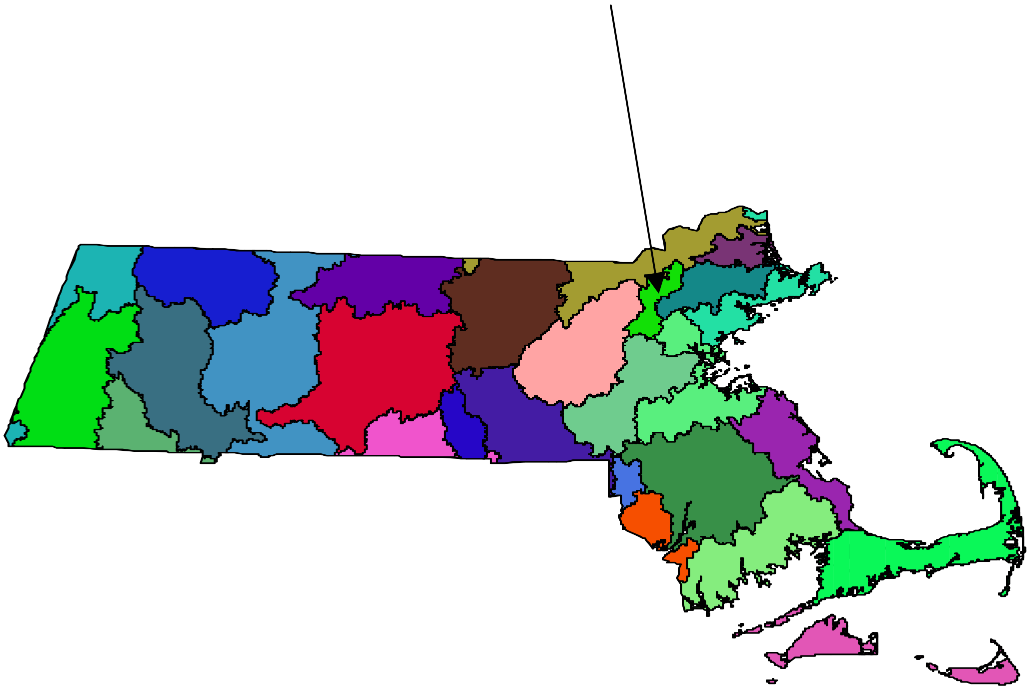
BACTERIA TMDL FOR THE SHAWSHEEN RIVER BASIN

Report MA83-01-2002-24



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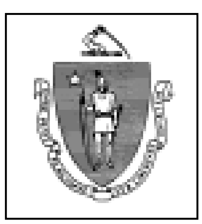

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ACKNOWLEDGMENT

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Total Maximum Daily Loads of Bacteria for Shawsheen River Basin

<u>DEP, DWM TMDL Report MA83-01-2002-24 CN 122.0 August, 2002</u>

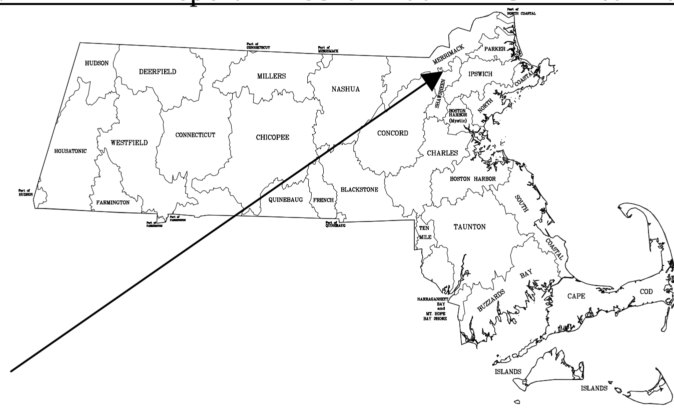
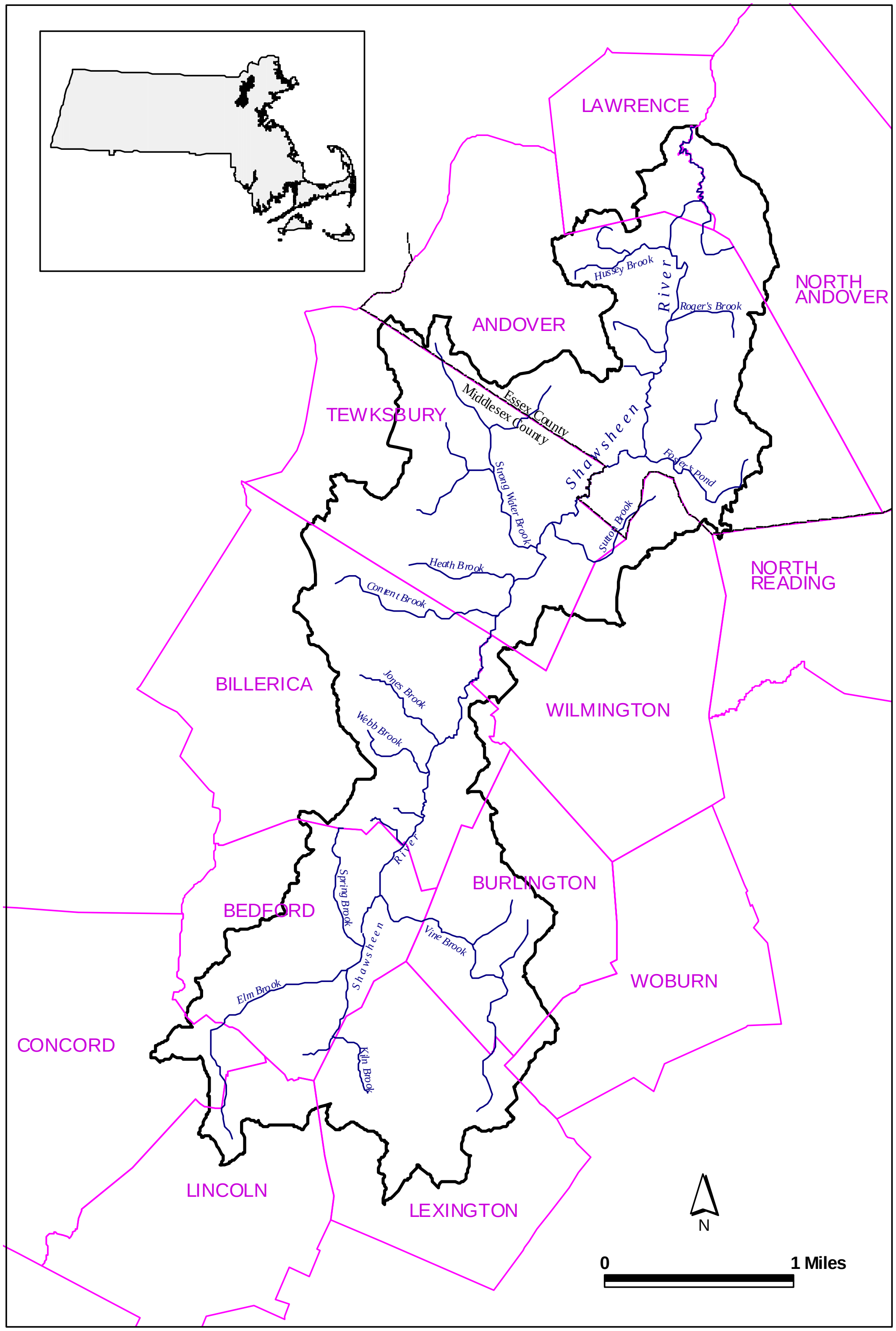


Figure 1: Location of the Shawsheen Basin in Massachusetts.

Key Feature:	**Fecal Coliform Bacteria TMDL for the Shawsheen River Watershed.**
Location:	**EPA Region 1.**
Land Type:	**New England Upland**
303d Listings:	**Fecal coliform (MA83-01, MA83-02, MA83-03, MA83-08, MA83-04, MA83-05, MA83-06).**
Data Sources:	**Merrimack River Watershed Council, Massachusetts Department of Environmental Protection, and Land Use information.**
Data Mechanism:	**Massachusetts Surface Water Quality Standards for Fecal Coliform, Ambient Data, and Best Professional Judgment**
Monitoring Plan:	**Merrimack River Watershed Council (MRWC) and Massachusetts Watershed Initiative Five-Year Cycle**
Control Measures:	**Watershed Management, Storm Water Management, Illicit Discharge Detection and Elimination, Combined and Sanitary Sewer Overflow Abatement, and Septic** System **Maintenance.**


LAWRENCE
NORTH ANDOVER
ANDOVER
TEWKSBURY
NORTH READING
BILLERICA
WILMINGTON
BURLINGTON
BEDFORD
WOBURN
CONCORD
LINCOLN
LEXINGTON
Essex County
Middlesex County
Shawsheen River
Hussey Brook
Roger's Brook
Strong Water Brook
Foster's Pond
Sutton Brook
Heath Brook
Content Brook
Jones Brook
Webb Brook
Spring Brook
Vine Brook
Elm Brook
Kiln Brook
N
0
1 Miles

SHAWSHEEN RIVER BACTERIA TMDL EXECUTIVE SUMMARY

This report represents a TMDL for bacteria in the Shawsheen River, a tributary to the Merrimack River.

Fecal Coliform Wasteload Allocations (WLAs) and Load Allocations (LAs) for the Shawsheen River and Identified Tributary Streams

Bacteria Source Category	WLA (organisms/100ml)	LA (organisms/100ml)
Point Source	Geomean $\leq$ 200 10% $\leq$ 400	
Sewer leaks	0	0
Sanitary Sewer Overflow	0	0
Illicit Sewer Connections	0	
Failing Septic Systems	0	0
Direct Wildlife		Geomean $\leq$ 200 10% $\leq$ 400
Urban Stormwater Runoff	Geomean $\leq$ 200 10% $\leq$ 400	Geomean $\leq$ 200 10% $\leq$ 400

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Executive Summary

The Shawsheen River and three tributaries to the Shawsheen River (Rogers Brook, Vine Brook and Elm Brook) were placed on the State of Massachusetts' 303(d) list of water quality impaired water bodies for bacteria. The applicable State standards specify that the maximum allowable concentration of fecal coliform bacteria shall not exceed a geometric mean of 200 organisms per 100 ml in any representative set of samples, nor shall more than 10% of the samples exceed 400 organisms per 100 ml. Water quality data collected in the watershed show that bacteria concentrations routinely exceed the State water quality standard.

The Shawsheen River is located in Essex and Middlesex Counties, Massachusetts, with its headwaters beginning approximately 12 miles northwest of Boston, Massachusetts. The Shawsheen River flows north from its source in Bedford, to Lawrence, where it merges with the Merrimack River. The Shawsheen watershed is located within the Merrimack hydrologic unit (No. 01070002). The land area of the Shawsheen River watershed is approximately 78 square miles, with suburban residential as the primary land use. Also located within the watershed, near the headwaters of the Shawsheen River, is the Hanscom Air Force Base in Bedford.

The maximum allowable bacteria concentration is defined by the water quality standards for bacteria for Class B waterbodies. Specifically, the maximum allowable bacteria concentration shall not exceed a geometric mean of 200 colonies per 100 ml in any representative set of samples nor shall more than 10% of the samples exceed 400 organisms per 100 ml.

Current bacterial source categories addressed in this TMDL include: 1) illicit sewer connections, 2) sewer line leaks, 3) septic systems, and 4) urban stormwater runoff. Illicit sewer connections, and sewer line breaks were determined to be the source components of greatest significance during dry weather, low flow conditions. Urban stormwater runoff was determined to be the source component of greatest significance during high flow conditions.

Reductions from sewer breaks and illicit sewer connections will be required in order to achieve compliance with water quality standards during dry weather. Reductions from urban stormwater runoff and illicit connections to storm sewer lines will be required in order to achieve compliance with water quality standards during wet weather. Immediate efforts should be devoted to eliminating continuous sources that have the greatest impact during dry weather. Urban stormwater runoff is much more difficult to control, so additional monitoring is recommended to pinpoint urban stormwater runoff sources before implementing controls. There are a lot of "good housekeeping" type practices (e.g., proper pet waste removal, street sweeping, reduction in runoff volumes through diversions of impervious areas to impervious areas, etc.) that should not be delayed until more data are collected.

Introduction

BACKGROUND

Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for water bodies that are not meeting designated uses under technology-based controls. The TMDL process establishes the maximum allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollutant sources and instream conditions. By following the TMDL process, States can establish water quality-based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1999).

High levels of fecal coliform bacteria have been recorded throughout the Shawsheen watershed. Fecal coliform bacteria are used as indicators for pathogenic microorganisms which can cause gastrointestinal illness through ingestion or by entering through broken skin. The entire length of the Shawsheen River appears in the "Final Massachusetts Section 303(d) list of waters - 1998" (MDEP, 1999), due to pathogen violations. In Massachusetts, use of the term "pathogens" on the 303(d) list directly corresponds to fecal coliform (personal communication with Arthur Johnson, 6/24/99). Additionally, three tributaries to the Shawsheen River, Rogers Brook (from its headwaters to its confluence with the Shawsheen River), Vine Brook (from its headwaters to its confluence with the Shawsheen River), and Elm Brook (from its headwaters to its confluence with the Shawsheen River) are also listed for pathogen violations.

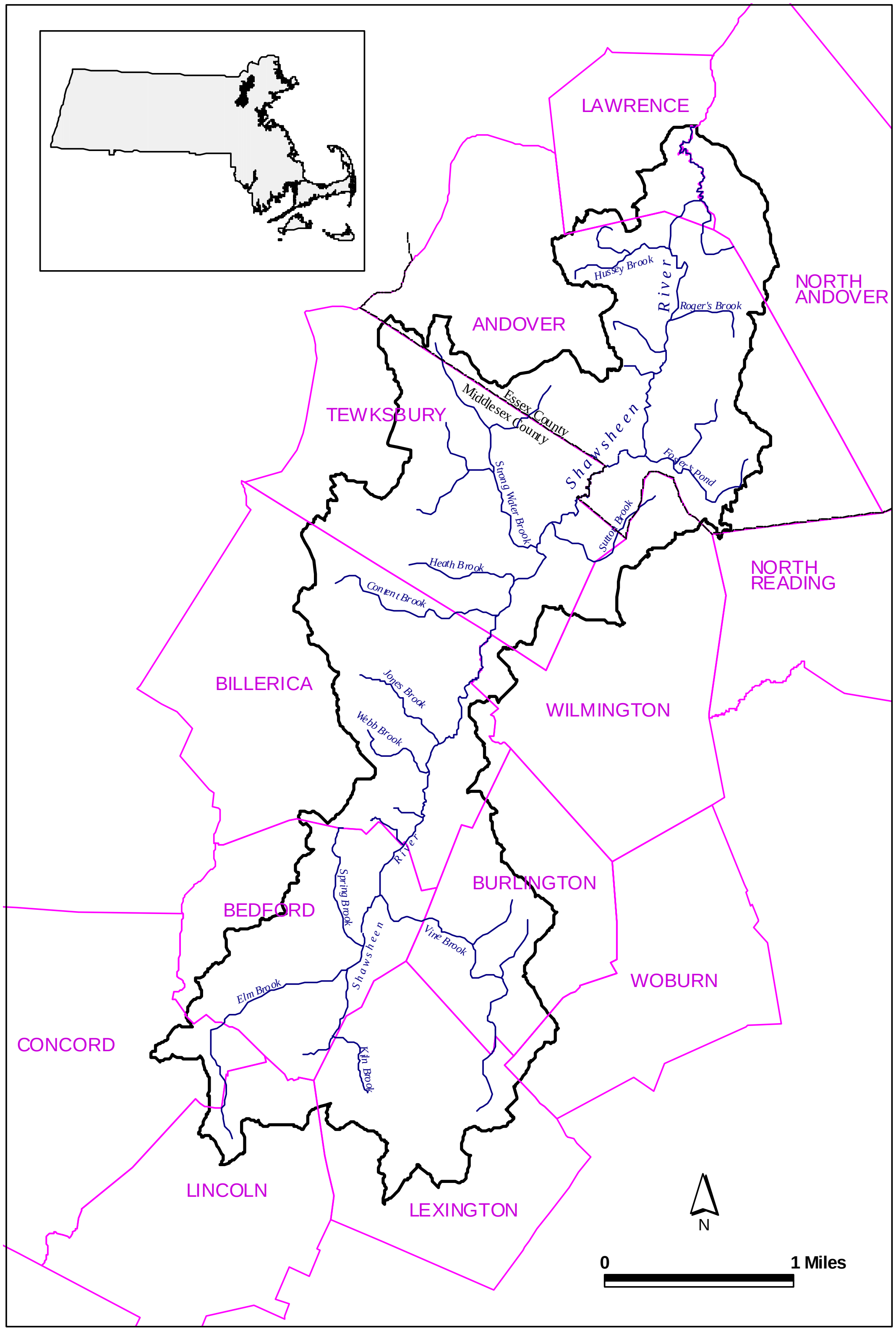
The purpose of this report is to establish a fecal coliform TMDL for segments of the Shawsheen River and tributaries that are currently not meeting Massachusetts' fecal coliform standards and to outline an implementation strategy to abate fecal coliform sources so bacteria standards can ultimately be attained. This TMDL applies not only to those segments within the Shawsheen River basin that appear on the 1998 303(d) list for pathogen violations, but also to all segments in this basin that are identified as being impaired by pathogens through the evaluation of water quality monitoring data as presented in this report. The goal of this TMDL is to improve water quality by reducing or eliminating fecal coliform loading from both point and nonpoint sources, such that the beneficial uses of the Shawsheen River and its tributaries are restored. The implementation strategy is included in Section 9 of this report.

SHAWSHEEN RIVER BASIN

The Shawsheen River meanders through relatively flat terrain in the coastal plain region of New England, just north of Metropolitan Boston. Land use patterns within the watershed have been influenced by its proximity to Boston and by the establishment of the Hanscom Air Force Base in Bedford in 1942 at the headwaters of the Shawsheen. The watershed is predominantly suburban residential with over 50% of the land area developed (Laffin, *et al.*, 1998). Impervious surfaces cover a substantial portion of the watershed, especially at the Air Force Base in the headwaters. Two large wetland areas occur in the middle section of the river, in Tewksbury. Other smaller wetlands are found throughout the watershed (Mattei *et al*., 1999). The Shawsheen River Basin including community boundaries and stream names are illustrated in Figure 1.

Based on rainfall collected in Bedford, the annual average precipitation equals 45.5 inches. Bedford is located near the headwaters of the Shawsheen River. November and December are the wettest months on average, with average monthly precipitation totals of 4.5 and 4.2 inches, respectively. February and August are the driest months on average, with average precipitation totals of 3.4 and 3.43 inches, respectively. These calculations were based on 37 complete years of precipitation data. All fecal coliform data analyzed within this report were collected between 1989 and 1998, between the months of June and October.

Figure 1. Shawsheen River Basin



Problem Assessment

The Shawsheen River along with three tributaries to the Shawsheen River (Vine Brook, Elm Brook and Rodgers Brook) were listed on the Massachusetts Department of Environmental Protection (MDEP) 1998 303(d) list (MDEP, 1999) as being impaired by pathogens. The segments listed for pathogens are presented in Table 1. The Shawsheen River was placed on the Massachusetts 1998 303(d) list due to pathogen violations recorded at MDEP ambient water quality monitoring stations. According to MDEP (personal communication with Arthur Johnson, 6/24/99) the term pathogens, in this case, directly corresponds to fecal coliform bacteria since that is the parameter represented in the State water quality standard.

Fecal coliform data collected by the Massachusetts Department of Environmental Protection and the Merrimack River Watershed Council (MRWC) reflect numerous violations of the fecal coliform water quality target. Data that were analyzed as part of this TMDL include fecal coliform data collected by the Merrimack River Watershed Council in 1996, 1997 and 1998 as well as fecal coliform data collected by MDEP in 1989 and 1995-96. Beginning in 1997, the Merrimack River Watershed Council's monitoring activities have been conducted according to an approved Quality Assurance Project Plan (QAPP). The 1996 MRWC data were not collected according to a QAPP.

This TMDL report addresses fecal coliform contamination originating within the Shawsheen River watershed. It addresses the entire length (25 miles) of the river from the headwaters to the confluence with the Merrimack River as well as all tributaries to the Shawsheen River that were identified as being impaired by pathogens on the 1998 303(d) list or through analysis of water quality monitoring data (Table 2). It does not address other pollutants identified on the 303(d) list that may be contributing to the non-attainment of water quality standards.

Table 1. Shawsheen River Basin Segments Listed for Pathogens on Massachusetts' 1998 303(d) List

Segment ID	Waterbody Name and Description
MA83-01	Shawsheen River, Summer Street (historically listed as Maguire Road) to confluence with Spring Brook, Bedford. Miles 25.0-23.3
MA83-02	Shawsheen River, Confluence with Spring Brook, Bedford to Central Street (historically listed as Horn Bridge), Andover. Miles 23.3-5.9
MA83-03	Shawsheen River, Central St. (Prior to 1997 cycle listed as Horn Bridge, Miles 5.9-0.0) to confluence with Merrimack River, Lawrence. Miles 6.2-0.0.
MA83-08	Shawsheen River, Headwater, north of Folly Pond and North Great Road, Lincoln to Summer Street, Bedford. Miles 27.0 – 25.0.
MA83-04	Rodgers Brook, Outlet of first unnamed pond, Andover (Prior to 1997 cycle listed as "Headwaters Billerica…, Miles 1.1-0.0") to confluence with Shawsheen River, Andover. Miles 1.3-0.0
MA83-06	Vine Brook, Headwaters (southeast of Granny Hill) near Grant Street, Lexington to confluence with Shawsheen River, Bedford. Miles 6.8-0.0
MA83-05	Elm Brook, Headwaters, Lincoln to confluence with Shawsheen River, Bedford. Miles 5.0 – 0.0

Table 2. Shawsheen River Basin Segments Identified as Impaired by Pathogens, Through Analysis of Water Quality Monitoring Data

Waterbody Name[1]		
Clark Brook	Little Content Brook Tributary (LCB 2.0)	Sandy Brook
Clark Pond	Long Meadow Brook	Spring Brook
Content Brook	Meadow Brook	Strong Water Brook
Elm Brook Tributary	North Lexington Brook	Sutton Brook
Kiln Brook	Pinnacle Brook	Tributary to Content Brook (COBT 0.0)
Kiln Brook Tributary (KBT 0.2)	Pomp's Pond Outlet	Tributary from Foster's Pond/Foster's Brook (FPR 2.4)

[1]MRWC Station ID is in parentheses, when waterbody name is ambiguous

Water Quality Standards

Fecal coliform bacteria are found in the intestinal tract of warm-blooded animals and their presence in surface waters is an indication of fecal contamination. The Surface Water Quality Standards for the Commonwealth of Massachusetts are described in 314 CMR 4.00. For Class B waters such as the Shawsheen River and its tributaries, the water quality standards require that fecal coliform bacteria concentrations shall not exceed a geometric mean of 200 organisms per 100 ml in any representative set of samples, nor shall more than 10 percent of the samples exceed 400 organisms per 100 ml.

Numeric targets along with the definition of Class B waters, as presented in the Massachusetts State Water Quality Standards, follow below:

> **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 public 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."
>
> **Fecal Coliform Bacteria** "Shall not exceed a geometric mean of 200 organisms per 100 ml in any representative set of samples nor shall more than 10% of the samples exceed 400 organisms per 100 ml. This criterion may be applied on a seasonal basis at the discretion of the Division."

Fecal Contamination of the Shawsheen River Basin

This section provides an inventory and analysis of available observed instream fecal coliform monitoring data in the Shawsheen River watershed. This section includes the following:

- Inventory of fecal coliform data
- Analysis of instream water quality monitoring data

INVENTORY OF FECAL COLIFORM DATA

This section provides an overview of fecal coliform data available for this report. The Shawsheen River and its tributaries have been monitored for fecal coliform since 1989. The database used for this TMDL contains over 1,200 fecal coliform samples collected by both the Massachusetts Department of Environmental Protection (1989, 1995-1996) and the Merrimack River Watershed Council (1996, 1997, 1998). All fecal coliform data were collected between the months of June and October. Fecal coliform data obtained from the following sources are discussed further below:

- Massachusetts Department of Environmental Protection
- Merrimack River Watershed Council

Massachusetts Department of Environmental Protection

The Massachusetts Department of Environmental Protection (MDEP) conducted two monitoring programs for fecal coliform on the Shawsheen River and its tributaries. Ten stations were sampled in the 1989 study, while samples were collected at 27 stations during the 1995-96 study. Of the stations in the MDEP surveys, a total of 8 and 16 were located on the Shawsheen River during the 1989 and 1995-96 surveys, respectively. All data were collected between June and October.

Merrimack River Watershed Council

The Merrimack River Watershed Council (MRWC) conducted three monitoring programs for fecal coliform on the Shawsheen River and its tributaries. Thirty-six stations were sampled in 1996, seventy-seven were sampled in 1997 and sixty-nine stations were sampled in 1998. Of these stations, a total of 3, 35 and 24 were located on the mainstem of the Shawsheen River in 1996, 1997 and 1998, respectively. All data were collected between June and October. The 1997 and 1998 MRWC data were collected using a QAPP; however, the 1996 data were not. All data are included in the analyses that follow.

ANALYSIS OF INSTREAM WATER QUALITY MONITORING DATA

This section presents an analysis of fecal coliform data collected within the Shawsheen River Basin between 1989 and 1998. Although only the MDEP data were considered in the decision to list the Shawsheen River on the 303(d) list (personal communication, Arthur Johnson, 6/99), data collected by both the MDEP and MRWC are compared to the State Water Quality Standards in this assessment, to determine exceedances within the watershed. Over 1,200 samples were collected within the Shawsheen River basin between 1989 and 1998. 450 of these samples were collected from the mainstem of the Shawsheen River between 1989 and 1998 at a total of 45 different locations along the length of the river.

Individual data may be obtained from the Merrimack River Watershed Council or the Massachusetts Department of Environmental Protection. Additional discussion of the data and figures showing monitoring locations may be found in the following reports:

Department of Environmental Protection, Massachusetts Division of Water Pollution Control. 1990. Shawsheen River 1989 Water Quality Survey Data and Water Quality Analysis. Publication No. 16, 483-25-25-10-90-CR.

Merrimack River Watershed Council. 1999. Shawsheen River Watershed 1996-1998 Volunteer Monitoring Report.

Massachusetts Department of Environmental Protection. 1995. 1996 Shawsheen Assessment Summary Report.

Defining Wet and Dry Weather Samples

A rain gage located in Bedford, Massachusetts was used for the wet and dry weather data analyses. Over the 1989-1998 period, 45% of the samples were dry weather samples, while 19% were wet weather samples. Wet weather samples were only available for 1996 and 1997. 36% of the samples fell into neither the wet nor the dry weather category. In order to make best use of all of the available data, comparisons to the water quality standards were made using all of the data. Where available, dry and wet weather samples were compared separately.

For the purposes of this TMDL, dry and wet weather samples are defined as:

- Dry weather sample: any sample collected on a day where no significant precipitation (<0.1 inch) was recorded in the previous 72 hours.
- Wet weather sample: any sample collected on a day where greater than 0.1 inches of rainfall was recorded.

The sum of wet and dry samples at a given station does not always add up to the total number of samples. This is related to the manner in which dry and wet weather sampling events are defined. The approach used leaves some samples undefined. For example, if a sample was collected on a day where precipitation was zero, it was not defined as a dry weather sample if the sum of precipitation on the three preceding days was >0.1 inches. This same sample would not be defined as a wet weather sample either because there was no precipitation on that day. The results collected on such a day are included in the calculation of the overall statistics, but are not included in the wet weather or dry weather summary statistics.

Table 3 presents total precipitation for the years during which monitoring occurred, and a comparison to the average precipitation for the Bedford station. As shown in this table, 1989 was the closest to an average year in terms of precipitation totals, while 1996 and 1998 were significantly wetter than average. 1995 and 1997 were drier than average years.

Table 3. Precipitation Analysis

Year	Total precipitation (in)	% difference from average[1]	Monitoring conducted
1989	44.7	-2%	Dry weather only
1995	41.0	-10%	Dry weather only
1996	61.5	35%	Wet and dry weather
1997	39.7	-13%	Wet and dry weather
1998	55.9	23%	Dry weather only

[1]Average total precipitation = 45.5 inches

Data Analysis

Tables 4 through 8 present the calculated geometric means and percent of samples exceeding 400 organisms per 100 ml for each location in 1989, 1995-96, 1996, 1997 and 1998. Geometric means were calculated using all data collected by either the MDEP or the MRWC within each of the time periods just presented. Consistent with the Water Quality Standards for fecal coliform, data are summarized and presented in terms of a geometric mean and also in terms of percent of samples that exceed 400 organisms/100 ml. In instances where both wet and dry weather samples were collected, results are presented for both conditions as well as for the entire data set.

An analysis of all data collected by MDEP and the MRWC between 1989 and 1998 is presented in Table 9. Consistent with the Water Quality Standards for fecal coliform, data are summarized and presented in terms of a geometric mean and also in terms of percent of samples that exceed 400 organisms/100 ml. In instances where both wet and dry weather samples were collected, results are presented for both conditions as well as for the entire data set. Data for MDEP and MRWC stations are reported separately because it was difficult to determine if stations established by these different entities coincided.

Review of fecal coliform data clearly illustrates the extent of the bacteria violations throughout the Shawsheen River Basin. Violations of the bacteria standard are regularly observed during wet and dry weather events in all four of the waterbodies listed for pathogens on the 303(d) list: Shawsheen River, Elm Brook, Roger’s Brook and Vine Brook. These four waterbodies have violated water quality standards during every period in which data are available. This TMDL applies not only to those segments within the Shawsheen River basin that appear on the 1998 303(d) list for pathogen violations, but also to all segments in this basin that are identified as being impaired by pathogens through the evaluation of water quality monitoring data as presented in this report.

Further illustrating the extent of the bacteria problem in the Shawsheen River watershed are the number of other tributaries in which violations of the bacteria standard are regularly or recently observed. These include: Content Brook, Kiln Brook, North Lexington Brook, Sutton Brook, Sandy Brook, Long Meadow Brook, Clark Brook, Clark Pond, Pinnacle Brook, Meadow Brook, Strong Water Brook, Tributary from Foster’s Pond/Foster’s Brook, Elm Brook Tributary, Kiln Brook Tributary, Little Content Brook Tributary, Tributary to Content Brook, Pomp’s Pond Outlet and Spring Brook.

Exceedingly high bacteria concentrations (>5,000 #/100ml) were observed in Vine Brook (1995-96, 1997, 1998), Strong Water Brook (1996), Roger's Brook (1996), Content Brook (1996), Elm Brook (1997), North Lexington Brook (1997), several locations along the Shawsheen River (1997, 1998), Kiln Brook (1998) and Pinnacle Brook (1998). In 1997, bacteria concentrations as high as 375,000 #/100ml, 26,000 #/100ml and 25,000 #/100ml were observed in the Shawsheen River, Elm Brook and Vine Brook, respectively. In 1998, bacteria concentrations as high as 112,000 #/100ml and 20,000 #/100ml were observed in the Shawsheen River and Pinnacle Brook, respectively. The high concentrations observed in the Shawsheen River were collected from the same station in 1997 and 1998.

Forty-five percent of the existing data represent dry weather conditions (as defined in Section 5.2.1). These data are valuable for identifying dry weather sources of bacteria such as leaking sewers and illicit sewer connections, but are of limited utility for assessing wet weather impacts. Nineteen percent of the data were collected during wet weather conditions. Wet weather samples were collected by the MRWC in 1996 and 1997. Recall that the 1996 MRWC data were not collected under a QAPP. There are no wet weather samples in either of the MDEP datasets or in the 1998 MRWC dataset (as defined in Section 5.2.1). To illustrate the relative magnitudes of dry and wet weather bacteria levels, Tables 6 and 7 provide separate geometric means for dry and wet weather conditions for the 1996 MRWC and 1997 MRWC datasets, respectively. The 1996 wet weather geometric means are consistently higher than the dry weather geometric means in Table 6 (1996 MRWC dataset). However, violations of the water quality standard are observed during both dry and wet weather. Similarly, 1997 wet weather fecal coliform geometric means are frequently higher than the dry weather geometric means (Table 7, 1997 MRWC dataset). Violations of the water quality standard are observed during both dry and wet weather. At several stations along Vine Brook, Elm Brook, and the Shawsheen River, the wet weather geometric mean is lower than the dry weather geometric mean. This may indicate a dilution effect, however, it may also be related to the timing of sample collection in relationship to peak storm runoff. Without additional wet weather data collection it is difficult to determine the cause for this.

A comparison of 1997 and 1998 dry weather geometric means for stations that were sampled during both of these years shows that, in general, dry weather geometric means are higher in 1998 than in 1997. Figure 2 shows the percent difference in 1998 dry weather geometric means at each station, as compared to 1997 results. The stations are not shown in any particular order.

Table 4. 1989 MDEP Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MDEP ID	Station Description	No. of Samples Collected[1]	Geometric Mean	% of Samples > 400	No. of Dry Weather Samples	Dry Weather Geometric Mean	% of Dry Samples > 400
Elm Brook	EB02	Grant Road bridge, Bedford	2	188	50	1	80	0
Shawsheen	SH01	0.2 mi downstream of confluence w/ Kiln Brook (Off Westview St., Bedford).	2	693	50	1	240	0
Shawsheen	SH01 A	Where river emerges from underground at Hanscom Field in Bedford	2	456	50	1	400	0
Shawsheen	SH02	0.4 mi downstream of confluence with Elm Brook. Page Rd. Bridge, Bedford	2	1,183	100	1	700	100
Shawsheen	SH06	Route 38 Bridge, Tewksbury Just downstream of marshy reach.	2	139	0	1	160	0
Shawsheen	SH06 A	Burlington water supply intake - located in swampy reach that begins 3.7 mi upstream of station (at Route 62)	2	173	50	1	600	100
Shawsheen	SH08	Located in the middle of an impounded area. Andover St. bridge at	2	268	0	1	180	0

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		Ballardvale, Andover.						
Shawsheen	SH09	Horn Bridge, Andover	2	120	0	1	90	0
Shawsheen	SH11	Route 114 bridge, South Lawrence.	2	268	0	1	240	0
Vine Brook	VB01	Route 62 culvert, Bedford	2	858	100	1	460	100

[1]No wet weather samples were collected.

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Table 5. 1995-96 MDEP Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MDEP ID	Station Description	No. of Samples Collected[1]	Geometric Mean	% of Samples > 400	No. of Dry Weather Samples	Dry Weather Geometric Mean	% of Dry Samples > 400
Elm Brook	EB02	At Great Rd., Routes 4 & 225, Bedford	5	310	40	3	363	33
Elm Brook	EB03	At South Rd, Bedford	1	60	0	0		
Kiln Brook	KB01	At Hartwell Ave., Lexington	1	80	0	0		
Rogers Brook	RB01	200ft from confluence w/Shawsheen	5	1982	100	3	1,887	100
Rogers Brook	RB02	Off Chestnut St. near headwaters, Andover	5	208	40	3	150	33
Shawsheen	SH12	At Merrimack St., Lawrence long rope to sample side of river approx. 30-40 feet above right where river goes underground	5	844	80	3	1,141	100
Shawsheen	SH11 A	Loring St., Lawrence	4	479	75	3	388	67
Shawsheen	SH07 A	At Route 38, Tewksbury	5	217	20	3	272	33
Shawsheen	SH07	At USGS gage (Salem Rd/Rte 129 (Shawsheen Avenue)). Billerica/Wilmington off bridge downstream side	5	122	0	3	168	

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Table 5. 1995-96 MDEP Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MDEP ID	Station Description	No. of Samples Collected[1]	Geometric Mean	% of Samples > 400	No. of Dry Weather Samples	Dry Weather Geometric Mean	% of Dry Samples > 400
Shawsheen	SH06 A	At Burlington water intake - behind school at Alexander Road, Billerica brick building pump station cement pontoon on river at intake	4	136	0	3	146	
Shawsheen	SH06	At Route 3A, Billerica off bridge downstream side	5	246	20	3	384	33
Shawsheen	SH11	At Route 114, Salem Turnpike	5	430	80	3	482	100
Shawsheen	SH02	At Page Rd, Bedford upstream from center cement bridge structure	5	313	40	3	315	33
Shawsheen	SH01	At Summer St., Bedford, north side of road downstream	5	139	40	3	141	33
Shawsheen	SH01 A-MA	Drainage culvert from below runway (Massport side), Bedford- discharges to Shawsheen R. from 6th pipe from left side of pipe array	4	39	0	3	48	
Shawsheen	SH01	Drainage culvert from	4	301	25	3	335	33

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Table 5. 1995-96 MDEP Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MDEP ID	Station Description	No. of Samples Collected[1]	Geometric Mean	% of Samples > 400	No. of Dry Weather Samples	Dry Weather Geometric Mean	% of Dry Samples > 400
	A-US	Hanscom AFB Bedford 3 pipes sampled from left pipe but all connected to same D box						
Shawsheen	SH01 B	At Hanscom School - Hanscom Air Force Base, Lincoln (from footbridge at school upstream - miles calculated from straight line SH01AUS to school.	5	181	20	3	126	
Shawsheen	SH10	At Route 28, Andover	5	175	0	3	197	
Shawsheen	SH09 A	Brook St. (near Shawsheen Rd) Andover	5	100	20	3	127	33
Shawsheen	SH09	At Central Street, Andover	5	90	0	3	78	
Shawsheen	SH08	Above Ballardvale Dam, Andover	5	103	0	3	124	
Spring Brook	SH03	Off downstream side of bridge on Rt. 62, Bedford	2	28	0	1	40	
Strong Water Brook	SW01	~100 feet from confluence, at Shawsheen St., Tewksbury	5	111	0	3	156	
Vine Brook	VB01	At Route 62, Bedford	5	219	20	3	352	33
Vine Brook	VB02	At Terrace Hall Ave near	1	160	0	0		

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Table 5. 1995-96 MDEP Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MDEP ID	Station Description	No. of Samples Collected[1]	Geometric Mean	% of Samples > 400	No. of Dry Weather Samples	Dry Weather Geometric Mean	% of Dry Samples > 400
	A	pump station, Burlington						
Vine Brook	VB02	At East St., near Grant Street, Lexington	1	40	0	0		
Vine Brook	VB0	At emergence of underground culvert at Grant St., Lexington	1	6300	100	0		

[1]No wet weather samples were collected.

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Table 6. 1996 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MRWC ID	Station Description	Dry Weather Geometric Mean	Number of Dry Samples	Wet Weather Geometric Mean	No. of Wet Samples	Total Number Samples	Overall Geometric Mean	Overall % of Samples > 400
Content Brook	COB 1.7	At Gray Street in Billerica	321	2	1250	4	8	562	50
Content Brook	COB 2.0	Whipple Street	250	2	2348	4	8	964	63
Content Brook	COB 3.5	At Shawsheen	339	2	596	4	8	442	25
Tributary to Content Brook	COBT 0.0		75	2	79	4	8	51	25
Tributary to Content Brook	COBT 1.0		152	2	165	4	8	135	0
Elm Brook	EB 0.5	On North side of Route 2A crossing, Lincoln, just before Concord line	92	2	624	4	8	238	38
Elm Brook	EB 2.0		215	2	332	4	8	208	25
Elm Brook	EB 4.0	At Great Road (62) crossing, Bedford	130	2	463	4	8	198	38
Foster's Pond	FPR 1.4	Foster's Pond on pond side of the dam	32	2	14	4	8	22	0
Tributary from Foster's Pond/ Foster's Brook	FPR 2.1	At River St. culvert in Andover	130	2	77	4	8	90	0
Tributary from Foster's Pond/	FPR 2.4	RR bridge just before Shawsheen enters	87	2	379	4	8	284	38

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Table 6. 1996 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MRWC ID	Station Description	Dry Weather Geometric Mean	Number of Dry Samples	Wet Weather Geometric Mean	No. of Wet Samples	Total Number Samples	Overall Geometric Mean	Overall % of Samples > 400
Foster's Brook		Ballardvale Mill Pond							
Kiln Brook	KB 0.5	Before landfill	130	1	770	3	5	353	40
Kiln Brook	KB 0.8	After leaving landfill	280	1	433	3	5	355	40
Meadow Brook	MDB 1.2	At culvert under Kendall Road, near Ames pond		0	800	1	1	800	100
Meadow Brook	MDB 2.6	By Canalas Waste property, Pinnacle Road crossover, Tewksbury (US of SWB)	134	1	800	1	3	311	33
Pomp's Pond	PP 0.0	On beachhead in Andover	28	3	29	4	9	31	0
Pomp's Pond outlet	PP 0.5	Pond outlet	93	3	502	4	9	149	22
Roger's Brook	ROB 0.0	At Highland Ave, Phillips academy	121	2	3550	2	6	420	50
Roger's Brook	ROB 1.0	School ball field before river is culverted	663	2	4460	2	6	1,477	83
Roger's Brook	ROB 1.5	Upstream of confluence w/ Shawsheen R.	635	2	5126	2	6	1,912	100
Shawsheen River	SH 1.0	Where Kiln Brook meets the Shawsheen	70	1	800	1	2	237	50

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Table 6. 1996 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MRWC ID	Station Description	Dry Weather Geometric Mean	Number of Dry Samples	Wet Weather Geometric Mean	No. of Wet Samples	Total Number Samples	Overall Geometric Mean	Overall % of Samples > 400
Shawsheen River	SH 12.3	Below Ballardvale dam - near pipe discharging brown scum.	90	1			1	90	0
Shawsheen River	SH 12.35	At outfall pipe from Pomp's Pond	223	3	246	4	9	256	33
Shawsheen River	SH 2.2	At Cedar Ridge Terrace, Bedford	30	1	800	1	2	155	50
Strong Water Brook	SWB 0.6	Where Strong Water Brook crosses Lee St. near Tewksbury cemetery		0	2846	3	3	2,846	100
Strong Water Brook	SWB 1.0	At culvert under East St. , near Tewksbury Cemetery	363	3	790	4	9	800	89
Strong Water Brook	SWB 2.0	Crossover at East St./Maple St. intersection near state hospital, Tewksbury	25	3	311	4	9	172	33
Strong Water Brook	SWB 3.0	At end of Algonquin Dr.	75	3	121	4	9	116	11
Strong Water Brook	SWB 3.3	Just before confluence with Shawsheen	84	2	296	4	7	205	29
Vine Brook	VB 1.8	Just upstream of Butters-	390	2	640	3	6	502	67

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Table 6. 1996 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MRWC ID	Station Description	Dry Weather Geometric Mean	Number of Dry Samples	Wet Weather Geometric Mean	No. of Wet Samples	Total Number Samples	Overall Geometric Mean	Overall % of Samples > 400
		worth Pond, below bridge on North St., Lexington							
Vine Brook (Pond)	VB 2.9	Butterfield Pond - near spillway where Vine Brook exits	63	2	685	4	7	282	43
Long Meadow Brook (trib to VB)	VB 4.0	Before Long Meadow Brook enters Vine Brook	92	2	718	4	7	349	57
Vine Brook	VB 4.3	By Lexington St., Burlington	123	2	267	4	7	206	43
Vine Brook	VB 5.0	At Terrace Hall Road, Burlington	80	3	454	4	9	176	22
Vine Brook	VB 5.3	Middlesex Turnpike, Burlington	86	3	669	2	7	156	29
Vine Brook	VB 6.3	South side of Route 62 overpass near on/off ramp for route 3 south, Bedford	85	3	385	4	9	180	33

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Table 7. 1997 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MRWC ID	Station Description	Dry Weather Geometric Mean	Number of Dry Samples	Wet Weather Geometric Mean	No. of Wet Samples	Total Number Samples	Overall Geometric Mean	Overall % of Samples > 400
Unnamed stream	BM 0.3	Near culvert on south side of reservation road between Oriole and Mayflower, Baker's Meadow, Andover	280	1	90	1	2	159	0
Unnamed stream	BM 0.7		20	1	200	1	3	68	0
Pond in Baker's Meadow	BM 0.8	About 100-200 m from where pond drains	2	1	55	2	6	12	0
Content Brook	COB 1.7	At Gray Street in Billerica	77	2	1,300	1	6	256	33
Content Brook	COB 2.8	Beech Road crossing, Tewksbury	408	2	N/A	0	5	344	20
Elm Brook	EB 0.5	On North side of Route 2A crossing, Lincoln, just before Concord line	430	1	71	2	5	201	20
Elm Brook	EB 1.5	On North side of Virginia Road, Concord	126	1	50	1	4	86	0
Elm Brook	EB 2.5	At Hartwell Road, crossing across street from Raytheon E-Systems, Bedford	315	2	128	2	5	156	20
Elm Brook	EB 3.3	Off Washington St., Bedford	498	2	770	2	6	563	83

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Table 7. 1997 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MRWC ID	Station Description	Dry Weather Geometric Mean	Number of Dry Samples	Wet Weather Geometric Mean	No. of Wet Samples	Total Number Samples	Overall Geometric Mean	Overall % of Samples > 400
Elm Brook	EB 4.0	At Great Road (62) crossing, Bedford	1,975	2	7,100	1	4	2,370	75
Elm Brook tributary	EBT 0.2		522	2	134	1	4	371	50
Foster's Pond	FPR 1.0	In Foster's pond	6	2	2	1	6	3	0
Foster's Pond	FPR 1.4	Foster's Pond on pond side of the dam	14	2	28	2	7	9	0
Tributary from Foster's Pond/ Foster's Brook	FPR 1.6	At Woburn Street Culvert	117	2	380	1	6	93	0
Tributary from Foster's Pond/ Foster's Brook	FPR 2.1	At River St. culvert in Andover	66	2	30	1	6	50	0
Heath Brook	HB 1.75	At east side of Foster Street crossover, Tewksbury	103	2	400	1	5	103	0
Hussey Brook	HP 1.3	Canterbury street at Hussey Brook crossover	2	1	2,700	1	3	52	33
Hussey Pond	HP 1.8	Off Poor Street, Andover	120	1	300	1	3	98	0
Kiln Brook	KB 0.6	Before Hartwell Ave, Bedford	460	1	252	2	6	212	33
Little Content Brook	LCB 1.0	At tributary site behind Adams property, Billerica	36	2	100	1	5	50	0
Little Content Brook	LCB 2.0	Governor Fuller tributary to Content Brook	268	2	94	1	6	135	0

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Table 7. 1997 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MRWC ID	Station Description	Dry Weather Geometric Mean	Number of Dry Samples	Wet Weather Geometric Mean	No. of Wet Samples	Total Number Samples	Overall Geometric Mean	Overall % of Samples > 400
Tributary									
Long Meadow Brook (trib to VB)	LMB 0.7	At Stone Brook Road, Burlington	2,000	1	440	1	3	682	67
McKee Brook	MC 0.3	End of Wyman Rd., Billerica	26	2	18	2	6	42	17
Meadow Brook	MDB 2.6	By Canalas Waste property, Pinnacle Road crossover, Tewksbury (US of SWB)	50	2	400	1	6	84	0
North Lexington Brook (Pond) trib. To Kiln Brook	NL 0.3	Where NLB exits pond, Lexington	216	3	789	3	10	362	40
Pomp's Pond (Pond)	PP 0.0	On beachhead in Andover	2	1	31	2	4	9	0
Sandy Brook (trib to VB)	SB 0.6	At Sandy Brook Road, Burlington	360	1	698	2	4	612	75
	SB 0.8		22,000	1	3,800	1	3	6,376	100
Shawsheen River	SH 0.0	At Hanscom AFB outfall pipes	1,210	3	1,000	2	8	1,243	63
Shawsheen River	SH 0.3	At Hanscom airfield outfalls, Bedford	743	3	1,000	2	8	856	50
Shawsheen	SH 1.8	Near parking lot drain pipes,	N/A	0	2,100	1	1	2,100	100

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Table 7. 1997 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MRWC ID	Station Description	Dry Weather Geometric Mean	Number of Dry Samples	Wet Weather Geometric Mean	No. of Wet Samples	Total Number Samples	Overall Geometric Mean	Overall % of Samples > 400
River		Bedford							
Shawsheen River	SH 10.6	At Route 93, Andover	740	1	295	2	6	200	17
Shawsheen River	SH 11.0	At Ryk Co. Chemical Co. in Andover	2,000	1	950	2	6	490	67
Shawsheen River	SH 12.3 (SHL 4)		150	1	219	2	6	233	17
Shawsheen River	SH 12.35 (SHL 5)		200	1	98	2	6	158	17
Shawsheen River	SH 13.3	At backyard access from 9 Abbott Bridge Drive, Andover	180	2	77	2	7	93	0
Shawsheen River	SH 13.4	Upstream of Horn Bridge at Central St., Andover	54	2	N/A	0	5	101	0
Shawsheen River	SH 14.2	At Essex St. bridge, Andover	106	2	173	2	6	116	0
Shawsheen River	SH 14.4	At marsh, Andover	9	2	693	2	7	131	29
Shawsheen River	SH 14.45	At 12" pipe behind Andover commons development	122	2	894	2	7	194	29
Shawsheen River	SH 14.5	At iron grate behind Andover commons development, Andover	138	2	300	2	7	279	43
Shawsheen	SH	At riverbank slightly upstream	157	2	219	2	7	246	29

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Table 7. 1997 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MRWC ID	Station Description	Dry Weather Geometric Mean	Number of Dry Samples	Wet Weather Geometric Mean	No. of Wet Samples	Total Number Samples	Overall Geometric Mean	Overall % of Samples > 400
River	14.55	from Post Office, Andover							
Shawsheen River	SH 14.6	At riverbank behind Post Office, Andover	290	2	1,470	2	7	482	57
Shawsheen River	SH 14.9	Downstream from Route 28	358	2	173	2	5	241	20
Shawsheen River	SH 15.5	Downstream from Haverhill Street bridge, Andover	452	2	424	2	7	579	57
Shawsheen River	SH 15.7	Downstream from Kenilworth St. bridge, Andover	452	2	424	2	7	664	57
Shawsheen River	SH 15.8	At discharging culvert 100 yards downstream from Kenilworth	14,000	1	N/A	0	2	1,122	50
Shawsheen River	SH 16.6	Just downstream of Route 114 bridge on East Bank, Andover	400	2	358	2	7	368	14
Shawsheen River	SH 17.8	Just downstream from Mass. Ave. crossover, North Andover	645	2	1,196	2	6	698	83
Shawsheen River	SH 18.25	At Shawsheen culvert before entering Merrimack River	329	2	2,491	2	6	542	67
Shawsheen River	SH 2.3	By intersection of Page Rd. and Shawsheen Rd., Bedford	270	1	550	1	3	287	33
Shawsheen River	SH 2.6	At Mill Dam Rd. residence, Bedford	360	1	810	1	4	421	50
Shawsheen River	SH 3.7	On south side of Middlesex Turnpike, Bedford	N/A	0	240	1	1	240	0

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Table 7. 1997 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MRWC ID	Station Description	Dry Weather Geometric Mean	Number of Dry Samples	Wet Weather Geometric Mean	No. of Wet Samples	Total Number Samples	Overall Geometric Mean	Overall % of Samples > 400
Shawsheen River	SH 3.8	Just downstream of Middlesex Turnpike, Bedford	74	2	223	2	7	92	14
Shawsheen River	SH 4.2	At pipe that drains Clark and Reed parking lot at end of Dunham Road in Billerica	20,712	2	32,863	2	6	44,041	100
Shawsheen River	SH 5.0	On south side of Route 3A overpass, Billerica	52	2	70	1	6	37	0
Shawsheen River	SH 5.5	In woods , Billerica	154	1	N/A	0	3	197	0
Shawsheen River	SH 6.1	Behind Shawsheen Tech High School, Billerica - suspect source - pipe w/ grey water	124	1	290	1	4	132	0
Shawsheen River	SH 7.1	100 yards upstream from Route 129 crossover	52	1	100	1	5	55	0
Shawsheen River	SH 7.5	At Whipple Road crossing on Tewksbury/Billerica/Wilmington line	66	2	220	1	6	116	0
Shawsheen River	SH 8.5	At Route 38 crossing, Tewksbury	83	2	104	1	6	72	0
Shawsheen River	SHT 0.0	At Doctor's Park tributary off Haverhill Street, Andover	10	1	94	1	2	31	0
Shawsheen River	SHT 0.5	At Den Rock Tributary just before it enters the culvert in the	60	1	221	2	5	239	40

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Table 7. 1997 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MRWC ID	Station Description	Dry Weather Geometric Mean	Number of Dry Samples	Wet Weather Geometric Mean	No. of Wet Samples	Total Number Samples	Overall Geometric Mean	Overall % of Samples > 400
		Demoulas Parking lot							
Sutton Brook	STB 0.3	At South St. crossing	77	2	99	2	6	120	17
Sutton Brook	STB 0.7	North side of old railroad grade off Regina St. , Tewksbury; just before confluence w/ Shawsheen	203	2	308	2	6	209	17
Strong Water Brook	SWB 2.0	Crossover at East St./Maple St. intersection near state hospital, Tewksbury	34	2	217	2	6	67	0
Strong Water Brook	SWB 3.3	Just before confluence with Shawsheen	69	2	194	2	7	86	0
Strong Water Brook	SWB 3.6		76	2	204	2	7	102	0
Vine Brook	VB 1.0	South of Vinebrook Road between Waltham and Sherburne Rds., Lexington	20,000	1	770	1	3	2,715	100
Vine Brook	VB 1.5	At North Culvert, Lexington	1,867	2	2,700	1	5	3,851	100
Vine Brook	VB 2.3	Just north of East St. crossing, Lexington	1,360	2	740	1	6	1,013	100
Vine Brook (Pond)	VB 2.9	Butterfield Pond - near spillway where VB exits	10	2	33	2	7	41	14
Vine Brook	VB 4.3	By Lexington St., Burlington	2,000	1	165	2	5	263	40
Vine Brook	VB 5.0	At Terrace Hall Road, Burlington	40	1	306	2	5	138	20

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Table 7. 1997 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin (#/100ml)

Stream	MRWC ID	Station Description	Dry Weather Geometric Mean	Number of Dry Samples	Wet Weather Geometric Mean	No. of Wet Samples	Total Number Samples	Overall Geometric Mean	Overall % of Samples > 400
Vine Brook	VB 5.8	Off Rt. 62 between Rt. 3 and Middlesex Turnpike, Bedford	128	2	42	1	6	82	0
Vine Brook	VB 6.3	South side of Route 62 overpass near on/off ramp for Route 3 south, Bedford	25	4	233	4	14	55	7

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Table 8. 1998 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin

STREAM	MRWC ID	No. of Samples Collected [1]	Geometric Mean	% of Samples > 400 (cfu/100 ml)	No. of Dry Weather Samples	Dry Weather Geometric Mean	% of Dry Samples >400 (cfu/100ml)
Unnamed stream	BM 0.3	5	94	0	4	73	0
Clark Brook	CB 0.4	1	2,000	100	1	2,000	100
Clark Pond	CB 0.7	8	248	38	5	310	40
Content Brook	COB 1.7	7	133	14	4	86	0
Content Brook	COB 2.8	7	277	14	5	213	0
Darby Brook	DAB 2.0	6	175	17	4	134	0
Elm Brook	EB 0.5	7	203	14	4	170	0
Elm Brook	EB 1.5	7	79	14	4	43	0
Elm Brook	EB 2.5	6	48	0	4	33	0
Elm Brook	EB 3.3	6	457	33	3	376	33
Elm Brook	EB 3.4	6	467	50	4	431	50
Elm Brook	EB 4.0	7	590	86	4	535	100
Tributary from Foster's Pond/ Foster's Brook	FPR 2.1	7	53	0	5	59	0
Heath Brook	HB 1.0	5	97	0	4	106	0
Heath Brook	HB 1.9	7	217	14	4	152	0
Hussey Brook	HP 1.3	8	117	0	5	94	0
Kiln Brook	KB 0.6	8	464	50	5	205	20
Kiln Brook tributary	KBT 0.2	8	454	50	5	337	40
Little Content Brook	LCB 1.0	3	82	0	2	123	0
Little Content Brook Tributary	LCB 2.0	3	203	33	2	191	50

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Table 8. 1998 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin

STREAM	MRWC ID	No. of Samples Collected [1]	Geometric Mean	% of Samples > 400 (cfu/100 ml)	No. of Dry Weather Samples	Dry Weather Geometric Mean	% of Dry Samples >400 (cfu/100ml)
Meadow Brook	MDB 2.6	7	122	14	5	55	0
North Lexington Brook (Pond) tributary To Kiln Brook	NL 0.3	5	240	20	2	100	0
Pinnacle Brook	PB 1.3	7	8,726	100	5	6,262	100
	PBR 0.2	2	16	0	1	6	0
Pinnacle Brook Tributary	PBT 0.4	2	268	50	1	36	0
Pomp's Pond	PP 0.0	8	16	0	5	39	0
Roger's Brook	ROB 0.0	8	317	25	5	273	20
Roger's Brook	ROB 1.5	8	231	38	5	115	20
Spring Brook	SB 0.8	7	420	43	4	361	50
Spring Brook	SB 2.3	6	58	0	3	16	0
Shawsheen R	SH 0.3	8	173	13	5	134	0
Shawsheen R	SH 0.6	8	407	50	5	319	40
Shawsheen R	SH 1.8	6	10	0	3	2	0
Shawsheen R	SH 11.4	8	178	0	5	142	0
Shawsheen R	SH 12.2	7	105	0	5	94	0
Shawsheen R	SH 12.3	6	155	0	4	133	0
Shawsheen R	SH 13.4	7	159	0	4	129	0
Shawsheen R	SH 14.4	7	215	0	4	187	0
Shawsheen R	SH 14.5	6	77	0	4	43	0
Shawsheen R	SH 14.6	6	522	67	4	608	75
Shawsheen R	SH 15.5	6	175	17	5	186	20

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Table 8. 1998 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin

STREAM	MRWC ID	No. of Samples Collected [1]	Geometric Mean	% of Samples > 400 (cfu/100 ml)	No. of Dry Weather Samples	Dry Weather Geometric Mean	% of Dry Samples >400 (cfu/100ml)
Shawsheen R	SH 17.3	7	112	14	5	73	0
Shawsheen R	SH 18.25	7	222	14	5	130	0
Shawsheen R	SH 2.3	6	131	0	4	82	0
Shawsheen R	SH 3.1	5	348	40	3	291	0
Shawsheen R	SH 3.7	6	332	33	3	437	33
Shawsheen R	SH 3.8	7	437	29	4	325	25
Shawsheen R	SH 4.2	7	10,986	100	4	12,775	100
Shawsheen R	SH 5.0	7	225	14	4	210	25
Shawsheen R	SH 5.5	5	349	80	4	323	75
Shawsheen R	SH 6.1	2	325	0	1	320	0
Shawsheen R	SH 7.1	6	234	17	3	171	0
Shawsheen R	SH 8.5	7	175	29	4	102	25
Shawsheen R	SH 9.0	6	122	17	4	74	0
Shawsheen R	SH 9.5	8	144	13	5	115	0
Shawsheen R	SHT 0.5	5	212	20	4	226	25
Sutton Brook	STB 0.3	7	260	29	5	157	0
Sutton Brook	STB 0.7	6	47	0	5	40	0
Strong Water Brook	SWB 2.0	7	337	29	5	233	20
Strong Water Brook	SWB 3.3	8	275	25	5	208	20
Vine Brook	VB 1.0	6	674	50	4	433	50
Vine Brook	VB 1.1	6	80	17	4	42	0
Vine Brook	VB 1.5	7	983	86	4	613	75
Vine Brook	VB 2.3	6	376	50	4	330	50

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Table 8. 1998 Merrimack River Watershed Council Fecal Coliform Data for the Shawsheen River Basin

STREAM	MRWC ID	No. of Samples Collected [1]	Geometric Mean	% of Samples > 400 (cfu/100 ml)	No. of Dry Weather Samples	Dry Weather Geometric Mean	% of Dry Samples >400 (cfu/100ml)
Vine Brook (Pond)	VB 2.9	6	66	17	4	42	0
Vine Brook	VB 4.3	7	331	29	4	257	25
Vine Brook	VB 5.0	7	156	14	4	147	25
Vine Brook	VB 6.5	7	150	0	4	167	0
Webb Brook	WB 1	3	211	33	1	132	0

[1]No wet weather samples were collected.

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Table 9. Analysis of All Fecal Coliform Data Collected by MDEP and MRWC (1989-1998)(#/100ml)

Stream	Station	Collecting Agency	Geometric Mean	% of Samples > 400 (cfu/100 ml)	Dry Weather Geometric Mean	Wet Weather Geometric Mean
Elm Brook	Elm Brook 0.02	MDEP	310	40%	363	
Elm Brook	Elm Brook 0.2	MDEP	188	50%	80	
Elm Brook	Elm Brook 0.9	MDEP	60	0%		
Kiln Brook	Kiln Brook 0.4	MDEP	80	0%		
Rogers Brook	Rogers Brook 0.1	MDEP	1982	100%	1887	
Rogers Brook	Rogers Brook 1.1	MDEP	208	40%	150	
Shawsheen R.	Shawsheen 0.3	MDEP	844	80%	1141	
Shawsheen R.	Shawsheen 0.8	MDEP	479	75%	388	
Shawsheen R.	Shawsheen 13.8	MDEP	139	0%	160	
Shawsheen R.	Shawsheen 13.9	MDEP	217	20%	272	
Shawsheen R.	Shawsheen 16.2	MDEP	122	0%	168	
Shawsheen R.	Shawsheen 17.5	MDEP	173	50%	600	
Shawsheen R.	Shawsheen 18	MDEP	136	0%	146	
Shawsheen R.	Shawsheen 19.6	MDEP	246	20%	384	
Shawsheen R.	Shawsheen 2.3	MDEP	268	0%	240	
Shawsheen R.	Shawsheen 2.7	MDEP	430	80%	482	
Shawsheen R.	Shawsheen 23.4	MDEP	1183	100%	700	
Shawsheen R.	Shawsheen 23.5	MDEP	313	40%	315	
Shawsheen R.	Shawsheen 25	MDEP	220	43%	161	
Shawsheen R.	Shawsheen 25.6	MDEP	456	50%	400	
Shawsheen R.	Shawsheen 25.99	MDEP	39	0%	48	

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Table 9. Analysis of All Fecal Coliform Data Collected by MDEP and MRWC (1989-1998)(#/100ml)

Stream	Station	Collecting Agency	Geometric Mean	% of Samples > 400 (cfu/100 ml)	Dry Weather Geometric Mean	Wet Weather Geometric Mean
Shawsheen R.	Shawsheen 26	MDEP	301	25%	335	
Shawsheen R.	Shawsheen 26.6	MDEP	181	20%	126	
Shawsheen R.	Shawsheen 4.8	MDEP	175	0%	197	
Shawsheen R.	Shawsheen 5.3	MDEP	100	20%	127	
Shawsheen R.	Shawsheen 5.9	MDEP	120	0%	90	
Shawsheen R.	Shawsheen 6.2	MDEP	90	0%	78	
Shawsheen R.	Shawsheen 8	MDEP	268	0%	180	
Shawsheen R.	Shawsheen 8.2	MDEP	103	0%	124	
Spring Brook	Spring Brook 0.2	MDEP	28	0%	40	
Strong Water Brook	Strong Water Brook 0.01	MDEP	111	0%	156	
Vine Brook	Vine Brook 0.6	MDEP	324	43%	376	
Vine Brook	Vine Brook 2	MDEP	160	0%		
Vine Brook	Vine Brook 6	MDEP	40	0%		
Vine Brook	Vine Brook 6.1	MDEP	6300	100%		
Unnamed stream	BM 0.3	MRWC	109	0%	95	90
Unnamed stream	BM 0.7	MRWC	68	0%	20	200
Pond in Baker's Meadow	BM 0.8	MRWC	12	0%	2	55
Clark Brook	CB 0.4	MRWC	2000	100%	2000	
Clark Pond	CB 0.7	MRWC	248	38%	310	
Content Brook	COB 1.7	MRWC	278	33%	117	1260
Content Brook	COB 2.0	MRWC	964	63%	250	2348

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Table 9. Analysis of All Fecal Coliform Data Collected by MDEP and MRWC (1989-1998)(#/100ml)

Stream	Station	Collecting Agency	Geometric Mean	% of Samples > 400 (cfu/100 ml)	Dry Weather Geometric Mean	Wet Weather Geometric Mean
Content Brook	COB 2.8	MRWC	303	17%	256	
Content Brook	COB 3.5	MRWC	442	25%	339	596
Tributary to Content Brook	COBT 0.0	MRWC	51	25%	75	79
Tributary to Content Brook	COBT 1.0	MRWC	135	0%	152	165
Darby Brook	DAB 2.0	MRWC	175	17%	134	
Elm Brook	EB 0.5	MRWC	216	25%	163	302
Elm Brook	EB 1.5	MRWC	82	9%	54	50
Elm Brook	EB 2.0	MRWC	208	25%	215	332
Elm Brook	EB 2.5	MRWC	82	9%	71	128
Elm Brook	EB 3.3	MRWC	507	58%	421	770
Elm Brook	EB 3.4	MRWC	467	50%	431	
Elm Brook	EB 4.0	MRWC	499	63%	520	800
Elm Brook Tributary	EBT 0.2	MRWC	371	50%	522	134
Foster's Pond	FPR 1.0	MRWC	3	0%	6	2
Foster's Pond	FPR 1.4	MRWC	14	0%	21	18
Foster's Pond	FPR 1.6	MRWC	93	0%	117	380
Tributary from Foster's Pond/Foster's Brook	FPR 2.1	MRWC	63	0%	72	64
Tributary from Foster's Pond/Foster's Brook	FPR 2.4	MRWC	284	38%	87	379
Heath Brook	HB 1.0	MRWC	97	0%	106	

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Table 9. Analysis of All Fecal Coliform Data Collected by MDEP and MRWC (1989-1998)(#/100ml)

Stream	Station	Collecting Agency	Geometric Mean	% of Samples > 400 (cfu/100 ml)	Dry Weather Geometric Mean	Wet Weather Geometric Mean
Heath Brook	HB 1.75	MRWC	103	0%	103	400
Heath Brook	HB 1.9	MRWC	217	14%	152	
Hussey Brook	HP 1.3	MRWC	94	9%	49	2700
Hussey Pond	HP 1.8	MRWC	98	0%	120	300
Kiln Brook	KB 0.5	MRWC	353	40%	130	770
Kiln Brook	KB 0.6	MRWC	332	43%	234	252
Kiln Brook	KB 0.8	MRWC	355	40%	280	433
Kiln Brook Tributary	KBT 0.2	MRWC	454	50%	337	
Little Content Brook	LCB 1.0	MRWC	60	0%	67	100
Little Content Brook Tributary	LCB 2.0	MRWC	155	11%	226	94
Long Meadow Brook	LMB 0.7	MRWC	682	67%	2000	440
McKee Brook	MC 0.3	MRWC	42	17%	26	18
Meadow Brook	MDB 1.2	MRWC	800	100%		800
Meadow Brook	MDB 2.6	MRWC	126	13%	60	566
North Lexington Brook	NL 0.3	MRWC	316	33%	159	789
Pinnacle Brook	PB 1.3	MRWC	8726	100%	6262	
	PBR 0.2	MRWC	16	0%	6	
Pinnacle Brook Tributary	PBT 0.4	MRWC	268	50%	36	
Pomp's Pond	PP 0.0	MRWC	19	0%	25	30
Pomp's Pond outlet	PP 0.5	MRWC	149	22%	93	502
Roger's Brook	ROB 0.0	MRWC	358	36%	216	3550

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Table 9. Analysis of All Fecal Coliform Data Collected by MDEP and MRWC (1989-1998)(#/100ml)

Stream	Station	Collecting Agency	Geometric Mean	% of Samples > 400 (cfu/100 ml)	Dry Weather Geometric Mean	Wet Weather Geometric Mean
Roger's Brook	ROB 1.0	MRWC	1477	83%	663	4460
Roger's Brook	ROB 1.5	MRWC	571	64%	188	5126
Sandy Brook	SB 0.6	MRWC	612	75%	360	698
Spring Brook	SB 0.8	MRWC	949	60%	822	3800
Spring Brook	SB 2.3	MRWC	58	0%	16	
Shawsheen R.	SH 0.0	MRWC	1243	63%	1210	1000
Shawsheen R.	SH 0.3	MRWC	385	31%	255	1000
Shawsheen R.	SH 0.6	MRWC	407	50%	319	
Shawsheen R.	SH 1.0	MRWC	237	50%	70	800
Shawsheen R.	SH 1.8	MRWC	22	14%	2	2100
Shawsheen R.	SH 10.6	MRWC	200	17%	740	295
Shawsheen R.	SH 11.0	MRWC	490	67%	2000	950
Shawsheen R.	SH 11.4	MRWC	178	0%	142	
Shawsheen R.	SH 12.2	MRWC	105	0%	94	
Shawsheen R.	SH 12.3	MRWC	180	8%	127	219
Shawsheen R.	SH 12.35	MRWC	211	27%	217	181
Shawsheen R.	SH 13.3	MRWC	93	0%	180	77
Shawsheen R.	SH 13.4	MRWC	131	0%	96	
Shawsheen R.	SH 14.2	MRWC	116	0%	106	173
Shawsheen R.	SH 14.4	MRWC	168	14%	68	693
Shawsheen R.	SH 14.45	MRWC	194	29%	122	894
Shawsheen R.	SH 14.5	MRWC	154	23%	63	300

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Table 9. Analysis of All Fecal Coliform Data Collected by MDEP and MRWC (1989-1998)(#/100ml)

Stream	Station	Collecting Agency	Geometric Mean	% of Samples > 400 (cfu/100 ml)	Dry Weather Geometric Mean	Wet Weather Geometric Mean
Shawsheen R.	SH 14.55	MRWC	246	29%	157	219
Shawsheen R.	SH 14.6	MRWC	500	62%	475	1470
Shawsheen R.	SH 14.9	MRWC	241	20%	358	173
Shawsheen R.	SH 15.5	MRWC	333	38%	240	424
Shawsheen R.	SH 15.7	MRWC	664	57%	452	424
Shawsheen R.	SH 15.8	MRWC	1122	50%	14000	
Shawsheen R.	SH 16.6	MRWC	368	14%	400	358
Shawsheen R.	SH 17.3	MRWC	112	14%	73	
Shawsheen R.	SH 17.8	MRWC	698	83%	645	1196
Shawsheen R.	SH 18.25	MRWC	335	38%	169	2491
Shawsheen R.	SH 2.2	MRWC	155	50%	30	800
Shawsheen R.	SH 2.3	MRWC	182	10%	104	550
Shawsheen R.	SH 2.6	MRWC	421	50%	360	810
Shawsheen R.	SH 3.1	MRWC	348	40%	291	
Shawsheen R.	SH 3.7	MRWC	317	29%	437	240
Shawsheen R.	SH 3.8	MRWC	200	21%	199	223
Shawsheen R.	SH 4.2	MRWC	20853	100%	15008	32863
Shawsheen R.	SH 5.0	MRWC	97	8%	132	70
Shawsheen R.	SH 5.5	MRWC	282	50%	279	
Shawsheen R.	SH 6.1	MRWC	178	0%	199	290
Shawsheen R.	SH 7.1	MRWC	121	9%	127	100
Shawsheen R.	SH 7.5	MRWC	116	0%	66	220

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Table 9. Analysis of All Fecal Coliform Data Collected by MDEP and MRWC (1989-1998)(#/100ml)

Stream	Station	Collecting Agency	Geometric Mean	% of Samples > 400 (cfu/100 ml)	Dry Weather Geometric Mean	Wet Weather Geometric Mean
Shawsheen R.	SH 8.5	MRWC	116	15%	96	104
Shawsheen R.	SH 9.0	MRWC	122	17%	74	
Shawsheen R.	SH 9.5	MRWC	144	13%	115	
Shawsheen R.	SHT 0.0	MRWC	31	0%	10	94
Shawsheen R.	SHT 0.5	MRWC	225	30%	173	221
Sutton Brook	STB 0.3	MRWC	182	23%	128	99
Sutton Brook	STB 0.7	MRWC	100	8%	63	308
Strong Water Brook	SWB 0.6	MRWC	2846	100%		2846
Strong Water Brook	SWB 1.0	MRWC	800	89%	363	790
Strong Water Brook	SWB 2.0	MRWC	165	23%	81	276
Strong Water Brook	SWB 3.0	MRWC	116	11%	75	121
Strong Water Brook	SWB 3.3	MRWC	173	18%	133	257
Strong Water Brook	SWB 3.6	MRWC	102	0%	76	204
Vine Brook	VB 1.0	MRWC	1072	67%	932	770
Vine Brook	VB 1.1	MRWC	80	17%	42	
Vine Brook	VB 1.5	MRWC	1736	92%	889	2700
Vine Brook	VB 1.8	MRWC	502	67%	390	640
Vine Brook	VB 2.3	MRWC	617	75%	529	740
Vine Brook	VB 2.9	MRWC	93	25%	32	249
Vine Brook	VB 4.0	MRWC	349	57%	92	718
Vine Brook	VB 4.3	MRWC	261	37%	280	228
Vine Brook	VB 5.0	MRWC	160	19%	99	398

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Table 9. Analysis of All Fecal Coliform Data Collected by MDEP and MRWC (1989-1998)(#/100ml)

Stream	Station	Collecting Agency	Geometric Mean	% of Samples > 400 (cfu/100 ml)	Dry Weather Geometric Mean	Wet Weather Geometric Mean
Vine Brook	VB 5.3	MRWC	156	29%	86	669
Vine Brook	VB 5.8	MRWC	82	0%	128	42
Vine Brook	VB 6.3	MRWC	87	17%	42	299
Vine Brook	VB 6.5	MRWC	150	0%	167	
Webb Brook	WB 1	MRWC	211	33%	132	

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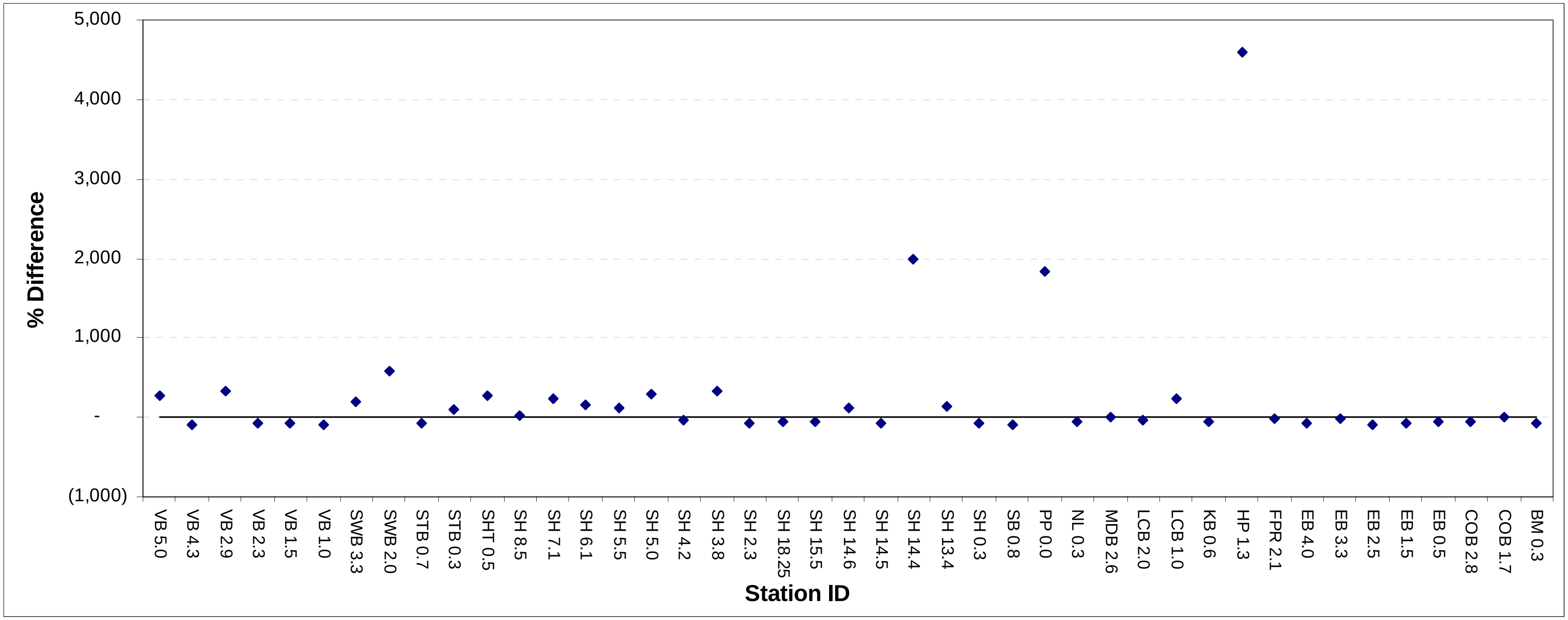
Figure 2. Percent Difference in Dry Weather Geometric Mean Bacteria Concentrations Between 1997 and 1998



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Identification of Fecal Coliform Bacteria Sources

This TMDL applies not only to those segments within the Shawsheen River basin that appear on the 1998 303(d) list for pathogen violations, but also to all segments in this basin that are identified as being impaired by pathogens through the evaluation of water quality monitoring data as presented in this report. As such, this TMDL evaluation examined all known potential sources of fecal coliform bacteria in the Shawsheen River watershed using all available information. Direct measurements were unavailable for many sources; however, through the evaluation of water quality monitoring data, investigations by the MRWC and MDEP, as well as through analysis of land uses within the watershed and literature values for typical stormwater concentrations, it was possible to perform an initial evaluation of bacteria sources.

Table 10 summarizes the 303(d) listed river segments that are impaired due to measured fecal coliform contamination and identifies suspected and known sources to these segments and their tributaries, as identified by the MRWC (Mattei *et al*., 1999) and by the MDEP (MDEP, 1996). Table 10 also includes all tributaries to the Shawsheen River that have been identified as being impaired through analysis of fecal coliform bacteria collected between 1989 and 1998, but which were not included on the 1998 303(d) list.

The MRWC has effectively used information and data collected through its monitoring program to target known and/or suspected bacteria sources. For example, a broken sewage pipe was discovered to be leaking raw sewage directly into the Shawsheen River. This problem was fixed and bacteria levels quickly returned to normal (Mattei *et al*., 1999). Another example is the "alarmingly high" bacteria levels on the Shawsheen River at Dunham Road (SH 4.2). The high bacteria levels at this site are due to raw sewage coming from a storm drainpipe at an industrial park on Dunham Road. High bacteria levels were also found behind Shawsheen Technical High School at site SH 6.1. Volunteers suspect a sewage leak. Volunteers have brought the problem of high bacteria levels at Dunham Road (site SH 4.2) to the attention of the Board of Health and local Department of Public Works. Steps are being taken to try and rectify this situation. The town of Billerica is requiring that all of the businesses in the industrial park tie into the public sewer system. The Billerica Board of Health is also investigating a suspected sewage leak which volunteers found near site SH 6.1 behind Shawsheen Technical High School" (Mattei *et al*., 1999).

Because violations of the bacteria water quality standard occur during dry and wet weather, the discussion that follows addresses both continuous (dry weather) and wet weather bacteria sources, as identified in Table 10. Continuous source categories evaluated include: point sources, broken sewer lines, illicit disposal to storm drains, poorly performing septic systems and direct wildlife. Wet weather source categories that were evaluated include: urban stormwater runoff and pump station overflows. Data analysis and comparison of data to suspected or known sources identified by the MRWC (Mattei *et al*., 1999) shows that illicit connections and sewer breaks are the most important sources during dry weather. Urban stormwater is the largest potential wet weather source of bacteria to the Shawsheen River. Other wet weather sources include illicit storm sewer connections and sewer breaks which are expected to be a source of bacteria not only during dry weather, but also during wet weather.

Table 10. Summary of Fecal Coliform Contamination in the Shawsheen River Watershed within 303(d) Listed Segments and Other Tributaries Identified Through Water Quality Data Analysis as Being Impaired

Location[1]	Known and Suspected Sources
Upper Shawsheen River (including tributary impacts)[2]	Broken sewage pipe (fixed); Stormwater runoff; Failing septic systems
Middle Shawsheen River (including tributary impacts)[2]	Illicit connection to storm drainpipe; Sewage leak; Stormwater runoff, farm (piggery); Failing septic systems
Lower Shawsheen River (including tributary impacts)[2]	Stormwater runoff; Failing septic systems; Dry weather discharges; Wildlife; possible sewer leak
Elm Brook[2]	Leaking septic systems; Stormwater runoff; possible sewer leak
Vine Brook[2]	Burlington Sewer Overflow (documented wet weather overflows); Manure piles near stream; possible sewer leaks; Stormwater runoff
Rogers Brook[2]	Pipes discharging during dry periods (possible sewer line leak); Stormwater runoff; Failing septic systems
Clark Brook	Unknown
Clark Pond	Unknown
Content Brook	Unknown
Elm Brook Tributary	Unknown
Kiln Brook	Unknown
Kiln Brook Tributary (KBT 0.2)	Unknown
Little Content Brook Tributary (LCB 2.0)	Unknown
Long Meadow Brook	Unknown
Meadow Brook	Unknown
North Lexington Brook	Unknown
Pinnacle Brook	Unknown
Pomp's Pond Outlet	Unknown
Sandy Brook	Unknown
Spring Brook	Unknown
Strong Water Brook	Unknown
Sutton Brook	Unknown
Tributary to Content Brook (COBT 0.0)	Unknown

Tributary from Foster's Pond/Foster's Brook (FPR 2.4)	Unknown

[1]MRWC Station ID is in parentheses, when waterbody name is ambiguous
[2]Appears on the Massachusetts 303(d) list for pathogen violations

This source assessment is divided into two sections:

- Potential dry weather/continuous sources
- Potential wet weather sources

POTENTIAL DRY WEATHER/CONTINUOUS SOURCES

Based on a review of NPDES permitted point sources in the watershed, information on the areas of the watershed serviced by septic systems and a review of the Shawsheen River Watershed 1996-1998 Volunteer Monitoring Report as well as the 1996 MDEP Shawsheen Assessment Summary Report, potential dry weather sources were identified. These sources, which are all continuous, even during wet weather events, include:

- point sources,
- sewer line breaks/leaks,
- illicit sewer connections,
- poorly performing septic systems,
- direct wildfowl, and
- livestock

Dry weather sources of fecal coliform within the Shawsheen River watershed are discussed below.

Point Sources

The greatest potential source of human fecal coliform from point sources is raw sewage. Ten NPDES permitted point sources are known to discharge in the Shawsheen River watershed; however, only the Battle Road Wastewater Plant (NPDES ID MA0031658) receives sanitary sewage and has a fecal coliform limit specified within its permit. Point sources without bacteria limits specified in their permits are not considered to be significant contributors of bacteria and are not discussed in this document.

The Battle Road Wastewater Plant discharges to an unnamed tributary to the Shawsheen River. Monthly operating report records obtained for this facility indicate that this facility did not violate its permit limit between April 1997 through May 1998 and is not likely to be a significant source of bacteria to the Shawsheen River. The permit limits along with monthly operating report data from April 1997 through May 1998 are summarized in Tables 11 and 12 below:

Table 11. Battle Road Wastewater Plant Discharge Limit

Permit Number	Flow (MGD)	Fecal coliform permit limit(#/100 ml)	
		Average Monthly	Daily Maximum
MA0031658	0.033	200	400

Table 12. Battle Road Wastewater Plant Discharge Characterization

Period	Number of Observations	Fecal Coliform (#/100 ml)	
		Average Monthly	Maximum Monthly
April 1997	4	23	92
May 1997	5	18.4	92
June 1997	4	40.5	154
July 1997	5	12	52
August 1997	N/A[1]	N/A	N/A
September 1997	4	16.5	66
October 1997	4	3	8
November 1997	4	3	12
December 1997	5	0	0
January 1998	4	0	0
February 1998	4	23	92
March 1998	4	0	0
April 1998	5	45.6	208
May 1998	4	29	108

[1]N/A = Not available.

Sewer Line Breaks/Leaks

Raw sewage, although not usually discharged intentionally, can reach waterbodies through leaks in sanitary sewer systems, overflows from surcharged sanitary sewers (sanitary sewer overflows), illicit connections of sanitary sewers to storm sewer collection systems, or unidentified broken sanitary sewer lines. According to the Center for Watershed Protection (CWP, 1999), "in some communities, as many as 10 percent of all pipe outfalls have dry weather flow. Even if only a few of these flows contain sewage, they can produce very high bacteria concentrations because of low instream flow." Typical values of fecal coliform in untreated domestic wastewater range from 10^6 to 10^7 MPN/100 ml (Metcalf and Eddy, 1991).

The Merrimack River Watershed Council volunteers have discovered suspected sewer line breaks and leaks within three tributary subwatersheds to the Shawsheen River which appear on the 303(d) list (Rogers Brook, Elm Brook and Vine Brook) as well as near several Shawsheen River sampling stations. Within the Rogers Brook watershed, two locations were noted by volunteers. The first location consisted of observed dry weather discharge to Rogers Brook. Second, a sewer overflow in Andover was discovered. Within the Vine Brook watershed, possible sewer breaks were noted to be affecting stations VB 1.0 and VB 1.5. Within the Elm Brook subwatershed, a possible sewer break was noted near station EB 4.0. Finally, several sewer line breaks/leaks were discovered to be directly affecting the Shawsheen River. A broken sewage main was discovered at the Hanscom Air Force Base near the headwaters of the Shawsheen River (Shawsheen Stations SH 0.0 and SH 0.3). In North Andover, near Mass Ave/Glenwood (Shawsheen River station SH 17.8), a sewage smell was reported by volunteers (p. 97 Mattei *et al.*, 1999).

A dry weather violation of fecal coliform water quality standards was observed at each of the stations identified in the discussion above. The sewer break noted on Elm Brook may also explain the increase in bacteria levels downstream of the Elm Brook confluence with the Shawsheen River (downstream of station SH 1.8). Likewise, the high bacteria levels in Vine Brook during dry weather, caused by possible sewer breaks, may explain the increase in low-flow concentrations in the Shawsheen River downstream of station SH 3.1.

Illicit Sewer Connections

Illicit disposal of sewage to storm drains results in direct discharges of sewage to receiving waters through storm drainage system outfalls. Illicit sewer connections can have as large an impact as broken or leaking sewer pipes. The Merrimack River Watershed Council volunteers discovered that some businesses were improperly discharging sewage and were not hooked up to the sewer system near Shawsheen River station SH 4.2. This is likely the cause of the excessive fecal coliform concentrations at this station.

Illicit sewer connections represent a direct threat to public health since they result in discharges of partially treated or untreated human wastes. Quantifying this source is extremely speculative without direct monitoring of the source because the magnitude is directly proportional to the volume of the sources and its proximity to the surface water. Typical values of fecal coliform in untreated domestic wastewater range from 10^6 to 10^7 MPN/100 ml (Metcalf and Eddy, 1991).

Poorly Performing Septic Systems

Septic systems designed, installed and maintained in accordance with 310 CMR 15.000: Title 5, are not significant sources of fecal coliform bacteria. “For the most part, properly sited and maintained septic systems can treat wastewater effectively and not threaten water quality. However, the effectiveness of septic systems strongly depends on site conditions and timely inspection and maintenance” (Schueler and Holland, 2000). Failing septic systems hold the potential to deliver bacteria to surface waters due to failure of the system to provide adequate treatment due to malfunctions. “The causes of septic system failure are numerous: inadequate soils, poor design, siting, testing or inspection, hydraulic overloading, tree growth in the drain field, old age and failure to clean out.” (Center for Watershed Protection, 1999). Typical values for fecal coliform in untreated domestic wastewater range from 10^6 to 10^7 MPN/100 ml (Metcalf and Eddy, 1991).

No information was available on the specific locations of septic systems, septic tank densities or failure rates in the Shawsheen River watershed. However, the Merrimack River Watershed Council (personal communication w/ Michelle Carley) surveyed each of the towns in the watershed to get an estimate of the percent of sewered versus non-sewered area of each town. This survey indicated that most of the Shawsheen River watershed is serviced by sewer lines, with only portions of the towns of Bedford, Andover, Billerica and Tewksbury serviced by septic systems. Using 1990 census data (Massachusetts Department of Housing and Community Affairs website) for each of the towns to estimate the number of homes and assuming a failure rate of 3%, the number of failing systems can be estimated for the portion of each town within the watershed (Table 13).

Table 13. Summary of % of Each Town Serviced by Sewer

Town	% Sewered	# Single Unit Homes in Watershed[1]	# Septic Systems[2]	# Failing systems[3]	Tributaries w/in Town Boundaries
Andover	90	3,963	396	12	Baker's Meadow, Content Brook, Roger's Brook, Hussey Pond
Bedford	94	2,511	151	5	Spring Brook, Elm Brook
Billerica	70	4,607	1,382	41	Content Brook, McKee, Web and Jones Brooks
Burlington	100				
Lawrence	100				
North Andover	100				
Tewksbury	45	5,629	3,096	93	Strongwater Brook, Sutton Brook, Content Brook, Heath Brook

[1] Number of single unit homes per 1990 U.S. Census * % of town in watershed
[2] Number of homes on septic systems in the watershed, assuming one septic system per home
[3] Number of homes with failing septic systems based on 3% national failure rate

Almost the entire length of the Shawsheen River (Shawsheen River stations SH 0.0 - SH 15.8) falls with the town boundaries of Bedford, Billerica, Tewksbury and Andover. Therefore, septic systems are a potential source of bacteria for much of the Shawsheen River, and also for the following tributaries: Baker's Meadow, Content Brook, Roger's Brook, Hussey Pond, Spring Brook, Elm Brook, McKee, Webb and Jones Brooks, Strongwater Brook, Sutton Brook and Heath Brook.

According to information obtained in the Shawsheen River Watershed 1996-98 Volunteer Monitoring Report (Mattei *et al*., 1999), septic systems are a suspect source of fecal coliform in the Vine Brook watershed (potentially outdated septic (VB 1.0)). However, this source is probably a minor impact on the Vine Brook system, since according to the survey results, the Vine Brook watershed is 100% sewered, being located in the towns of Lexington and Burlington. It would be prudent to more closely examine the number of septic systems in the watershed to verify that they are not a dry weather source to Vine Brook.

Direct Wildfowl

Animals that are not pets can be a potential source of fecal coliform, even in an urban environment. "Geese, gulls and ducks are speculated to be a major bacterial source in urban areas, particularly at lakes and stormwater ponds where large resident populations have become established. However, relatively little data are available to quantify whether geese and ducks are a major source of fecal coliforms." (CWP, 1999). Wildfowl are of particular concern in the following subwatersheds: Pinnacle Brook, Strong Water Brook, Foster's Pond and Baker's Meadow (Mattei *et al*., 1999) due in part to the undeveloped land adjacent to some of these waterways. Of these tributaries, dry weather fecal coliform water quality violations were only observed at the mouth of Strong Water Brook. Therefore, it is unlikely that wildfowl are a significant source of fecal coliform bacteria violations.

Livestock

A farm located on the banks of Pinnacle Brook, a tributary to Strong Water Brook, is a suspected source for the fecal coliform levels observed at PB 1.3 (Mattei *et al*., 1999). The dry weather geometric mean at PB 1.3 was 6,262 in 1998. Pinnacle Brook may contribute to the water quality violations observed at the mouth of Strong Water Brook.

POTENTIAL WET WEATHER SOURCES

Potential sources for wet weather violations of fecal coliform standards were identified from an analysis of land use patterns, a literature review and a review of the Shawsheen River Watershed 1996-1998 Volunteer Monitoring Report. Potential wet weather sources include:

- Stormwater runoff
- Pump station overflows

High stormwater runoff loads of bacteria are more likely to be caused by bacteria from domestic animals rather than from livestock and wildlife. This is based on an analysis of fecal coliform violations at stations downstream of areas with higher concentrations of livestock and wildlife.

Stormwater Runoff

With over half of the watershed developed with either urban or residential land use, the potential for conversion of precipitation to significant amounts of stormwater runoff exists. Stormwater runoff may carry fecal coliform from pets, livestock and wildlife to the Shawsheen River and its tributaries. Urban stormwater runoff appears to be a significant wet weather source of bacteria not only to the Shawsheen River, but also to its tributaries. In several tributary watersheds, including Vine Brook and Elm Brook, an apparent correlation has been noted (Mattei *et al*., 1999) between the highly developed lower sections with high bacteria levels, in addition to an apparent correlation between high turbidity and fecal coliform levels. In Elm Brook, runoff is suspected of contributing fecal coliform since most Bedford residents are on the town sewer system, although it should be remembered that a possible sewer leak was also noted in the Elm Brook subwatershed near station EB 4.0.

The concentration of bacteria in stormwater runoff can vary widely. Typical stormwater event mean concentrations derived from studies in Marquette, MI and Madison, WI are presented in Table 14. As shown in this table, event mean concentrations may vary depending on land use. Additionally, event mean concentrations may vary depending on location so it is preferable to collect site-specific stormwater data to most accurately characterize bacteria concentrations in runoff. Sources contributing to fecal coliform in stormwater runoff are discussed below.

Table 14. Concentrations (Geometric Mean Colonies/100ml) of Fecal Coliforms from Urban Source Areas

Land Use	Marquette, MI	Madison, WI
No. of storms sampled	12	9
Commercial parking lot	4,200	1,758
High traffic street	1,900	9,627
Medium traffic street	2,400	56,554
Low traffic street	280	92,061
Commercial rooftop	30	1,117
Residential rooftop	2,200	294
Residential driveway	1,900	34,294
Residential lawns	4,700	42,093

Steuer *et al*., 1997; Bannerman *et al*., 1993 as cited in Schueler and Holland, 2000

Domestic animals

One source of bacteria in stormwater runoff in urban areas like the Shawsheen River watershed, is the feces from household pets such as cats and dogs, which comprise a large potential source of bacteria (~23,000,000 #/gm (CWP, 1999)). A rule of thumb estimate for the number of dogs is ~1 dog per 10 people producing an estimated 0.5 pound of feces per dog per day. This translates to an estimated 10,700 dogs in the watershed producing 5,400 pounds of feces per day (personal communication, Don Waye). Unless this waste is picked up and properly disposed, runoff flushes the bacteria from the parks and yards where pets are walked, into nearby waterways.

Livestock

In rural areas, runoff from livestock areas may be a source of bacteria. Within the Shawsheen River Watershed, only 1% of the watershed area is classified as pasture land, and the tributary watersheds with the highest percentage of pasture land are Sutton Brook and Strong Water Brook, with 13% and 5% respectively, of their areas being classified as such. Sutton Brook only slightly violated water quality standards at its mouth during dry weather (geometric mean=203 in 1997) and wet weather (geometric mean=308 in 1997), indicating that stormwater runoff of livestock waste is likely not a significant problem in this watershed.

Wildlife

Rural wildlife can also contribute to stormwater loads of bacteria. Wildfowl are noted to be of particular concern in the following subwatersheds: Pinnacle Brook, Strong Water Brook, Foster's Pond and Baker's Meadow (Mattei *et al.*, 1999) due in part to the undeveloped land adjacent to some of these waterways. Of these tributaries, wet weather fecal coliform water quality violations were observed at the mouth of Strong Water Brook and Foster's Pond. These exceedances may be due to the runoff of bacteria from deposits left by wildlife, although their contribution is difficult to quantify.

Pump Station Overflows

"All wastewater that is collected through sewer systems is exported out of the watershed for treatment and discharge. Sewer systems are being expanded in most towns thereby increasing the export of water out of the Shawsheen River watershed." According to the MRWC (personal communication, MRWC, 6/99), the only combined sewers are in Lawrence and overflow to the Merrimack River. Therefore, combined sewer overflows are not considered in this source analysis.

Although there are no known combined sewers in the watershed, there was a pumping station overflow noted on Terrace Hall Road (VB 6.5) where the sewer overflows into Vine Brook (MRWC hot spot results, 1999). Pump station by-passes may contribute fecal coliform concentrations which are likely to be similar to those from combined sewer overflows. "Fecal coliform bacteria concentrations from combined sewer overflows are on the order of 10^4 - 10^7 counts/100 ml (CWP, 1999)." While fecal coliform concentrations are expected to be very high in these overflows, the total fecal load delivered to Vine Brook depends upon the quantity of water that is discharged.

Total Maximum Daily Load Development

Section 303(d) of the Federal Clean Water Act (CWA) requires states to place waterbodies that do not meet the water quality standards on a list of impaired waterbodies. The CWA requires each state to establish Total Maximum Daily Loads (TMDLs) for listed waters and the pollutant contributing to the impairments. TMDLs determine the amount of a pollutant that a waterbody can safely assimilate without violating the water quality standards.

Total Maximum Daily Loads (TMDLs) are comprised of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for non-point sources and natural background levels. In addition, the TMDL must include a Margin of Safety (MOS), either implicitly or explicitly, that accounts for uncertainty in the relationship between pollutant loads and the quality of the receiving water body. Conceptually, this definition is denoted by equation 1.

$$LC = TMDL = \Sigma WLAs + \Sigma LAs + MOS \qquad \textbf{Equation 1.}$$

The term LC represents the loading capacity, or maximum loading that can be assimilated by the receiving water while still achieving water quality standards. The overall loading capacity is subsequently allocated into the TMDL components of Waste Load

Allocations (WLAs) for point sources, Load Allocations (LAs) for non-point sources, and the Margin of Safety (MOS).

Fecal Coliform TMDL

LOADING CAPACITY

The pollutant loading that a waterbody can safely assimilate is expressed as either mass per time, toxicity or some other appropriate measure (40 C.F.R. Section 130.2(i)). Typically, TMDLs are expressed as total maximum daily loads. However, MDEP believes it is appropriate to express bacterial TMDLs in terms of concentration because the fecal coliform standard is also expressed in terms of the concentrations of organisms per 100 ml. Since source concentrations may not be directly added, the previous equation does not apply. To ensure attainment with Massachusetts' water quality standards for bacteria, all sources (at their point of discharge to the receiving water) must be equal to or less than the standard. Expressing the TMDL in terms of daily loads is difficult to interpret given that the very high numbers of bacteria and the magnitude of the allowable load are dependent on flow conditions and, therefore, will vary as flow rates change. For example, a very high number of bacteria is allowable if the volume of water that transports the bacteria is high too. Conversely, a relatively low number of bacteria may exceed water quality standards if flow rates are low. For all the above reasons, the TMDL is simply set equal to the standard and may be expressed as follows (Equation 2):

TMDL = Fecal coliform standard = $WLA_{(p1)}$ = $LA_{(n1)}$ =$WLA_{(p2)}$ = etc.   Equation 2.

Where:

$WLA_{(p1)}$ = allowable concentration for point source category (1)

$LA_{(n1)}$ = allowable concentration for nonpoint source category (1)

$WLA_{(p2)}$ = allowable concentration for point source category (2), etc.

For Class B surface waters the fecal coliform TMDL includes two components: (1) the geometric mean of a representative set of fecal coliform samples shall not exceed 200 organisms per 100 ml; and (2) no more than 10% of the samples shall exceed 400 organisms per 100 ml. The Shawsheen River and its tributaries are all Class B waters.

The goal to attain water quality standards at the point of discharge is environmentally protective, and offers a practical means to identify and evaluate the effectiveness of control measures. In addition, this approach establishes clear objectives that can easily be understood by the public and individuals responsible for monitoring activities. Also, the goal of attaining standards at the point of discharge minimizes human health risks associated with exposure to pathogens because it does not consider losses due to die-off and settling that are known to occur.

WASTELOAD ALLOCATIONS AND LOAD ALLOCATIONS

There is only one permitted point source discharger of fecal coliform within the Shawsheen River Basin. The fecal coliform permit limits for this discharger are: an average monthly concentration of 200 #/100 ml and a daily maximum concentration of 400 #/100 ml. A WLA set equal to the fecal coliform standard will be assigned to the

Battle Road Wastewater Plant discharge. Based on a review of recent monthly operating reports, it appears that this facility is in compliance with its permit limits and also in compliance with the fecal coliform water quality standard.

Direct storm water discharges of fecal coliform from storm drainage systems also occur within the Shawsheen River Basin. Piped dischargers are, by definition, point sources regardless of whether they are currently subject to the requirements of NPDES permits. Therefore, a WLA set equal to the fecal coliform standard will be assigned to the portion of the storm water that discharges to surface waters via storm drains.

WLAs and LAs are identified for all known source categories including both dry and wet weather sources for all Class B segments within the Shawsheen River Basin. Establishing WLAs and LAs that only address dry weather bacteria sources would not ensure attainment of standards because of the significant contribution of wet weather bacteria sources to fecal coliform criteria exceedences. Leaking sewer lines and illicit sewer connections represent the primary dry weather point sources of bacteria, while failing septic systems represent the nonpoint sources. Wet weather point sources include discharges from storm water drainage systems, and pump station overflows.

Table 15 presents the fecal coliform bacteria WLAs and LAs for each of the source categories. Source categories representing discharges of untreated sanitary sewage to receiving waters are prohibited, and therefore assigned WLAs and LAs equal to zero. The WLA and LA for stormwater discharging to the Shawsheen River and its tributaries are set equal to the fecal coliform standard for Class B waters.

Table 15. Fecal Coliform Wasteload Allocations (WLAs) and Load Allocations (LAs) for the Shawsheen River and Identified Tributary Streams

Bacteria Source Category	WLA (organisms/100ml)	LA (organisms/100ml)
Point Source	Geomean $\leq$ 200 10% $\leq$ 400	
Sewer leaks	0	0
Sanitary Sewer Overflow	0	0
Illicit Sewer Connections	0	
Failing Septic Systems	0	0
Direct Wildlife		Geomean $\leq$ 200 10% $\leq$ 400
Urban Stormwater Runoff	Geomean $\leq$ 200 10% $\leq$ 400	Geomean $\leq$ 200 10% $\leq$ 400

The TMDL should provide a discussion of the magnitudes of the pollutant reductions needed to attain the goals of the TMDL. Since accurate estimates of existing source contributions are generally unavailable, it is difficult to estimate the pollutant reductions for specific sources. For the illicit sources, the goal is complete elimination (100% reduction). However, overall wet weather bacteria load reductions can be estimated using typical storm water bacteria concentrations, as presented in Table 14, and the magnitude of the wet weather data observed in the Shawsheen Basin. This information indicates that 1 to 2 orders of magnitude reductions in stormwater fecal coliform loadings will be necessary.

In addition, overall reductions needed to attain water quality standards can be estimated using the extensive ambient fecal coliform data that are available for the Shawsheen Basin. Using ambient data is beneficial because it provides more realistic estimates of existing conditions and the magnitude of cumulative loading to the surface waters. Reductions are calculated using data from both wet weather conditions and combined wet and dry conditions and are presented in Table 16.

Stations selected for presentation in Table 16 include those that are located on 303(d) listed segments and also which have both wet and dry weather monitoring data available. Stations were selected where violations of bacteria standard were observed. Both Stations ROB 1.5 and SH 18.25 are the most downstream stations on Rogers Brook and the Shawsheen River, respectively. Shawsheen River station 4.2 was selected for inclusion in Table 16 due to its location downstream of an illicit sewer connection, to highlight the need for elimination of illicit sources.

Data from 1997 were used preferentially in Table 16 because these data were collected using a QAPP, the sampling included wet and dry weather data collection, and this data set is the most recent data set with both wet and dry data. Data collected in 1996 by the MRWC were used for Rogers Brook because Rogers Brook was not monitored in 1997.

Examination of wet weather data separately provides estimates of magnitudes of reductions from all sources during wet weather conditions. As indicated in Table 16, bacteria reductions of 1 to 2 orders of magnitude (e.g., 2,000 to 200 (1 order of magnitude); 20,000 to 200 (2 orders of magnitude)) are needed to attain water quality standards. For example, when viewing the data in Table 16 at station EB 3.3, a reduction of 74% is needed to reduce fecal coliform levels to meet water quality standards during wet weather conditions. The 90% observation listed in the table means that 90% of the samples collected at this station fall below the value of 760 organisms per 100ml. That value would have to be reduced to 400 organisms per 100 ml to meet water quality criteria. This translates to a 47.4% reduction.

Table 16. Estimates of Fecal Coliform Loading Reductions to the Shawsheen River and Tributaries

Station	EB 3.3	VB 1.5	ROB 1.5	SH 4.2	SH 18.25
Wet weather Geo. Mean **% Reduction[1]**	770 **74.0**	2,700 **92.6**	5,126 **96.1**	32,863 **99.4**	2,491 **92.0**
Overall Geo. Mean **% Reduction[1]**	563 **64.5**	3,851 **94.8**	1,912 **89.5**	44,041 **99.5**	542 **63.1**
90% Observation **% Reduction[2]**	760 **47.4**	5,200 **92.3**	7,100 **94.4**	54,000 **99.3**	660 **39.4**

[1]Geometric mean to be less than or equal to 200 organisms per 100 ml

[2] No more than 10% of the samples shall exceed 400 organisms per 100 ml

Margin of Safety

This section addresses the incorporation of a Margin of Safety (MOS) in the TMDL analysis. The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS can either be implicit (e.g., incorporated into the TMDL analysis through conservative assumptions) or explicit (e.g., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Realistically, influent water will mix with the receiving water and become diluted below the water quality standard, provided that the influent water concentration does not exceed the TMDL concentration. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling that are known to occur.

Seasonal Variability

In addition to a Margin of Safety, TMDLs must also account for seasonal variability. Bacteria sources to the Shawsheen River arise from a mixture of continuous and wet weather-driven sources, and there may be no single critical condition that is protective for all other conditions. For example, leaking septic system contributions are assumed to be relatively constant over time, and their control will be most critical during drought conditions. Urban runoff, on the other hand, will be most critical during wet weather periods. This TMDL has set WLAs and LAs for all known and suspected source categories equal to the fecal coliform criteria independent of seasonal and climatic conditions. This will ensure the attainment of water quality standards regardless of seasonal and climatic conditions. Any controls that are necessary will be in place throughout the year, and therefore, will be protective of water quality at all times.

Implementation Activities and Future Monitoring

The Shawsheen River TMDL site data indicate that bacteria enter the Shawsheen River from a number of contributing sources, under a number of conditions. This section describes activities that are currently ongoing and/or planned, designed to ensure that the TMDL can be implemented. It is divided into separate sections describing:

- Control of point sources
- Septic tank controls
- Urban runoff
- Additional monitoring

CONTROL OF POINT SOURCES

The Battle Road treatment plant is not a source of bacteria that needs to be further controlled, although existing permitted effluent concentrations must be maintained. However, other point sources including pump station bypasses, illicit connections to storm drains and sewer line breaks should all be addressed.

Many of these sources are either already under control or are in the process of being addressed. The pump station bypass on Vine Brook will be addressed within the next 5-

10 years when an interceptor line is built. The illicit disposal of sewage discovered near Shawsheen River station 4.2 is currently being addressed. Additionally, the sewer overflow in Andover, impacting Roger's Brook, is currently being addressed by the Massachusetts DEP. Finally, a broken sewage main discovered at the Hanscom Air Force Base was fixed in 1997. Further examination of the sewer lines should be conducted to identify any additional leaks or breaks.

It is strongly recommended that communities in the Shawsheen Basin implement an illegal connection identification and removal program, especially in those areas that are known to be in violation of the bacteria standard during dry weather based on the sampling results. This may be the single most important implementation activity that takes place in the Basin. Such initiatives have been shown to have dramatic benefits in the Charles Basin. Information on techniques to accomplish this is available. As a result of an MWI grant, MRWC has recently created a GIS data layer of all pipes along the mainstem of the Shawsheen, with information that notes the presence of any discharge (during dry weather) and the characteristics of the discharge, all of which will help focus efforts.

SEPTIC TANK CONTROLS

Septic system bacteria contributions to the Shawsheen River may be reduced in the future through septic system replacement that is currently occurring in the lower Shawsheen basin. Additionally, the implementation of Title V, which requires inspection of private sewage disposal systems before the sale, expansion or change in use of properties where they are present, will aid in the discovery of poorly operating or failing systems. Because systems which fail must be repaired or upgraded, it is expected that the bacteria load from septic systems will be significantly reduced in the future.

From the Massachusetts DEP website, several steps which can be taken to maintain a properly operating septic system include:

(Website address http://www.magnet.state.ma.us/dep/brp/files/yoursyst.htm))

- DO have your tank pumped out and system inspected every 3 to 5 years by a licensed septic contractor (listed in the yellow pages).
- DO keep a record of pumping, inspections, and other maintenance. Use the back page of this brochure to record maintenance dates.
- DO practice water conservation. Repair dripping faucets and leaking toilets, run washing machines and dishwashers only when full, avoid long showers, and use water-saving features in faucets, shower heads and toilets.
- DO learn the location of your septic system and drainfield. Keep a sketch of it handy for service visits. If your system has a flow diversion valve, learn its location, and turn it once a year. Flow diverters can add many years to the life of your system.
- DO divert roof drains and surface water from driveways and hillsides away from the septic system. Keep sump pumps and house footing drains away from the septic system as well.

- DO take leftover hazardous household chemicals to your approved hazardous waste collection center for disposal. Use bleach, disinfectants, and drain and toilet bowl cleaners sparingly and in accordance with product labels.
- DON'T allow anyone to drive or park over any part of the system. The area over the drainfield should be left undisturbed with only a mowed grass cover. Roots from nearby trees or shrubs may clog and damage your drain lines.
- DON'T make or allow repairs to your septic system without obtaining the required health department permit. Use professional licensed septic contractors when needed.
- DON'T use commercial septic tank additives. These products usually do not help and some may hurt your system in the long run.
- DON'T use your toilet as a trash can by dumping nondegradables down your toilet or drains. Also, don't poison your septic system and the groundwater by pouring harmful chemicals down the drain. They can kill the beneficial bacteria that treat your wastewater. Keep the following materials out of your septic system:
    - NONDEGRADABLES: grease, disposable diapers, plastics, etc.
    - POISONS: gasoline, oil, paint, paint thinner, pesticides, antifreeze, etc

URBAN RUNOFF

"Bacteria levels in urban stormwater are so high that watershed practices will need to be exceptionally efficient to meet current fecal coliform standards during wet weather conditions (CWP, 1999)". The recommended plan of action for the Shawsheen River is to collect additional monitoring data to isolate sources prior to designing an implementation plan for structural controls. Watershed managers should be aware that urban runoff has been listed by TMDL Federal Advisory Committee as an extremely difficult problem worthy of a long implementation schedule. Furthermore, it should be noted that it may be very difficult to reduce urban stormwater fecal coliform concentrations such that water quality standards are met. A review by the Center for Watershed Protection concludes that "**current stormwater practices**, stream buffers and source controls have a modest potential to reduce fecal coliform levels, but cannot reduce them far enough to meet water quality standards in most urban settings (CWP, 1999)." Therefore, more intensive “good housekeeping” practices, such as proper pet waste removal, street sweeping and reductions in impervious areas, are likely to be necessary, at a minimum, to increase reductions of stormwater bacteria loadings.

ADDITIONAL MONITORING

Additional data are recommended in two areas as part of the TMDL implementation plan to identify sources and assess water quality standards attainment in response to implementation activities. These areas are: wet weather sources and instream conditions.

Wet Weather Sources

Wet weather monitoring will need to be conducted in order to isolate wet weather sources and assist in identifying those sources which are most easily controllable. Monitoring of runoff from a variety of different land uses (parks, residential, commercial, industrial, forest and agriculture) will assist in identifying those land uses which are likely to contribute higher loads of fecal coliform to the Shawsheen River.

Instream Conditions

Future data collection in the Shawsheen River systems will be useful in order to monitor trends in bacteria concentration and verify that implementation of controls is leading to compliance with water quality standards. This monitoring could be conducted on a seasonal (e.g. quarterly) basis, and should be structured to include at least one high flow and one low flow period.

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APPENDIX 1: PUBLIC PARTICIPATION

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
Division of Watershed Management, 627 Main Street, Worcester, MA 01608

JANE SWIFT, Governor — LAUREN A. LISS, Commissioner — BOB DURAND, Secretary

Shawsheen BACTERIA TMDL Mtg

MEETING ATTENDEES LIST

Meeting: Shawsheen River TMDL
Presenters: Russell Isaac
Date: 3/12/02 Place: Billerica Town Hall

Name	Affiliation or address	phone or email
1) [illegible]	DEP-NERO	978 661-7816
2) Russell Isaac	DEP-DWM	
3) Brian Friedmann	DEP-DWM	
4) Elaine Hartman	DEP-DWM	508-767-2857
5) Curt Laffin	Hudson, NH	603 [illegible] [illegible]
6) Brian Moore	Andover MA	978-623 8350 [illegible]
7) Bob Potter	SRWA	Bpotter@aol.com
8) [illegible]	EPA	
9) Judy Carlson	DEP	978-661-7676
10) David Webster	EPA	617-918-1791
11) Tara Oakley	Chief of Staff Rep. Jim Miceli	617-722-2572
12)		
13)		
14)		

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COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
Division of Watershed Management, 627 Main Street, Worcester, MA 01608

JANE SWIFT, Governor — LAUREN A. LISS, Commissioner — BOB DURAND, Secretary

Shawsheen BACTERIA TMDL Mtg

MEETING ATTENDEES LIST

Meeting: Shawsheen River TMDL
Presenters: Russell Isaac
Date: 3/12/02 Place: Billerica Town Hall

Name	Affiliation or address	phone or email
1) William Dunn	EOEA Team Leader	
2) Tham Saravanapavan	Merrimack River Watershed Council	tham@merrimack.org
3)		
4)		
5)		
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8)		
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MEMORANDUM (DRAFT)

SUBJECT: Shawsheen River TMDL Meeting

PREPARED BY: Elaine Hartman, DEP-DWM

DATE: March 18, 2002

LOCATION AND DATE: Town Hall, Billerica, MA March 12, 2002, 7-9 pm

PRESENTATIONS:
Russell Isaac, MADEP, presented the TMDL report process, and information on bacteria data and standards as applied to this TMDL;
Tham Saravanapavan, MRWC, presented additional information on the water quality studies conducted in the watershed and on upcoming work which will be conducted to identify bacterial sources in the watershed:

Bill Dunn, EOEA watershed team leader for the Shawsheen River was present to answer questions.

GIS displays: MRWC GIS maps of: (1) Shawsheen River Basin and Surrounding Communities (2) Shawsheen River Basin Sampling Locations.

Handouts: MADEP PowerPoint presentation; TMDL full draft report and summary sheets; material on septic systems and Title V; funding for improvements; and various other material on related meeting topics.

Note: The TMDL report is undergoing public review and comments should be submitted by April 12, 2002. The report is available on the web.

About 4 stakeholders attended the meeting, and 9 representatives of the state and federal agencies and the watershed association, including: USEPA, MADEP-NERO, MADEP-BRP-DWM; MWRC; EOEA.

Attachments: Presentations by MADEP; attendance sheet.

Questions and Statements by Stakeholders and Agencies:
1. One Andover resident indicated that he has lived on the Shawsheen River for a number of years and every other year the sewer system overflows into the river at high flows during which time waste is seen in the river. An interceptor has been required by DEP to be located in this area to alleviate this problem. Is this being handled as point source or nonpoint source for remediation?
DEP/EPA response: Most towns have tried to remove sump pumps from being attached to systems which discharge to the river, as these systems then become overloaded and surcharge to the river. DEP will check to see what is happening, as this should not be happening routinely.

2**.** The resident from Andover inquired as to what effect does this discharge have on the river, and was it sampled for as part of this study?
DEP responded that if the sewer line is surcharging you do not need to sample there because you know there is a problem. For a sanitary system this needs to be addressed, and is the responsibility of the town. DEP requested the location of this situation.
The resident from Andover responded that it was at No. Main St. and Stevens, and that an interceptor was installed a couple of weeks ago, and inquired what the next step would be.
DEP indicated that it would look into the situation in Andover. DEP also responded that we have moved from a time when there was no treatment, to a time when treatment plants have been installed and more and more treatment is taking place at the plants. We have reached a time when we need more than just treatment plant, when public education and outreach to address personal behaviors will have an impact on what is happening instream. Monitoring is important not just to get the data but also to get people involved and to see what is happening.

3. A resident indicated that if the precipitation is greater than 0.5 inches in a 24-48 hour period overflows occur together with sump pump inflows. DEP indicated that recently a report was issues that showed the results of an MIT contest to look at managing infiltration on home sites. There were a number of innovative approaches. A resident indicated that the town is seeking funding to do I/I work, and questioned how does one enforce or address this illegal discharge from basements into the sewer lines.

The EOEA team leader commented on the process used in the Neponset watershed to address the inflow and infiltration issue. A house to house inspection was conducted. The town felt it was a key factor in reducing levels. A resident indicated that the Board of Health will do this regularly with dye etc. to inspect connections. Most storm drain systems were not designed to pick up these basement flows. This basement pumping then creates a problem in the river because the WWTF does not have the capacity to include these flows.
USEPA indicated that on a federal level they do not go to the house level for enforcement. Instead they place the enforcement on the treatment plant through restricting future connections. For Deer Island, EPA put in a limitation on new connections based on I/I reductions.
Resident indicated that some towns have minimal capacity at the WWTFs so the burden then gets transferred to the consultant proposing new developments to reduce the I/I.

4. The MWRC representative indicated that for the Shawsheen River there are two problems for flow: (1) flooding; and (2) low flows, when there are not sufficient baseflows for the summer. MRWC is working on this. The Phase 2 stormwater program is a good vehicle to take control of these issues on a municipal level. Existing ordinances can be amended using Phase 2. EPA has a good model one online.
EPA responded that the TMDL process is also a good tool to do this.

5. The EOEA team leader indicated that there is EOEA funding to work with municipalities to help them with the Phase 2 and MS4 process in 5 Shawsheen and

additional Merrimack communties. The EOEA team would like to get additional funds for non MS4 communities to develop good housekeeping practices. $15,000 effort this year. In FY04 there is an additional $15,000 possible.

6. DEP indicated that educating the students to educate the adults is also a good method for change.
8. EPA has a good web page for perviousness and pavement issues. A resident indicated that high impact plastic is also used. In his area of the watershed it is 60% impervious.

7. Representative Macelli staff member spoke and indicated that the Representative from Tewksbury offers his help.

8. EPA stated that the new stormwater regulations are a kinder gentler way of providing improvements with more flexibility in methods.