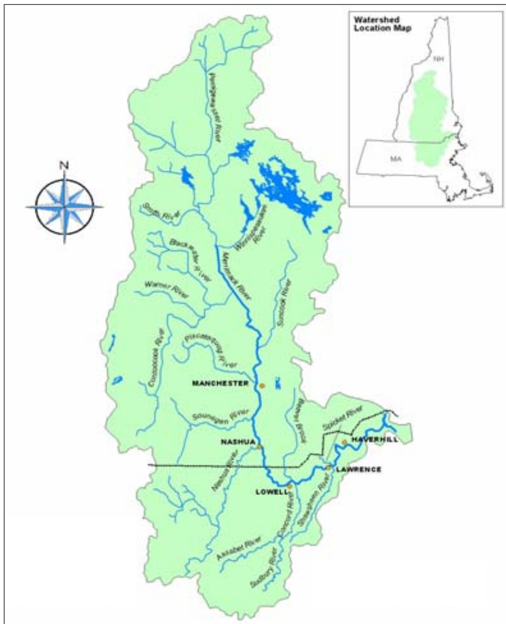

Merrimack River Watershed Assessment Study

Summary of Information on Pollutant Sources

Prepared for:

New England District
U.S. Army Corps of Engineers

Sponsor Communities:
Manchester, NH
Nashua, NH
Lowell, MA
GLSD, MA
Haverhill, MA

January 2004

Manchester and Nashua, New Hampshire

Merrimack RIVER BASIN Community Coalition

Lowell, GLSD, and Haverhill, Massachusetts

The River Basin Community Coalition concept was conceived in June 1998 in response to regulatory requirements to mitigate Combined Sewer Overflows (CSO) discharges. Because the coalition communities faced an aggregate financial commitment of 0.5 to 1.0 billion dollars, the five founding technical managers and administrators from each community believed that such an investment should be made wisely. They believed that this wise investment should be founded on good science that holistically embraces the needs of the watershed. Generally speaking the mission is to "spend smart" by making wise science based investments in activities related to water quality improvements that are not solely focused on CSO mitigation.

Executive Summary

The purpose of this interim report is to present a summary of the information gathered on pollutant sources in the Merrimack River watershed, under Task 2C of the Merrimack River Watershed Assessment Study. The report includes a discussion of the following topics:

- Combined Sewer Overflows (CSOs) in the five sponsor communities of Manchester and Nashua, New Hampshire; Lowell and Haverhill, Massachusetts; and the Greater Lawrence Sanitary District (GLSD), Massachusetts
- Stormdrain outfalls in 22 communities along the mainstem Merrimack River downstream of Hooksett, New Hampshire
- Information on the quantity and quality of discharges from municipal and privately-owned treatment plants and industrial point sources along the Merrimack River
- Information on other sources of pollutants, including sediments, air deposition, groundwater plumes from landfills, erosion along streambanks, areas with failing septic systems, pump station overflows, and illicit wastewater discharges to stormdrains

This report is intended only to provide a quantitative summary of these sources. This information will be used as input during subsequent modeling efforts to be conducted during subsequent tasks under this Study.

Combined Sewer Overflows

Combined Sewer Overflows (CSOs) currently exist in the five sponsor communities of Manchester and Nashua, New Hampshire; Lowell and Haverhill, Massachusetts; and the Greater Lawrence Sanitary District (GLSD), Massachusetts. These CSOs discharge combined sanitary and stormwater flows of varying quantity and quality to the Merrimack River and several of its major tributaries. Table ES-1 presents a summary of the maximum number of discharge events and the total annual discharge volumes for each of the five communities expected in a typical year.

Table ES-1: Summary of Average Annual CSO Discharges

Community	Maximum Number of Discharge Events per Year	Average Annual Discharge Volume (MG)
Manchester, New Hampshire	49	220
Nashua, New Hampshire	25	26
Lowell, Massachusetts	37	352
GLSD, Massachusetts	14	112
Haverhill, Massachusetts	41	71

MG= Million gallons

Under the existing conditions, a total of 781 million gallons of combined flow is discharged annually to the Merrimack River and its tributaries. The majority of these overflows occur in the cities of Manchester, New Hampshire and Lowell, Massachusetts. Nashua, New Hampshire has the lowest average discharge of untreated flows. The annual CSO volume contribution is inconsequential (approximately 0.04-percent) in comparison to the total annual flow of the Merrimack River at 7697cfs (or 1,814,875MG) as recorded at the USGS gaging station in Lowell, Massachusetts.

Currently, each of the five communities is under Administrative Order from the U.S. Environmental Protection Agency (USEPA) to develop and implement a Long-Term CSO Control Plan (LTCP) to mitigate the impact of their CSO discharges. Each of the five communities is at varying stages of this process.

Stormdrains

As part of this task, CDM collected information on stormdrain locations from the following 22 communities along the mainstem Merrimack River south of Hooksett, New Hampshire:

Massachusetts

1. Salisbury
2. Newburyport
3. Amesbury
4. West Newbury
5. Merrimac
6. Groveland
7. Haverhill
8. Methuen
9. North Andover
10. Lawrence
11. Andover
12. Dracut
13. Tewksbury
14. Lowell
15. Chelmsford
16. Tyngsboro

New Hampshire

1. Hudson
2. Nashua
3. Bedford
4. Litchfield
5. Merrimack
6. Manchester

Stormdrain mapping was available in Geographic Information System (GIS) format for eight of the 22 communities: Methuen, Lawrence, Dracut, Andover, Tewksbury, and Lowell, Massachusetts; and Manchester and Nashua, New Hampshire. The GIS database for each community generally contained information on the location and rim elevation of catchbasins and drain manholes, the location of stormdrain piping, and the location and size of stormdrain and CSO (as applicable) outfalls.

In addition to the available GIS information, Normandeau Associates conducted field surveys during the fall of 2002 to identify stormdrain outfalls discharging to the mainstem Merrimack River between Hooksett, New Hampshire and Newburyport, Massachusetts. Table ES-2 provides a summary of the size category and number of outfalls identified by Normandeau.

Table ES-2: Summary of Field Surveyed Stormdrains

Type of Outfall	Number Observed
Outfall pipe with diameter less than 36-inches	114
Outfall pipe with diameter greater than 36-inches	55
Miscellaneous (includes confluences of major tributaries and mill/canal discharges)	37
TOTAL=	**206**

Of the outfalls located by Normandeau, approximately 20 of them were CSO structures, which could not be distinguished from the stormdrains during field surveys. These structures have not been included in the overall count provided in Table ES-2.

The outfall information collected as part of this field survey will be used in place of community supplied information (i.e. GIS stormdrain databases) in towns where no such data was available.

Municipal and Privately-Owned WWTPs

Information was collected on the quantity and quality of municipal and privately-owned wastewater treatment plants (WWTPs) in the Merrimack River watershed under average daily and storm conditions.

Based on information obtained from the USEPA, a total of 46 municipal and privately-owned WWTPs are permitted to discharge to the mainstem Merrimack River and its tributaries. Of these, 32 are classified as “major” dischargers by the USEPA; the remaining 14 are classified as “minor” dischargers. The USEPA defines major municipal dischargers as those facilities with design flows greater than one million gallons per day.

Table ES-3 provides a summary of the total WWTP flows in the following three categories: (1) sponsor communities, (2) mainstem Merrimack River, (3) major tributaries that join the Merrimack River downstream of Hooksett, New Hampshire.

Table ES-3: Summary of Total WWTP Discharge Flows in the Merrimack River Watershed

Drainage Area Category	Total WWTP Flow (MGD)
Sponsor Communities	108
Mainstem Merrimack River	23.3
Major Tributaries	44.7
TOTAL=	**176**

MGD= Million gallons per day

The largest WWTP flows are discharged directly to the mainstem Merrimack River from the sponsor communities, at a total of 108 MGD, or 167 cubic feet per second (cfs). The total WWTP flow is small in comparison to the average annual flow of the Merrimack River at 7697 cfs, as measured at the USGS gaging station in Lowell, Massachusetts (approximately 3.5-percent of the average annual flow). However, it represents a more significant portion of the flows during the summer months, when average August streamflow is 2802 cfs in Lowell, and at the more critical 7Q10 level of 950 cfs, at approximately 10 and 28-percent, respectively.

Industrial Point Sources

Information was collected on the average quality and quantity of industrial point source discharges in the Merrimack River watershed. According to information obtained from the USEPA, 48 industrial facilities currently discharge to the mainstem Merrimack River and its tributaries. Of these, 11 are classified as "major" dischargers, with design flows greater than one million gallons per day.

Table ES-4 provides a summary of the total industrial point source discharges in the following three categories: (1) sponsor communities, (2) mainstem Merrimack River, (3) major tributaries that join the Merrimack River downstream of Hooksett, New Hampshire.

Table ES-4: Summary of Total Industrial Discharge Flows in the Merrimack River Watershed

Drainage Area Category	Total Flow (MGD)
Sponsor Communities	6.19
Mainstem Merrimack River[1]	243
Major Tributaries	4.10
TOTAL=	**253**

[1]Note: 238 MGD of flow is from a single discharger- Pubic Service of New Hampshire (PSNH)

MGD= Million gallons per day

The largest industrial flows are discharged directly to the mainstem Merrimack River (approximately 243 MGD (376 cfs)). It is important to note that 238 MGD of this total flow (or 98-percent) may be attributed to one discharger- Public Service of New Hampshire (PSNH), which operates a hydropower facility on the mainstem Merrimack River. PSNH's permitted flow relates to cooling water discharges. The total flow of the industrial discharges in the Merrimack River watershed is low (approximately five-percent) in comparison to the total average annual flow in the Merrimack River of 7697 cfs. However, they are more significant when compared to the average August monthly flow of 2802 cfs at Lowell, Massachusetts or the 7Q10 of 950 cfs at this same location, 14 and 41-percent, respectively.

Other Sources of Pollutants

Information was collected on additional sources of pollutants in the Merrimack River watershed, including sediments, air deposition, groundwater plumes from landfills, erosion along streambanks, areas with failing septic systems, pump station overflows, and illicit wastewater discharges to stormdrains. A summary of this information is provided below.

Sediments

A review of available literature revealed a general lack of data on sediment quality in the mainstem Merrimack River and its major tributaries. However, the watershed's industrial past points to a strong potential for sediment contamination. Studies have documented primarily exposed bedrock channels in the majority of the mainstem River. Therefore, it is expected that the majority of sediment deposition occurs upstream of the major dams on the mainstem, as well as in the estuarine portion of the River because of lower velocities that allow sediments to settle in these areas.

USGS Sediment Sampling

Sediment sampling was performed by the USGS in the New England Coastal Basin (NECB) study area as part of their National Water-Quality Assessment (NAWQA) Program. One station in the mainstem Merrimack River was sampled adjacent to the USGS gaging station in Lowell, Massachusetts. Streambed sediments were analyzed for a total of 141 contaminants, including 45 trace elements, 32 organochlorine compounds, and 64 semi-volatile organic compounds.

In general, the median concentrations of trace elements in the NECB were 1.5 to 8 times higher than those found nationally in the 46 NAWQA study units. However, the results for the Merrimack River sampling station were consistently among the lowest in the NECB, though generally still higher than wider median NAQWA values. Similar trends were seen in the concentrations of total polycyclic aromatic hydrocarbons (PAHs) and total polychlorinated biphenyls (PCBs).

Other Sediment Monitoring

Additional sediment sampling in the Merrimack River watershed was performed by Marie M. Studer, a doctoral candidate at the University of Massachusetts- Boston in completion of her dissertation entitled "*The chemistry and geochemistry of selected metals in the Merrimack River of New England and regulatory considerations of water quality*". Studer undertook a two-year study between January 1989 and April 1991 to determine the geochemical behavior of select metals and the anthropogenic influences of water column metal concentrations in the mainstem River and its headwaters.

As part of that study, two sediment cores were collected from the Indian River Shoals, a freshwater tidal marsh in West Newbury, Massachusetts. Sediment samples were prepared and analyzed for select metals, including silver (Ag), aluminum (Al), cadmium (Cd), copper (Cu), chromium (Cr), iron (Fe), manganese (Mg), nickel (Ni), lead (Pb), and zinc (Zn), radionuclides, organic carbon, and grain-size distribution. Studer found that the metal concentrations fell into the following three patterns based on similarity of their profiles when plotted versus depth:

- Concentrations of abundant crust metals (aluminum, iron, and manganese), as well as nickel were relatively constant with depth
- All other metals were found to have relative constant concentrations at depths greater than 20-cm; elevated levels were observed in the top 15 to 20-cm
- Sharp increases in silver and cadmium were observed between 10 and 15-cm. More gradual increases in copper, chromium, lead, and zinc occurred starting deeper in the core

Studer attributed these differences to those metals that were dominated by weathering (i.e. aluminum, iron, and manganese) versus those that were impacted by anthropogenic mobilization over the past century or more.

Sediment Impacts

In addition to the potential for metals contamination in the soils, bed sediments may serve as a potential source of nutrient contamination through sediment nutrient fluxes, as well as a potential sink of dissolved oxygen. The largest impact from the sediments is expected upstream of the dams and in the estuarine portion of the Merrimack River. However, these impacts are expected to be fairly minimal; as a result, the development of a model to simulate sediment nutrient fluxes and sediment oxygen demand is not expected during Phase I of this study.

Atmospheric Deposition

Air deposition has been identified as a potential contributor to water quality problems throughout the United States. Mercury deposition has been identified as a major source of contamination in the Merrimack River basin and the broader New England region. Recent investigations by the USGS through their National Mercury Pilot

Study showed some of the highest mercury concentrations in the country in the New England Coastal Basin study unit, which encompasses 23,000 square miles in central Maine, eastern portions of New Hampshire and Massachusetts, most of Rhode Island, and a small portion of Connecticut. As a result of the elevated mercury levels, both Massachusetts and New Hampshire have issued statewide advisories on fish consumption.

Groundwater Plumes from Landfills

Landfills represent a significant potential source of non-point source pollution in the Merrimack River watershed, since older landfills were not properly engineered to contain toxic materials that were disposed of in the facilities. According to available information, solid waste disposal sites cover approximately 7808 acres in the Merrimack River watershed. This represents approximately 0.25-percent of the total watershed area. Table ES-5 presents a summary of the number of landfills within 100-feet, 500-feet, 1000-feet, and one-mile of the mainstem Merrimack River.

Table ES-5: Summary of landfills adjacent to the mainstem Merrimack River

Distance from mainstem	Number of landfills
100-feet	0
500-feet	4
1000-feet	14
1-mile	97

Recent regulations have sought to limit the impact of solid waste disposal sites on the environment by containing the solid waste and preventing groundwater contamination. Some landfills in the Merrimack River watershed have been capped or lined in an effort to contain the waste, leachate, and rainfall that may otherwise flush contaminants into the groundwater.

Erosion Along Streambanks

During Fall 2002, Normandeau Associates conducted field surveys to identify areas along the Merrimack River mainstem with areas of erosion greater than approximately 50-feet. The survey was limited to the area between Hooksett, New Hampshire and Newburyport, Massachusetts. The survey revealed approximately 55 areas with eroded or undercut streambanks. No areas of erosion fitting the survey criteria were observed downstream of Haverhill, Massachusetts.

Failing Septic Systems

Septic systems are used for the subsurface disposal of wastewater. These systems must be maintained in order to function properly; poorly maintained systems may fail and cause localized water quality problems. However, even well maintained systems may cause adverse impacts on water quality. Conventional septic systems are designed primarily for the removal of pathogens. Thus, even properly maintained systems provide minimal treatment of other constituents, such as nutrients. As a result, a high density of small septic systems, such as those in a residential development, may result in excessive nutrient concentrations in the groundwater and in downgradient surface waterbodies. The extent of this pollution is largely governed by the distance of the septic system from the downgradient receiving waterbody.

Information on the number of septic systems in the Merrimack River watershed was obtained from 1990 U.S. Census Bureau data. Table ES-5 provides a summary of the population, number of housing units, and percentage of housing units served by public sewer and septic systems for each of the nine counties intersecting the watershed. Additional information for specific communities is provided in Section 6.5.1 of this report.

Table ES-5: 1990 Sewage Disposal Information for Nine Communities in the Merrimack River Watershed

State	County	Population	Housing Units	Public Sewer (%)	Septic (%)
MA	Essex	670,080	271,977	81.7%	18.0%
	Middlesex	1,398,468	543,796	80.7%	19.0%
	Worcester	709,705	279,428	68.0%	31.6%
NH	Belknap	49,216	30,306	43.9%	52.7%
	Carroll	35,410	32,146	12.3%	84.2%
	Cheshire	70,121	30,350	43.4%	54.8%
	Grafton	74,929	42,206	44.0%	54.4%
	Hillsborough	336,073	135,622	67.6%	32.0%
	Merrimack	120,005	50,870	49.7%	49.4%
	Rockingham	245,845	101,773	40.9%	58.1%
	Strafford	104,233	42,387	56.7%	42.8%
	Sullivan	38,592	19,532	42.2%	55.9%

Source: http://venus.census.gov/cdrom/lookup

Note: "Other" sewage disposal systems make up the remaining percentages in each county.

A review of the available literature did not reveal any information regarding septic system failure rates for communities in the Merrimack River watershed. However, previous work performed as part of the Rouge River National Wet Weather Demonstration Project in the Detroit, Michigan metropolitan area provides a basis with which to develop a generalized failure rate for the watershed. The study concluded that during an average year five to 15-percent of the septic systems in a watershed would be failing, based on estimate of the anticipated time it would take for home owners to discover and repair the problem.

Pump Station Overflows

Pump station overflows, and more generally sanitary sewer overflows (SSOs), occur as a result of unintentional discharges of raw sewage from municipal sanitary sewer systems. SSOs may be attributed to avoidable (*i.e.* inadequate system operation or maintenance or improper system design) or unavoidable (*i.e.* vandalism, blockages, or extreme weather conditions) circumstances.

To our knowledge, no studies have been conducted in the Merrimack River watershed to identify or quantify the impact of SSO discharges. However, a review of the literature reveals that sanitary sewer and pump station overflows have not been identified as a major source of pollution in the Merrimack River watershed.

Illicit Wastewater Discharges to Stormdrains

Illicit connections are defined as "illegal and/or improper connections to storm drainage systems and receiving waters" (Center for Watershed Protection 1998). Source of illicit discharges may include illegal sanitary sewer connections, effluent from septic systems, commercial carwash or other industrial discharges, and improper disposal of auto or household toxics.

A review of the literature reveals that few studies have been conducted by communities in the Merrimack River watershed to identify and eliminate illicit connections. However, as part of Phase II of USEPA's National Pollutant Discharge Elimination System (NPDES) Stormwater Regulations, communities falling under the rule will be required to develop, implement, and enforce an illicit discharge elimination program. Approximately 100 communities in the Merrimack River watershed fall under these Phase II requirements.

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Section 1
Introduction

1.1 Interim Report Scope and Objectives

The goal of this interim report is to present a summary of the information gathered on pollutant sources in the Merrimack River watershed, under Task 2C of the Merrimack River Watershed Assessment Study. This report includes a discussion of the following:

- Combined sewer overflows (CSOs) in the cities of Manchester and Nashua, New Hampshire, Lowell and Haverhill, Massachusetts, and the Greater Lawrence Sanitary District (GLSD), Massachusetts

- Stormdrain outfalls in 22 communities along the mainstem Merrimack River downstream of Hooksett, New Hampshire

- Information on the quantity and quality of discharges from municipal and privately-owned wastewater treatment plants and industrial point sources along the Merrimack River

- Other sources of pollutants, including sediments, air deposition, groundwater plumes from landfills, erosion along streambanks (mainstem only south of Hooksett, New Hampshire), areas with failing septic systems, pump station overflows, and illicit wastewater discharges to stormdrains

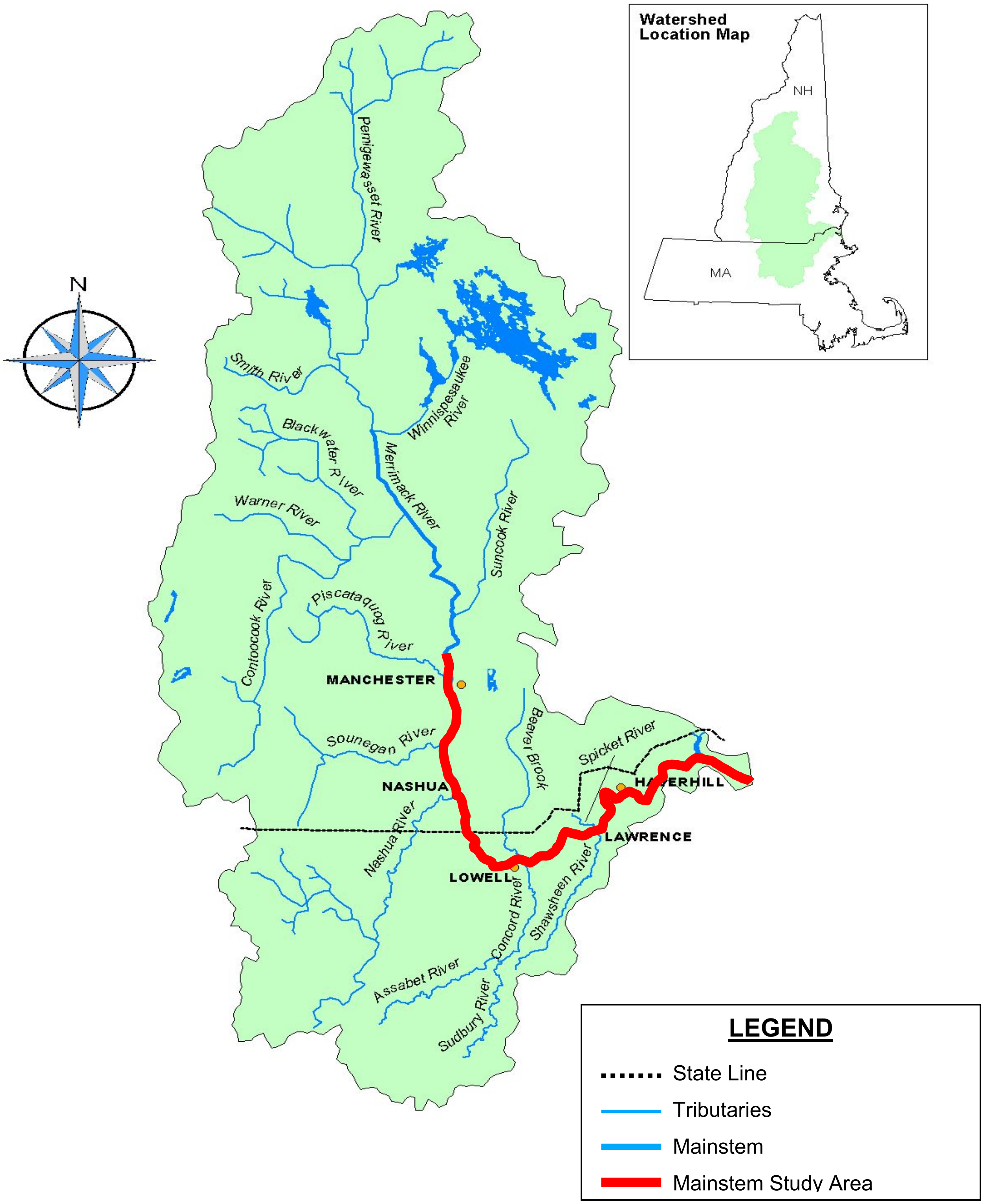
This report is only intended to provide a summary of the available data for the topics listed above. The information on pollutant sources collected under this task will be used as input during subsequent modeling efforts to be performed under this Study.

1.2 Study Area Definition

For the purposes of the water quality monitoring and modeling efforts, the project study area has been defined as the portion of the Merrimack River mainstem located south of the Hooksett Dam in Hooksett, New Hampshire to the mouth of the River at the Atlantic Ocean near Salisbury and Newburyport, Massachusetts. This Study Area definition was used in the collection of information on pollutant sources, with the exception of municipal wastewater treatment plants (WWTPs) and industrial point sources. Discharge quality and quantity information for these sources was gathered for the entire mainstem Merrimack River.

A map of the overall watershed is provided in Figure 1-1, with the mainstem Study Area highlighted in red.

Figure 1-1: Merrimack River Watershed



The Study Area includes the five sponsor communities of Manchester and Nashua, New Hampshire, Lowell and Haverhill, Massachusetts, and GLSD, as well as the following four dams on the mainstem Merrimack River:

- Hooksett Dam in Hooksett, New Hampshire
- Amoskeag Dam in Manchester, New Hampshire
- Pawtucket Dam in Lowell, Massachusetts
- Essex Dam in Lawrence, Massachusetts

The watersheds of 11 major tributaries to the Merrimack River south of Hooksett, New Hampshire are also included in the Study Area (Table 1-1).

Table 1-1: Confluence of Major Tributaries in the Study Area

Location of Confluence	Major Tributary
Manchester, New Hampshire	Piscataqoug River Cohas Brook
Merrimack, New Hampshire	Souhegan River
Nashua, New Hampshire	Nashua River Salmon River
Lowell, Massachusetts	Stony Brook Beaver Brook Concord River
Lawrence, Massachusetts	Shawsheen River Spicket River
Amesbury, Massachusetts	Powwow River

The rationale for this Study Area delineation was based on several factors. First, the majority of the documented pollution problems within the overall Merrimack River mainstem occur in this lower reach. Based on a review of the most recent Massachusetts and New Hampshire water quality assessment documents, the majority of pollution problems occur south of Hooksett, New Hampshire. Furthermore, this Study Area delineation brackets the five sponsor communities, providing a baseline water quality signal in the River upstream of the first Combined Sewer Overflows (CSOs) in Manchester, New Hampshire and a comprehensive assessment of the downstream impacts of these and other pollutant sources. Additionally, this segment of the River encompasses the majority of the beneficial uses observed in the basin, including drinking water supply, hydropower, recreation (swimming and boating), and aquatic life/habitat. Finally, this Study Area definition was outlined by the United States Army Corps of Engineers (USACE) and the Merrimack River Basin Community Coalition in the project scope of work as the mainstem segment of interest.

Section 2
Combined Sewer Overflows

Combined sewer overflows (CSOs) currently exist in the following five sponsor communities of the Merrimack River Watershed Assessment Study: Manchester and Nashua, New Hampshire and Lowell, Greater Lawrence Sanitary District (GLSD), and Haverhill, Massachusetts. These CSOs discharge combined sanitary and stormwater flows of varying quantity and quality to the Merrimack River and several of its major tributaries. Table 2-1 presents a summary of the maximum number of discharge events and the total annual discharge volumes in a typical year for each community. The maximum number of discharge events in a typical year is based on the highest number of discharges from all of the CSO discharges in each of the communities. The average annual overflow statistics were generated by computer model developed for each community. A continuous simulation model was performed for each community using a representative rainfall record.

Table 2-1: Summary of Average Annual CSO Discharges

Community	Maximum Number of Discharge Events per Year	Average Annual Discharge Volume (MG)
Manchester, New Hampshire	49	220
Nashua, New Hampshire	25	26
Lowell, Massachusetts	37	352
GLSD, Massachusetts	14	112
Haverhill, Massachusetts	41	71

MG= million gallons

Source: CDM 1995, 1997, 2001, 2002a, and 2002b; Personal communication with Metcalf & Eddy (5/23/03)

In general, a total of 781 million gallons (MG) of combined flow is discharged to the receiving waterbodies. The majority of these overflows occur in the cities of Manchester, New Hampshire and Lowell, Massachusetts; Nashua, New Hampshire has the lowest average annual discharge of untreated flows. The annual CSO volume contribution is inconsequential (approximately 0.04-percent) in comparison to the total annual flow of the Merrimack River at 7697cfs (or 1,814,875MG) as recorded at the USGS gaging station in Lowell, Massachusetts.

The following sections of this report summarize the existing layout of each community's combined sewer system and provide information on the location, drainage area, and discharge quantity, frequency, and quality for each CSO outfall.

2.1 Manchester, New Hampshire

On September 9, 1994 the U.S. Environmental Protection Agency (USEPA) issued an Administrative Order to the City of Manchester, New Hampshire requiring the completion of a Long-Term CSO Control Plan (LTCP) in accordance with state and federal CSO policies. The Final LTCP was submitted to the regulatory agencies in May 1995 (CDM 1995).

2.1.1 System Description

The City of Manchester, New Hampshire owns and operates a wastewater collection system and wastewater treatment plant (WWTP) that services the towns of Manchester, Goffstown, Hooksett, Bedford, and Londonderry, New Hampshire. The wastewater collection system in the City of Manchester serves approximately 90 to 95-percent of the population and approximately 45-percent (9800 acres) of the total land area in the city (CDM 1995). The remaining population in Manchester is served by subsurface disposal systems. The following eight interceptors convey wastewater to the treatment plant located along the banks of the Merrimack River in Manchester:

- East Interceptor- South (EIS)
- East Interceptor- North (EIN)
- Central Interceptor (CI)
- Northeast Interceptor (NEI)
- Southeast Interceptor (SEI)
- West Interceptor- North (WIN)
- West Interceptor- South (WIS)
- Piscataquog River Interceptor (PRI)

2.1.2 Combined Sewer System and Overflows

Approximately 70-percent of the land area served by the wastewater collection system in Manchester is comprised of combined sewer lines. The majority of the combined system is located in the central portion of the city along the Merrimack and Piscataquog Rivers. The newer, separate service areas are primarily located in the northern and southern portions of the city. The four outside communities that are served by the Manchester WWTP have separate sanitary and drainage systems, and as such were not evaluated under the LTCP (CDM 1995).

According to the 1995 LTCP, 26 CSO outfalls are located in the Manchester collection system, including an emergency overflow outfall at the West Side Pumping Station. Of the 26 outfalls, eight discharge to the Piscataquog River and 18 discharge to the Merrimack River. Table 2-2 summarizes the CSO outfall number, CSO name, receiving waterbody, contributing combined sewer areas, and interceptor connection for the 26 outfalls in Manchester, New Hampshire.

The CSO outfalls are connected to a total of 31 CSO regulating structures that control the flow from the contributing combined sewer basins. During dry-weather, sanitary wastewater is conveyed directly to the interceptor system and ultimately to the WWTP. During wet-weather conditions, flows exceeding the interceptor capacity are by-passed to the outfall and discharged to the receiving waterbody. Flap gates or backwater controls are installed on five of the CSO outfalls (West Side Pumping Station, Bremer Street CSO, Turner Street CSO, Third Street CSO, and Crescent Road

CSO) to prevent river water from entering the combined/interceptor system during high river flows.

Computer simulation models were developed using USEPA's Stormwater Management Model (SWMM) to simulate the combined sewer and interceptor system. These models were used to estimate the average annual CSO discharge volumes, frequencies, and durations. Table 2-2 presents a summary of average annual results for each CSO outfall.

In general, the most significant discharges in terms of annual volume occur at WWTP Manhole 1, the Cemetery Brook CSO, the West Bridge Street CSO, and the South Main Street CSO. Discharges from these four CSO comprise more than 85-percent of the total CSO volume discharged to the Merrimack and Piscataquog Rivers. In addition, these CSOs discharge most frequently, occurring approximately once every two weeks.

According to the LTCP, some of the CSOs with high-frequency discharges are impacted by surcharging along the interceptor, resulting in backflow through the regulator. Therefore, these discharges do not represent the resultant CSO discharges that would occur from the contributing drainage area alone. The West Hancock Street CSO, for example, has one of the highest discharge frequencies because the regulator acts as a supplemental diversion for flow from South Main Street (South) (CDM 1995).

Table 2-2: Manchester, New Hampshire CSO location, contributing drainage area, and average annual statistics

CSO Outfall No.	CSO Name	Interceptor Connection	Receiving Waterbody	Contributing Combined Sewer Area (acres)	Average Annual CSO Statistics		
					No. of Events	*Annual Total Duration (hr)*	*Annual CSO Volume (MG)*
009	Poor Street	WIS	Merrimack River	66	18	32	0.8
011	Schiller Street	WIS	Merrimack River	110	30	71	3.7
013	Hancock Street (West)	WIS	Merrimack River	18	49	196	1.5
018	Turner/Ferry Streets	WIN-2	Merrimack River	28	14	24	0.8
022	Bridge Street (West)	WIN-2	Merrimack River	171	36	106	20.2
024	Bremer Street	WIN-2	Merrimack River	76	10	15	1.1
025	Lorraine Street	WIN-2	Merrimack River	13	9	14	0.3
030	Victoria Street	NEI	Merrimack River	15	0	0	0
031	Stark Street	NEI	Merrimack River	408	14	24	2.1
032	Electric Street	PRI	Piscataquog River	24	14	24	1.4
033	Theophille Street	PRI	Piscataquog River	107	14	24	2.2
034	Sullivan Street	PRI	Piscataquog River	77	8	11	0.7
036	Varney Street	PRI	Piscataquog River	90	28	63	4
037	South Main St. (North)	PRI	Piscataquog River	118	9	12	0.6
038	South Main St. (South)	WIS	Piscataquog River	96	49	196	12.3
039	Third Street	PRI	Piscataquog River	6	32	82	1.8
042	Crescent Road	EIS	Merrimack River	67	2	2	0.1
043	Tannery Brook	EIS	Tannery Brook/ Merrimack River	239	1	1	0.3
044	Cemetery Brook	EIN	Merrimack River	3047	26	56	59.5
045	Granite Street	CI	Merrimack River	12	1	1	0.1
046	Bridge Street	CI	Merrimack River	124	16	29	3
047	Pennacook Street	CI	Merrimack River	517	6	8	2.9
050	WWTP MH#1	EIN	Merrimack River	--	26	89	98.4
051	West Side PS Emergency Outlet	West Side Pumping Station	Piscataquog River	--	7	12	1.8
052	WWTP MH#2	EIN	Merrimack River	--	--	--	--
053	Walnut/North Streets Canal/W. Pennacook	CI	Merrimack River	--	0	0	0
Total/ Maximum				**N/A**	**49**	**196**	**219.6**

Source: CDM 1995

2.1.3 CSO Water Quality and Receiving Water Impacts

During the development of the LTCP, water quality samples were collected and analyzed from select CSO discharges. The resultant CSO pollutant concentrations were reviewed and representative CSO quality concentrations were adopted for the study; these data are summarized in Table 2-3.

Table 2-3: Representative CSO pollutant concentrations for Manchester, New Hampshire

Pollutant	Units	Range of Concentrations	Adopted Concentration
Oil & Grease	mg/L	2.5- 7.7	3.2
Petroleum Hydrocarbons	mg/L	0- 2.5	2.5
Total BOD_5	mg/L	39- 102	53
E. Coli	cfu/100mL	800- 80,000	40,000
TKN	mg/L	1.8- 24.9	7.6
Nitrate-N	mg/L	0- 1.0	0.5
Ammonia-N	mg/L	0.1- 14.0	3.9
Total Phosphorus	mg/L	0.1- 1.2	0.5
Chlorides	mg/L	3.0- 55.0	24
Settleable Solids	mg/L	0.3- 38.0	8.3
Total Suspended Solids	mg/L	6.0- 780	211
Copper	µg/L	0.5- 160	52
Lead	µg/L	0.5- 210	53
Zinc	µg/L	5- 620	211

Source: CDM 1995
cfu= Colony Forming Units

The LTCP also presented an evaluation of the CSO-related impacts to receiving water quality based on field investigations and an analysis of CSO pollutant loading. Upon review of the analysis, state and federal agencies determined that CSO discharges along the Merrimack River exceeded water quality standards for floatables and coliforms; discharges along the Piscataquog River exceeded coliform, floatables, and copper criteria. Copper was considered particularly significant given the high concentration in the CSO discharge and the low dilution potential of the Piscataquog River (CDM 1995). As a result, receiving water uses impacted by the CSO discharges include aesthetics (floatables, oil and grease, etc.) and primary and secondary contact recreation (CDM 1995). The LTCP noted that downstream water suppliers drawing from the Merrimack River were not expected to be impacted by the CSO discharges. Dissolved oxygen, nutrients, and solids in the Merrimack and Piscataquog River were not found to be adversely affected by the CSO discharges (CDM 1995).

2.2 Nashua, New Hampshire

On October 5, 1995, the USEPA issued an Administrative Order to the City of Nashua, New Hampshire requiring the city to complete a CSO Facilities Plan and Nine Minimum Control Measures Report. In response, a Long-Term CSO Control Plan was prepared by CDM and submitted to the USEPA in September 1997. As part of this work, a comprehensive computer simulation model of Nashua's collection system was developed using SWMM. In 1999, the city entered into an administrative order with the USEPA requiring the city to separate its combined sewers by the end of 2019. However, following the issuance of this order, the city of Nashua began working with the consulting firm of Metcalf & Eddy to reassess its proposed separation plan. Most recently, Metcalf & Eddy prepared the "Report on Baseline Conditions Update and Development and Evaluation of Alternatives to the City's Current CSO Control Plan", dated January 2003, for the city of Nashua. This report provides a summary of the revised CSO control plan, which includes infrastructure improvements on aging combined sewer lines, implementation of stormwater controls, increased storage at select CSO locations, and improvements to the Nashua wastewater treatment facility.

This section of the report provides a summary of information on the Nashua system obtained from the 1997 LTCP and more recent information obtained from personal communications with engineers at Metcalf & Eddy.

2.2.1 System Description

The City of Nashua, New Hampshire owns and operates a wastewater collection system and treatment plant that conveys and treats wastewater discharges from the communities of Nashua and Hudson, New Hampshire and a small portion of Merrimack, New Hampshire. The system conveys sanitary flow from approximately 96-percent of Nashua's population and approximately 78-percent of the city's total land area (CDM 1997). The remaining population in Nashua is served by subsurface disposal systems. According to the 1997 LTCP, five main interceptors convey wastewater to the treatment plant located along the banks of the Merrimack River: North Merrimack Interceptor, Nashua River Interceptor, Salmon Brook Interceptor, South Merrimack Interceptor, and South Merrimack Interceptor II. Hudson owns and operates its own collection system, which discharges to the Nashua system at the city limits.

2.2.2 Combined Sewer System and Overflows

According to the 1997 LTCP, approximately 25-percent of the land area served by the collection system in the City of Nashua is served by combined sewers; the remaining 75-percent is served by separate sanitary lines. The majority of the combined system is located in the older, more densely populated sections of the city. The newer, separated collection systems are primarily located in the northern, western, and southern portions of the city. The communities of Hudson and Merrimack, New Hampshire are both served by separate sanitary and drainage systems; as such they were not evaluated as part of the LTCP (CDM 1997).

According to a personal communication with engineers at Metcalf & Eddy on May 23, 2003, nine CSO outfalls currently exist in the city of Nashua. Four discharge to the Merrimack River and four discharge to the Nashua River. The ninth outfall is located along the Nashua River; however, it is bolted shut and cannot activate. During dry-weather, sanitary wastewater is conveyed directly to the interceptor system and ultimately to the WWTP. During wet weather conditions, however, flow exceeding the hydraulic capacity of the interceptor and treatment system is diverted through the outfalls and discharged to the Merrimack and Nashua Rivers. Table 2-4 presents a summary of the NPDES Permit Number, location, and contributing drainage area (total, combined, and separate) for each CSO outfall. Also provided is a summary of the average number of discharge events per year and the total annual CSO discharge volume (personal communication with Metcalf & Eddy). The computer model HydroWorks was employed to simulate the combined sewer system and predict the CSO discharges.

The Nashua collection system discharges approximately 26MG of untreated combined sewer overflow to the Merrimack and Nashua Rivers annually. In general, the Hollis Street (CSO 005) and Nashua River (CSO 006) CSOs contribute the largest CSO discharge volumes. Together, the discharges from these two CSOs comprise approximately 70-percent of the total average annual CSO volume discharged from the system. The Burke Street, Broad Street, and Locke Street outfalls discharge most frequently, occurring an average of approximately once every two weeks.

Table 2-4: Nashua, New Hampshire CSO location, interceptor, contributing drainage area, and average annual statistics

CSO No.	Location	Interceptor	Receiving Waterbody	Approximate Drainage Area (acres)			Average Annua
				Total	*Combined*	*Separate*	*Average No. of Events*
002	Salmon Brook	Salmon Brook	Merrimack River	341	246	95	0
003	Farmington Brook	South Merrimack	Merrimack River	384	350	34	17
004	Burke Street	North Merrimack	Merrimack River	136	136	0	25
005	Hollis Street	North Merrimack	Merrimack River	935	624	311	17
006	Nashua River	North Merrimack	Nashua River	418	400	18	10
007	Tampa Street	Nashua River	Nashua River	70	70	0	2
008	Broad Street	Nashua River	Nashua River	302	199	103	23
009	Locke Street	North Merrimack	Nashua River	55	55	0	20
012	Jackson/ Beaucher	Nashua River	Nashua River	95	95	0	0
Total/ Maximum							**25**

Source: Personal communication with Metcalf & Eddy (5/23/03)

2.2.3 CSO Water Quality and Receiving Water Impacts

A CSO monitoring program was implemented by CDM in Fall 1991 and Spring 1992 to characterize the wet-weather water quality of the CSO discharges. More recently, Metcalf & Eddy performed additional wet-weather sampling at stormdrain and CSO outfalls in the City; the samples were analyzed for E. coli. The resultant CSO pollutant concentrations were reviewed and representative CSO quality concentrations were adopted. Table 2-5 provides a summary of these results; all values except for E. coli are based on values provided in the 1997 LTCP.

Table 2-5: Representative CSO pollutant concentrations for Nashua, New Hampshire

Pollutant[1]	Units	Range of Concentrations	Adopted Concentrations
Total Suspended Solids	mg/L	17- 74	45
BOD	mg/L	7- 49	18
Total Phosphorus	mg/L	0.24- 1.4	0.693
TKN	mg/L	0.4- 4.5	1.51
Lead	mg/L	0.011- 0.060	0.025
Copper	mg/L	<0.02- 0.05	0.029
Zinc	mg/L	0.049- 0.15	0.084
Settleable Solids	mg/L	<0.5- 1.3	0.76
E. coli[2]	colonies/100mL	2100- 760,000	215,000
E. coli (stormwater)[2]	colonies/100mL	800- 44,000	5,000
pH	---	6.5- 7.3	---
Temperature	°C	12- 18	---

[1]Source: CDM 1997, except as noted

[2]Source: Personal Communication with Metcalf & Eddy (5/23/03)

2.3 Lowell, Massachusetts

On November 10, 1988, the City of Lowell, Massachusetts entered into a Consent Order Judgement with the USEPA regarding the development and implementation of sewer system improvements to address infiltration/inflow, combined sewer overflows, and operational issues at the WWTP (CDM 2001). During the 1990's, the Lowell Regional Wastewater Utility (LRWWU) submitted a series of reports detailing the City's CSO Planning Approach. A Draft Long-Term CSO Control Plan and Environmental Impact Report was submitted to the USEPA in June 2001. A computer model of the LRWWU was developed using SWMM in preparation of the Draft LTCP.

2.3.1 System Description

The Lowell Regional Wastewater Utility owns and operates a wastewater collection system and stormwater drainage system within the City of Lowell, Massachusetts. The Lowell system serves approximately 100-percent of the population and developed area of the city. A limited number of septic systems still serve individual buildings in the northwestern portion of the city. Four main interceptors in Lowell convey collected wastewater to the regional WWTP at Duck Island in the Merrimack River: Southwest Bank Interceptor, North Bank Interceptor, Southeast Bank I Interceptor, and Southeast Bank II Interceptor. The interceptors are located along the banks of the Merrimack and Concord Rivers.

The communities of Chelmsford, Dracut, and Tewksbury, Massachusetts discharge to the Lowell collection system based on inter-municipal agreements with the City. Tyngsboro, Massachusetts currently purchases capacity from Dracut to discharge to the WWTP.

2.3.2 Combined Sewer System and Overflows

Approximately one-third of the land area served by the WWTP in the City of Lowell is served by combined sewers; the remaining 66-percent is served by a separated system. Areas with combined sewers are confined mainly to the central and eastern portions of the city. The communities of Chelmsford, Dracut, Tewksbury, and Tyngsboro, Massachusetts each operate and maintain separated sanitary wastewater collection systems (CDM 2001).

Nine CSO diversion structures relieve the LRWWU interceptor system during wet-weather events. During dry-weather conditions, wastewater flow is conveyed through the structures on its way to the WWTP. However, during wet-weather, flow exceeding the downstream conveyance capacity of interceptor system is discharged through the CSOs. Of the nine outfalls, seven discharge to the Merrimack River, one discharges to the Concord River, and one discharges to the Beaver Brook (CDM 2001). Table 2-6 presents a summary of the NPDES Permit Number, location, and contributing drainage area for each CSO outfall.

Computer simulation models were developed using SWMM to model the combined sewer and interceptor system for the City of Lowell. A five-year continuous simulation was conducted to estimate the average annual CSO discharge volumes, frequencies, and durations. Table 2-6 presents a summary of average annual results for each CSO outfall.

The LRWWU collection system discharges approximately 352 MG of untreated combined sewage to the Merrimack River, Concord River, and Beaver Brook annually. In general, the Warren Street CSO contributes the largest volume of CSO discharges per year at 202 MG, which represents approximately 57-percent of the total annual discharge volume. The Merrimack River, Warren Street, and Beaver Brook outfalls are most active, with an average of 37, 35, and 31, respectively, discharges per year (or approximately three times per month). Typically, the Walker Street and First Street CSO diversion structures discharge less than once per year.

Table 2-6: Lowell, Massachusetts CSO location, interceptor, contributing drainage area, and average annual statistics

NPDES Outfall No.	Location	Interceptor	Receiving Waterbody	Approximate Drainage Area (acres)	Average Annual CSO Statistics		
					Average No. of Events	*Annual Total Duration (hr)*	*Annual CSO Volume (MG)*
002-SDS#1	Walker Street	Southwest Bank	Merrimack River	140	0	0	0
007-SDS#2	Beaver Brook	North Bank	Beaver Brook	520	31	167	55
008-SDS#3	West Street	North Bank	Merrimack River	530	1	2	6.4
011-SDS#4	Read Street	North Bank	Merrimack River	175	11	25	2.5
012-SDS#5	First Street	North Bank	Merrimack River	90	0	0	0
020-SDS#6	Warren Street	Southeast Bank II	Concord River	2230	35	163	202
027-SDS#7	Tilden Street	Southeast Bank I	Merrimack River	350	10	22	4.8
030(1)-SDS#8	Barasford Avenue	Southeast Bank II	Merrimack River	600	14	42	26.8
030(2)-SDS#8	Merrimack River	Southeast Bank II	Merrimack River	365	37	278	54
Total/ Maximum					**37**	**278**	**351.5**

2.3.3 CSO Water Quality and Receiving Water Impacts

A monitoring program was conducted between May and September 1999 to determine the wet-weather impacts of CSO and stormwater discharges in Lowell, Massachusetts. Water quality samples were collected and analyzed at three CSO outfalls and six stormdrain outfalls. Table 2-7 shows the range of concentrations for pollutant parameters in the CSO samples collected during 1999, as well as the concentration adopted for use in the LTCP.

Table 2-7: Representative CSO pollutant concentrations for Lowell, Massachusetts

Pollutant	Units	Range of Concentrations	Adopted Concentration
Total Suspended Solids	mg/L	26- 212	107
BOD	mg/L	27- 85	60
Total Phosphorus	mg/L	0.5- 2.0	1.1
Lead	mg/L	ND- 0.184	0.06
Copper	mg/L	0.022- 0.073	0.044
Zinc	mg/L	ND- 0.312	0.129
E. Coli	colonies/100mL	3100- 7900	4500
Fecal Coliform	colonies/100mL	7200- 28,000	28,000

ND= Non-detect
Source: CDM 2001

A water quality analysis was completed as part of the LTCP to examine the changes in water quality in the Merrimack River, Concord River, and Beaver Brook as a result of CSO discharges. This analysis indicated that the CSO discharges do contribute to the overall pollutant load in each receiving waterbody; however, the impact was found to be insignificant in comparison to the stormwater load from the watershed for all parameters except for fecal coliform bacteria (CDM 2001).

Additionally, according to the LTCP, CSO discharges to the Beaver Brook and Concord River were found to have little environmental impact due to the downstream location of the outfalls in the respective receiving waterbodies. The elevated pollutant levels are diluted significantly by the Merrimack River flow once the water reaches the River.

A bacteria model was also developed in preparation of the LTCP for the Merrimack River from Lowell to the mouth of the River at the Atlantic Ocean. The model indicated that the Lowell CSOs contribute to the exceedance of bacteria standards for both contact recreation and shellfishing under mean August flow for storms greater than the one-month event (CDM 2001).

2.4 Greater Lawrence Sanitary District (GLSD)

On June 25, 1999 the USEPA issued an Administrative Order (Docket No. 99-13) to the Greater Lawrence Sanitary District (GLSD) requiring the completion of a Long-Term Control Plan to bring their CSOs in compliance with state and federal CSO policies and water quality standards. A Draft Long-Term CSO Control Plan and Environmental Impact Report was submitted to the USEPA in November 2002 (CDM 2002a). A computer model of the GLSD system was also developed in preparation of the LTCP using SWMM.

2.4.1 System Description

The GLSD system consists of a network of collection systems from five communities (Lawrence, Methuen, Andover, and North Andover, Massachusetts and Salem, New Hampshire) that feed into two large main interceptors on the north and south banks (North Bank and South Bank Interceptors) of the Merrimack River in Lawrence, Massachusetts. Two smaller interceptors, the Old Spicket River Interceptor and the New Spicket River Interceptor, collect flow from Salem, New Hampshire and portions of Methuen and Lawrence, Massachusetts and convey it to the North Bank Interceptor. The North and South Bank Interceptors ultimately convey flow to the GLSD WWTP in North Andover, Massachusetts.

2.4.2 Combined Sewer System and Overflows

The City of Lawrence, Massachusetts is largely a combined system, while the other four communities served by the WWTP are entirely separated systems. Portions of Lawrence generally along the outer edge of the city are served by separated systems.

Five overflow structures relieve the GLSD interceptor system when necessary during wet weather events. Two are located on the North Bank Interceptor, two on the South Bank Interceptor, and one on the downstream end of the New Spicket River Interceptor. Table 2-8 presents a summary of the annual overflow statistics for each of the five CSOs.

Table 2-8: GLSD CSO location and average annual statistics

Location	Receiving Waterbody	Average Annual Statistics		
		Average No. of Events	*Annual Total Duration (hr)*	*Annual CSO Volume (MG)*
South Bank Interceptor				
CSO002	Merrimack River	8	24	24.8
CSO003	Merrimack River	1	2	0.3
North Bank Interceptor				
CSO004	Merrimack River	14	44	76.8
CSO005	Merrimack River	3	3	1.6
Spicket River Interceptor				
CSO006	Spicket River	5	8	8.3
Total/ Maximum	**N/A**	**14**	**44**	**111.8**

Source: CDM 2002a
MG= Million gallons

The annual CSO statistics indicate that the GLSD collection system has a high level of control (CDM 2002a). CSO002 and CSO004 are most active due to a lower elevation of the overflow weirs in the regulators; the other CSOs overflow much less frequently.

2.4.3 CSO Water Quality and Receiving Water Impacts

According to the Draft Long-Term CSO Control Plan and Environmental Impact Report (CDM 2002a), the contribution of GLSD CSOs to water quality exceedances is generally limited due to the intermittent nature of the discharges and relatively large river flow, with the exception of fecal coliform bacteria. Table 2-9 provides a summary of the baseline pollutant concentrations and loads from the GLSD CSO system (CDM 2002a); these loads are based on an overflow volume of approximately 112 million gallons per year, on the average.

Table 2-9: Baseline CSO Pollutant Concentrations and Loads for GLSD CSOs

Pollutant	Units	Adopted Concentration
BOD	mg/L	41
Fecal Coliform	cfu/100mL	165,000
TKN	mg/L	2.24
TP	mg/L	0.7
TSS	mg/L	120
Lead	mg/L	0.073
Copper	mg/L	0.041
Zinc	mg/L	0.157

CSO discharges on the Spicket River, which occur approximately five times per year, impact the water quality in the lower segment of the river at its confluence with the Merrimack River. Except for fecal coliform bacteria, CSO discharges to the

Merrimack River do not significantly raise the in-stream pollutant concentrations due to the relatively large river flow. However, high bacteria counts far exceed the water quality standard of 200cfu/100ml for full body contact (*i.e.* swimming) (CDM 2002a).

A bacteria model of the Merrimack River was developed for the Long-Term Control Plan downstream of the Essex Dam in Lawrence, Massachusetts. The findings of this model indicate that GLSD's CSOs contribute to the exceedance of shellfishing bed and contract recreation water quality standards for most of this lower portion of the mainstem River. Water quality standards are not met until the mouth of the Merrimack River at the ocean.

The following table (Table 2-10) excerpted from the Draft LTCP provides a summary of the pollution sources impairing river uses in the Merrimack River, and the relative impact of CSO discharges from the GLSD system in contributing to these impairments.

Table 2-10: Pollution sources impairing river uses

River Uses	**Water Quality Standard in Violation**	**Sources**		
		GLSD CSOs	*Other CSOs*	*NPS Pollution*
Swimming	Pathogens	a	d	f
Boating	Pathogens	a	d	f
Fishing	Metals (Spicket River)	a	---	f
Shellfishing	Pathogens	b	e	f
Water Intake (see note c)	---	---	---	---
Passive Recreation/ Aesthetics	Floatables/Scum	a	d	f

Source: CDM 2002b
NPS= Non-point Source
Notes: a- GLSD CSOs impair river uses 14 times per year
b- GLSD CSOs rarely impact shellfish resources
c- Merrimack River water is readily treatable, as evidenced by the successful use of water at upstream intakes
d- Other CSOs impair river uses 35 times per year
e- Generally impacted by CSOs downstream of GLSD
f- NPS includes stormwater about every three days and other sources of pollution that can be continuous

2.5 Haverhill, Massachusetts

On August 9, 1999, the USEPA issued Administrative Order (AO), Docket No. 99-17 to the City of Haverhill, Massachusetts requiring the completion of their CSO planning efforts to bring their system in compliance with state and federal CSO policies and water quality standards. A Draft Long-Term Control Plan/ Draft Environmental Impact Report (EIR) was submitted to the regulatory agencies in September 2000. In subsequent negotiations, additional overflow regulators were discovered on the upstream reaches of the Little River. Thus, on December 18, 2001, the USEPA issued AO (Docket No. 02-06) to the City requiring completion of a Revised Draft Long-Term CSO Control Plan/ Draft EIR; this document was submitted in January 2002. The final Plan/EIR was issued in August 2002. A SWMM model was developed for the City of Haverhill in preparation of this plan.

2.5.1 System Description

The City of Haverhill, Massachusetts owns and operates a wastewater collection system and treatment plant located on the southern shore of the Merrimack River. Wastewater is conveyed to the treatment plant through a system of seven major interceptors located along the banks of the Merrimack and Little Rivers. The interceptor system also includes three major river crossings that carry flow from the north side of the Merrimack River to the south side of the River. These are referred to as the Lower, Middle, and Upper Siphon.

2.5.2 Combined Sewer System and Overflows

Approximately 37-percent of the WWTP service area in Haverhill is served by combined sewers, representing approximately 438,000 linear feet of sewer line. The majority of the combined system is located in the older, more densely populated downtown area along the Merrimack River. Areas further north or south of the River tend to be newer and, thus, generally include separate sanitary and storm sewers.

Originally, there were 23 CSO regulators and four diversional structures in Haverhill connected to 25 outfalls. Of the 25 outfalls, ten were connected to the Little River, one to the outlet of Lake Saltonstall, and fourteen to the Merrimack River. Four of the original outfalls have been bricked up and, thus, no longer discharge. Therefore, according to the August 2002 Final Long-Term Control Plan/ EIR, there are now 23 CSO regulators and 21 outfalls operating in the city (CDM 2002b). Table 2-10 presents a summary of the NPDES Permit Number, location, interceptor system, and contributing drainage area for each CSO outfall.

The 21 outfalls are each connected to the interceptor system by their own regulator structures. These regulators divert flow from the collection system to the outfall during wet weather events when the flow exceeds the hydraulic capacity of the interceptor. During dry-weather, flow is conveyed directly to the interceptor system, and ultimately to the WWTP. The diversional structures only discharge when gates are closed and flow is directed to the associated outfall; currently the gates at all four diversional structures operate in the open position.

As part of the LTCP, a five-year continuous model simulation was performed using SWMM to determine the average annual discharge frequency, volume, and duration of each CSO discharge; these results are presented in Table 2-11. No values are provided for the closed overflows. According to the LTCP, eight CSOs had no overflows, while another four discharged less than four times per year. The majority of overflows occurred at Little River, Bradford Avenue, and the three siphon crossings. Ninety-percent (or 65MG) of all overflows occur at these six locations. This is expected, as the siphon gates were placed at their lowest setting to restrict flow to the WWTP (CDM 2002b).

Table 2-11: Haverhill, Massachusetts CSO location and average annual statistics

NPDES Permit No.	Overflow Location	Interceptor System	Receiving Waterbody	Average Annual CSO Statistics		
				Average No. of Events	*Annual Total Duration (hr)*	*Annual CSO Volume (MG)*
001	Bates Bridge	Riverside Interceptor	Merrimack River	0.2	0.2	0
010	Boardman Street	Lower Siphon Interceptor	Merrimack River	0.4	0.6	0
013	Lower Siphon	Lower Siphon Interceptor	Merrimack River	14.4	70	17.1
016	Fire Station	Lower Siphon Interceptor	Merrimack River	0	0	0
019	Main Street- North	Lower Siphon Interceptor	Merrimack River	0	0	0
021A	Middle Siphon- L.R.	Middle Siphon Interceptor	Merrimack River	41.6	237	18.9
021B	Emerson Street (CLOSED)	Essex Street Interceptor	Little River	--	--	--
021C	Essex Street (CLOSED)	Essex Street Interceptor	Little River	--	--	--
021D	Little River- North	Essex Street Interceptor	Little River	13	34.3	3.17
021E	Little River- South	Essex Street Interceptor	Little River	15.2	29.8	1.21
-	Orchard St. Diversional Structure	Essex Street Interceptor	Little River	0	0	0
022	R.R. Bridge	Upper Siphon Interceptor	Merrimack River	0	0	0
023	River Street	Upper Siphon Interceptor	Merrimack River	0	0	0
024	Upper Siphon	Upper Siphon Interceptor	Merrimack River	27.8	126	17.6
025	Beach Street	Upper Siphon Interceptor	Merrimack River	0	0	0
031	Front Street	Bradford Interceptor	Merrimack River	8.8	15.3	1.19
032	Bradford Avenue	Bradford Interceptor	Merrimack River	18.4	264	6.8
033	So. Prospect Street	Bradford Interceptor	Merrimack River	4.8	4.4	0.05
034	Middlesex Street	Bradford Interceptor	Merrimack River	8.2	26.6	0.35
035	Main Street- South	Bradford Interceptor	Merrimack River	14	31.3	1.47
036	Ferry Street	Bradford Interceptor	Merrimack River	18.6	82	2.17
-	Mill Street (CLOSED)	Mill Street Interceptor	Merrimack River	--	--	--
-	Duncan St. Diversional Structure	30-inch sewer in Winter St.	Little River	0	0	0
-	Hale St. Regulator	39x50-inch sewer in Hale St.	Little River	3.4	4.3	0.66
-	Lafayette Square Regulator (CLOSED)	42-inch sewer in Essex St.	Lake Staltonstall	--	--	--
-	Broadway Diversional Structure	24-inch sewer in Broadway	Little River	0	0	0
-	High Street Diversional Structure	24-inch sewer in High St.	Little River	0.2	0	0
Total/ Maximum			**N/A**	**41.6**	**264**	**70.67**

Source: CDM 2002b

2.5.3 CSO Water Quality and Receiving Water Impacts

During Phase I of Haverhill's long-term control planning process, water quality samples were collected and analyzed from various CSO discharges. The resultant CSO pollutant concentrations were reviewed and representative CSO quality concentrations were adopted for this Long-Term Control Plan and published in the Final Long-Term Control Plan/ Final EIR. The data review indicated that first-flush pollutant concentrations at each CSO varied with no direct correlation. The data also indicated that no strong correlations could be drawn between pollutant concentrations and representative land use. Accordingly, pollutant concentrations from the sampling program were averaged and adopted for use at all CSO outfalls. Table 2-12 provides a summary of the range of pollutant concentrations and average concentrations adopted for the CSO discharges.

Table 2-12: Representative CSO pollutant concentrations for Haverhill, Massachusetts

Pollutant	Units	Range of Concentrations	Adopted Concentrations
Total Suspended Solids	mg/L	17- 110	53
Settleable Solids	mg/L/hr	<0.1- 3.4	1.28
Total Phosphorus	mg/L/hr	0.25- 1.5	0.84
Total Copper	mg/L	<0.05- 0.08	0.057
Total Lead	mg/L	0.014- 0.087	0.032
Total Zinc	mg/L	0.07- 0.46	0.15
Total Coliform	count/100mL	<2000- 4,000,000	1,415,000
Fecal Coliform	count/100mL	<2000- 820,000	180,500
E. Coli	count/100mL	<2000- 390,000	124,500
Temperature	C	7- 14	--
pH	--	6.0- 7.5	--
Dissolved Oxygen	mg/L	5.0- 10.6	--
Hardness	mg/L	12- 240	--

Source: CDM 2002b

The adopted concentration for each pollutant is generally the geometric mean value for the concentration range. In some cases, extremely high or extremely low concentrations were discarded before calculating the value.

According to the Draft LTCP, the impact of CSO discharges on receiving water quality was evaluated for fecal coliform at discharge concentrations of 180,500 cfu/100mL for the three-month storm event under mean August flow conditions. Table 2-13 presents a summary of the receiving water fecal coliform concentrations for the discharge concentrations. The CSO impact is much greater on the Little River than in the mainstem Merrimack River due to the difference in flow volumes.

Table 2-13: Receiving water impacts for CSO discharges (Fecal coliform) at Mean August flow for the three-month storm event

Location	Receiving Water Fecal Coliform Concentrations
	180,500 cfu/100mL
Merrimack River upstream of Little River confluence	3,029
Little River	81,142
Merrimack River downstream of Little River confluence	8,546

Source: CDM 2002b
cfu= colony forming units
Massachusetts Class SB water quality standard for Fecal coliform= Less than an MPN of 88org/100mL

A fate model was also developed for bacteria under mean August flow conditions. The model indicated that Haverhill's CSO discharges contribute to water quality exceedances on the Merrimack River downstream to the mouth of the River at the Atlantic Ocean. The exception is for the one-month storm, where the state swimming standard is met at the lower end of the River in Newburyport, Massachusetts.

It is important to note that, to date, the CSO systems and associated receiving water impacts from each of the five communities have been studied independently with no consideration of upstream sources. The current Merrimack River Watershed Assessment Study will provide a more in-depth look at the water quality in the Merrimack River and relative pollutant contribution from various sources.

Section 3
Stormdrains

This section provides a summary of the stormdrain information collected as part of this task for the following 22 communities along the mainstem Merrimack River south of Hooksett, New Hampshire:

Massachusetts

1. Salisbury
2. Newburyport
3. Amesbury
4. West Newbury
5. Merrimac
6. Groveland
7. Haverhill
8. Methuen
9. North Andover
10. Lawrence
11. Andover
12. Dracut
13. Tewksbury
14. Lowell
15. Chelmsford
16. Tyngsboro

New Hampshire

1. Hudson
2. Nashua
3. Bedford
4. Litchfield
5. Merrimack
6. Manchester

3.1 Community Stormdrain Information

Community stormdrain information was collected from a variety of sources, including stormdrain mapping available in Geographic Information System (GIS) and field surveys conducted by Normandeau Associates in Fall 2002. For the purposes of this study, it was assumed that the effects of stormdrains less than 36-inches in diameter would be modeled using land use data.

3.1.1 GIS Stormdrain Mapping

Stormdrain information was available in GIS format for the following eight communities:

- Methuen, MA
- Lawrence, MA
- Andover, MA
- Dracut, MA
- Tewksbury, MA
- Lowell, MA
- Nashua, NH
- Manchester, NH

The GIS database for each community generally contained information on the location and rim elevation of catchbasins and drain manholes, the location of stormdrain piping (including invert at catchbasin and manhole connections), and the location stormdrain and CSO (as applicable) outfalls. A pdf figure containing the stormdrain information for each of the eight communities is provided on a CD at the end of this section.

3.1.2 Field Surveys

As part of the Merrimack River Watershed Assessment Study, Normandeau Associates conducted field surveys during Fall 2002 to identify stormdrain outfalls discharging to the mainstem Merrimack River. The surveyed area extended from Hooksett, New Hampshire to Newburyport, Massachusetts. Areas where hazards to navigations existed, such as shoals, impassable falls, and rapids, were not surveyed.

The Normandeau survey crew took notes and collected digital photos and location information using a sub-meter Global Positioning System (GPS) at each discharge pipe, culvert, and tributary discharging into the Merrimack River. Positional data were collected (NAD 83, Massachusetts Mainland, meters) using a Trimble Pro-XRS GPS and TSC-1 data logger. Offsets were measured using a Contour Laser Rangefinder (Gyro-compensated), and fed directly into the TSC-1 data logger.

Table 3-1 provides a summary of the size category and number of outfalls identified by Normandeau Associates. Additional field notes compiled during the survey are provided in Appendix A, along with northing and easting information for each outfall.

Table 3-1: Summary of Field Surveyed Stormdrains

Type of Outfall	Number
Outfall pipe with diameter less than 36-inches	114
Outfall pipe with diameter greater than 36-inches	55
Miscellaneous (includes confluences of major tributaries and mill/canal discharges)	37
TOTAL=	**206**

Of the outfalls located by Normandeau, approximately 20 of them were CSO structures, which could not be distinguished from the stormdrains during field surveys. These structures have not been included in the overall count provided in Table 3-1.

The outfall information collected as part of this field survey will be used in place of community supplied data in towns were no such information is available. A GIS coverage of the surveyed outfall locations was developed as part of this task. A pdf figure displaying Normandeau's survey result is provided on a CD at the end of this section.

3.2 Drainage Area Delineations

For the purposes of future modeling studies, the Merrimack River watershed was divided into 28 sub-areas, in accordance with the following boundaries:

- Watershed delineations for the Pemigewasset and Winnipesaukee Rivers, which joins to form the Merrimack River in Franklin, New Hampshire
- The contributing drainage area to the mainstem Merrimack River north of Hooksett, New Hampshire, including the major tributaries of the Contoocook, Soucook, and Suncook Rivers.
- A separate delineation for each of the five sponsor communities of Manchester and Nashua, New Hampshire and Lowell, Lawrence, and Haverhill, Massachusetts
- The contributing drainage area to 11 major tributaries (see Table 1-1) that join the Merrimack River downstream of Hooksett, New Hampshire
- Six "corridors" delineating the drainage area (outside of the major tributaries) contributing directly to the mainstem Merrimack River south of Hooksett, New Hampshire

These delineations were made in GIS based on coverages available from MassGIS and New Hampshire Geographically Referenced Analysis and Information Transfer System (GRANIT) and available topographic information from United States Geological Survey (USGS) quad sheets. The watershed delineations are provided graphically in Figure 3-1. Table 3-2 provides a summary of the 28 sub-basins and their associated drainage areas.

Table 3-2: Merrimack River Sub-watersheds

Category	Sub-watershed Name	Drainage Area (mi^2)
Sponsor Communities	Manchester, NH	34.9
	Nashua, NH	31.7
	Lowell, MA	14.5
	Lawrence, MA	7.4
	Haverhill, MA	35.6
Mainstem Merrimack River	Upper Merrimack (Franklin to Hooksett, NH)	1291
	Merrimack Corridor 1 (Hooksett to Manchester, NH)	51.2

Category	Sub-watershed Name	Drainage Area (mi²)
Mainstem Merrimack River (cont'd)	Merrimack Corridor 2 (Manchester to Nashua, NH)	87.8
	Merrimack Corridor 3 (Nashua, NH to Lowell, MA)	44.4
	Merrimack Corridor 4 (Lowell to Lawrence, MA)	48.6
	Merrimack Corridor 5 (Lawrence to Haverhill, MA)	39.5
	Merrimack Corridor 6 (Haverhill, MA to Atlantic Ocean)	61.1
Major Tributaries	Assabet River	188
	Beaver Brook	114
	Cohas Brook	57.2
	Concord River	81.8
	Upper Nashua River	181
	Lower Nashua River	221
	Pemigewasset River	1017
	Piscataquog River	215
	Powwow River	55.4
	Salmon Brook	22.9
	Shawsheen River	74.9
	Souhegan River	219
	Spickett River	74.9
	Stony Brook	45.6
	Sudbury River	162
	Winnipesaukee River	482

Within the six larger Merrimack River corridors, sub-catchments were delineated for smaller tributary streams to the mainstem Merrimack River not listed in Table 1-1. In New Hampshire, these delineations were made based on available topographic information from the USGS quad sheets. In Massachusetts, sub-basin delineations of similar resolution were available from MassGIS. These sub-area delineations where verified based on available topographic data.

The remaining area outside of these sub-catchments was assumed to either runoff directly into the mainstem River or be collected by the stormdrain system and discharged to the River. Due to the large number of outfalls identified during the GIS data collection effort and field surveys, individual sub-catchments were not delineated for each outfall structure. Instead, the remaining area was divided into a series of sub-catchments with discharge points along the mainstem. Each area generally included several outfalls along the Merrimack River.

Figure 3-1
Merrimack River Watershed
Merrimack River Tributary and Sponsor Community Delineations

CDM

3.3 Stormdrain Areas in CSO communities

This section provides a summary of the separated stormdrain systems in each of the five sponsor communities of Manchester and Nashua, New Hampshire; Lowell and Haverhill, Massachusetts; and the Greater Lawrence Sanitary District. Additional information on the combined areas in each community is provided in Section 2.0.

3.3.1 Manchester, New Hampshire

Approximately 30-percent of the sewer collection system in the city of Manchester, New Hampshire is served by a separate stormwater drainage system. These drainage areas are located predominately in the northern and southern portions of the system; however, where it has been cost effective, the city has separated combined sewer areas. For example, extensive separation of stormwater from sanitary wastewater flow has been performed in the riverfront commercial use areas west of Elm Street.

The stormwater drainage system is comprised of both natural and man-made open channels and installed drainage conduit. According to the LTCP (CDM 1995) developed for the city, eight major separated stormdrain outfalls discharge to the Piscataquog River and approximately 30 drain outfalls discharge to the Merrimack River within Manchester. The LTCP also cites numerous outfall pipes that discharge separate stormwater flow to the rivers from small basins consisting of one or two streets along both rivers and from Route 293 highway drainage along the Merrimack River.

3.3.2 Nashua, New Hampshire

According to the LTCP developed for the city of Nashua (CDM 1997), approximately 75-percent of the sewered area in the city is served by a separate sanitary collection system. Stormwater drainage in these areas is collected by a drainage piping system and/or directly discharges to receiving waterbodies or man-made open channels. The separated service areas are predominately located in the northern, western, and southern portions of the system, with stormdrain outfalls tributary to the Nashua and Merrimack Rivers, and the Salmon Brook.

3.3.3 Lowell, Massachusetts

According to the LTCP developed for the city of Lowell (CDM 2001), approximately 66-percent of the sewered area in the city is served by a separate sanitary collection system. Stormwater drainage in these areas is collected by a drainage piping system and /or discharges directly to watercourses and man-made open channels. There are approximately 26-miles of separated drainage pipe in the city. The separated areas are predominately located in the western and southeastern portions of the city. As of the 2001 LTCP, new drainage pipe had been installed in central Lowell as part of on-going urban renewal and street reconstruction projects, as well as in many new developments. Where an appropriate outfall could be readily constructed, drainage flows were conveyed to a receiving waterbody or wetland. Where this could not be accomplished, the drainage line was reconnected to a combined sewer line. For the most part, this partial separation condition has occurred with new developments where the Sewer Use Ordinance required a separate system, but it was too cost prohibitive for the developer to extend the drain to an existing separated drainage channel.

3.3.4 Lawrence, Massachusetts

The GLSD system consists of a network of collection systems from the following five communities: Lawrence, Andover, North Andover, and Methuen, Massachusetts, and Salem, New Hampshire. According to the LTCP developed by GLSD (CDM 2002a), the city of Lawrence is largely a combined system, while the other four communities served by the WWTP are entirely separated systems. Portions of Lawrence generally along the outer edge of the city are served by separate drainage and sewer systems

3.3.5 Haverhill, Massachusetts

According to the LTCP developed for the city of Haverhill (CDM 2002b), approximately 37-percent of the city's sewer service area has combined sewers. The remaining 63-percent is comprised of separated drainage and sewer lines. The majority of the combined area is located in the older, more densely populated downtown area along the Merrimack River. Areas further north or south of the Merrimack River tend to be newer and generally include separate sanitary and storm sewers.

3.4 Stormwater Quality

Limited information currently exists on stormwater quality throughout the Merrimack River watershed. However, pollutant event mean concentrations (EMCs) are widely available in published literature at both the national and regional scale for most of the primary pollutants of concern. EMCs are flow-weighted average concentrations calculated for a given storm event. They are defined as the sum of individual measurements of stormwater pollutant loads divided by the total storm runoff volume. EMCs are widely used as the primary statistic for evaluations of stormwater quality and analysis of receiving waterbody impacts. EMCs are generally associated with land use categories, which make them useful in the analysis of non-point source pollutant loading.

On May 15, 2003, CDM issued a memorandum summarizing the available EMC values both nationally and regionally from the following sources:

- *Default EMC values available in the Watershed Management Model (WMM).* These values were based on data from the USEPA's National Urban Runoff Program (NURP) (1983), the Northern Virginia Planning District Commission (1979, 1983), and the Federal Highway Administration (1990)

- *Regional values averaged from New England studies.* Mean regional EMCs were computed from available data collected in the Boston area during the USEPA's

NURP and stormwater sampling data from other sampling programs in Boston, Massachusetts (1999-2000), Worcester, Massachusetts (2002-2003), Manchester, New Hampshire (1992), and Lowell, Massachusetts (1992)

- *National values averaged throughout the United States.* Mean national EMCs were computed from several sources, including USEPA's NURP, the Rouge River National Wet Weather Demonstration Project, USGS, USEPA's National Pollutant Discharge Elimination System (NPDES) database, and monitoring data from Maryland, Michigan, and Virginia

A review of the available data revealed that the relative magnitude of the reported EMCs was fairly consistent among the data sources. As a result, CDM recommended the use of the New England regional EMC values for the land use categories and pollutant constituents for which this data was available, and the use of default values in the WMM model for all others. A summary of the selected EMC values for pollutants of concern is provided in Table 3-3 for the eight land use categories that will be used in future modeling efforts.

Table 3-4 provides a summary of the land use breakdowns for the 28 sub-watersheds listed in Table 3-2. The majority of the Merrimack River watershed is comprised of Forest/Rural Open land use (78.8-percent). In total, urban areas, including medium density residential, commercial, industrial, and urban open space land use categories combine for a distant second at approximately 10.3-percent of the total watershed area. However, the major urban centers, such as the five sponsor communities, are more closely centered around the Merrimack River mainstem, which increases the potential pollutant impact from these urbanized areas.

Table 3-3: Summary of Event Mean Concentrations by Land Use Category

Pollutant	Units	Land Use Category							
		Agriculture/ Pasture	*Commercial*	*Forest/Rural Open*	*Highways*	*Industrial*	*Medium Density Residential*	*Urban Open*	*Water/ Wetlands*
BOD	mg/L	3	10	3	24	12	23	3	4
COD	mg/L	53	43	27	103	85	69	27	6
Total Suspended Solids	mg/L	145	44	51	141	42	49	51	6
Total Dissolved Solids	mg/L	415	58	415	294	202	144	415	12
Total Phosphorus	mg/L	0.37	0.15	0.11	0.43	0.11	0.41	0.11	0.08
Dissolved Phosphorus	mg/L	0.09	0.07	0.027	0.22	0.75	0.18	0.03	0.04
TKN	mg/L	1.92	1.25	0.94	1.82	2.9	2.38	0.94	0.79
Nitrate/Nitrite	mg/L	4.06	0.6	0.8	0.83	1.11	1.12	0.8	0.59
Lead	mg/L	0	0.101	0	0.049	0.063	0.057	0.014	0.011
Copper	mg/L	0	0.084	0	0.037	0.113	0.033	0	0.007
Zinc	mg/L	0	0.151	0	0.156	0.164	0.134	0.04	0.03
Cadmium	mg/L	0	0.002	0	0.003	0.005	0.004	0.001	0.001
Fecal Coliform	#/100mL	5,000	2,600	300	600	600	25,001	5,000	300
E. coli	#/100mL	N/A	N/A	N/A	N/A	N/A	38,607	N/A	N/A

Table 3-4: Merrimack River Watershed Land Use Summary

CATEGORY	SUBBASIN	TOTAL AREA (mi^2)	LAND USE CATEGORY															
			Forest/Rural Open		Urban Open		Agriculture/Pasture		Medium Density Residential		Commercial		Industrial		Highway		Water/Wetland	
			%	*Area*	*%*	*Area*	*%*	*Area*	*%*	*Area*	*%*	*Area*	*%*	*Area*	*%*	*Area*	*%*	*Area*
Sponsor Communities	Manchester, NH	34.9	38.68%	13.51	5.09%	1.78	1.24%	0.43	31.67%	11.07	9.23%	3.22	3.44%	1.20	3.79%	1.32	6.87%	2.40
	Nashua, NH	31.7	43.48%	13.79	4.92%	1.56	3.89%	1.23	27.59%	8.75	8.52%	2.70	3.39%	1.08	3.50%	1.11	4.71%	1.49
	Lowell, MA	14.5	16.50%	2.40	7.50%	1.09	0.00%	0.00	52.49%	7.63	14.09%	2.05	2.94%	0.43	0.88%	0.13	5.60%	0.81
	Lawrence, MA	7.4	5.53%	0.41	5.66%	0.42	0.00%	0.00	54.09%	4.01	13.54%	1.00	12.89%	0.96	3.01%	0.22	5.29%	0.39
	Haverhill, MA	35.6	45.65%	16.27	4.50%	1.60	12.63%	4.50	20.53%	7.32	4.83%	1.72	0.71%	0.25	2.41%	0.86	8.75%	3.12
Mainstem Merrimack River	Upper Merrimack	1290.6	86.91%	1121.69	0.34%	4.39	5.17%	66.73	2.65%	34.20	0.36%	4.65	0.07%	0.90	0.69%	8.91	3.80%	49.04
	Merrimack Corridor 1	51.2	86.67%	44.33	0.17%	0.09	4.93%	2.52	3.47%	1.78	0.19%	0.10	0.14%	0.07	1.58%	0.81	2.85%	1.46
	Merrimack Corridor 2	87.8	74.86%	65.69	1.10%	0.96	9.13%	8.01	7.79%	6.83	2.06%	1.80	0.45%	0.40	1.27%	1.12	3.35%	2.94
	Merrimack Corridor 3	44.4	66.19%	29.37	2.74%	1.22	9.74%	4.32	11.95%	5.30	2.15%	0.95	0.21%	0.09	0.88%	0.39	6.13%	2.72
	Merrimack Corridor 4	48.6	64.99%	31.62	2.24%	1.09	7.94%	3.86	16.12%	7.84	1.57%	0.77	0.00%	0.00	3.22%	1.57	3.90%	1.90
	Merrimack Corridor 5	39.5	51.40%	20.31	2.29%	0.91	11.62%	4.59	16.73%	6.61	3.18%	1.25	0.56%	0.22	2.79%	1.10	11.44%	4.52
	Merrimack Corridor 6	61.1	52.98%	32.38	1.71%	1.05	13.41%	8.19	15.24%	9.31	3.34%	2.04	0.19%	0.12	0.84%	0.52	12.29%	7.51
Major Tributaries	Assabet River	187.9	72.46%	136.19	1.24%	2.33	7.93%	14.90	13.00%	24.43	2.14%	4.02	0.05%	0.09	1.15%	2.17	2.23%	4.19
	Beaver Brook	113.6	66.56%	75.58	1.15%	1.31	7.28%	8.27	19.17%	21.77	1.76%	2.00	0.07%	0.08	1.30%	1.47	2.29%	2.60
	Cohas Brook	57.2	86.62%	49.55	0.39%	0.22	1.25%	0.72	3.90%	2.23	0.53%	0.30	0.00%	0.00	0.20%	0.11	7.12%	4.07
	Concord River	81.8	67.79%	55.48	0.55%	0.45	5.77%	4.72	19.20%	15.71	2.63%	2.15	0.10%	0.08	2.96%	2.42	0.99%	0.81
	Upper Nashua River	181.1	81.87%	148.30	0.32%	0.58	10.07%	18.24	4.18%	7.57	0.62%	1.12	0.14%	0.26	0.14%	0.26	2.67%	4.83
	Lower Nashua River	221.3	68.57%	151.78	2.26%	5.00	9.64%	21.34	10.29%	22.78	3.65%	8.08	0.84%	1.85	0.80%	1.78	3.94%	8.73
	Pemigawasset River	1016.5	92.31%	938.33	0.43%	4.37	2.59%	26.33	1.43%	14.54	0.15%	1.52	0.03%	0.30	0.55%	5.59	2.49%	25.31
	Piscataquog River	214.9	90.16%	193.80	0.35%	0.75	5.37%	11.53	1.62%	3.49	0.25%	0.55	0.03%	0.06	0.00%	0.00	2.21%	4.75
	Powwow River	55.4	68.46%	37.89	0.92%	0.51	11.37%	6.29	9.19%	5.09	1.31%	0.72	0.06%	0.03	0.13%	0.07	8.56%	4.74
	Salmon Brook	22.9	77.74%	17.78	0.63%	0.14	12.88%	2.94	2.02%	0.46	0.29%	0.07	0.00%	0.00	0.00%	0.00	6.44%	1.47
	Shawsheen River	74.9	45.04%	33.74	3.16%	2.37	2.66%	2.00	35.36%	26.49	10.81%	8.10	0.57%	0.43	1.87%	1.40	0.54%	0.40
	Souhegan River	218.8	84.63%	185.20	0.73%	1.59	7.76%	16.98	4.26%	9.31	0.75%	1.64	0.09%	0.21	0.21%	0.45	1.58%	3.45
	Spickett River	74.9	62.61%	46.89	1.42%	1.07	8.86%	6.64	14.15%	10.60	4.09%	3.06	0.10%	0.08	1.43%	1.07	7.33%	5.49
	Stony Brook	45.6	70.67%	32.25	0.39%	0.18	8.56%	3.90	13.99%	6.38	1.79%	0.82	0.04%	0.02	1.75%	0.80	2.82%	1.29
	Sudbury River	161.6	54.51%	88.09	2.41%	3.89	8.06%	13.02	22.90%	37.00	5.36%	8.66	0.49%	0.78	1.30%	2.09	4.98%	8.05
	Winnipesauke River	481.9	66.90%	322.36	0.88%	4.24	4.14%	19.95	6.55%	31.56	0.87%	4.19	0.04%	0.19	0.34%	1.64	20.29%	97.77

Source: MassGIS and New Hampshire GRANIT GIS coverages

3.5 USEPA Phase II Stormwater Regulations

In an effort to control the quality of stormdrain discharges, the USEPA is currently implementing Phase II of its National Pollutant Discharge Elimination System (NPDES) stormwater regulations. Phase I focused on municipal storm sewer systems serving population of 100,000 or more people. Under Phase II, operators of regulated small municipal storm sewer systems (MS4s) are required to obtain a NPDES permit and develop a stormwater management program to prevent harmful pollutants from being discharged into the local waterbodies. Regulated small MS4s are defined as all small MS4s located in "urbanized areas" (UAs), as defined by the U.S. Census Bureau, and all those small MS4s located outside of UAs that are designed by the NPDES permitting authorities. According to the Census Bureau definition, an urbanized area is defined as

> "*a land area comprising one or more place- central place(s)- and the adjacent densely settled surrounding area- urban fringe- that together have a residential population of at least 50,000 and an overall population density of at least 1000 people per square mile*" (USEPA 1999)

Under the Phase II regulations, the MS4s are required to develop and implement a stormwater management plan aimed at minimizing the impacts of stormwater runoff on water quality and aquatic life. The plan must include the following six minimum control measures:

- Public Education and Outreach
- Public Participation/ Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post- Construction Runoff Control
- Pollution Prevention/ Good Housekeeping

The MS4s are required to develop a series of measurable goals aimed a evaluating the effectiveness of the plan. The USEPA published the Phase II Final Rule in the Federal Register on December 8, 1999. It is anticipated that communities will begin implementing their respective stormwater management plans during summer or fall 2003; the implementation of plans must be completed over a five-year period.

Figure 3-2 provides a summary of the towns in the Merrimack River watershed that fall partially or wholly within a defined "urbanized area" (http://cfpub.epa.gov/npdes/stormwater/urbanmaps.cfm). Those that are only partially urbanized are required to develop and implement a management plan for only that portion of the town. Table 3-5 provides a list of the communities shown in Figure 3-2.

Table 3-5: Communities located partially or wholly within an urbanized area

MA Phase II Communities		NH Phase II Communities
• Acton • Amesbury • Andover • Ashland • Ayer • Bedford • Berlin • Billerica • Bolton • Boxborough • Boxford • Burlington • Carlisle • Chelmsford • Clinton • Concord • Dracut • Dunstable • Fitchburg • Framingham • Gardner • Georgetown • Grafton • Groton • Groveland • Harvard • Haverhill • Holliston • Hopkinton • Hudson • Lancaster • Lawrence • Leominster • Lexington • Lincoln • Littleton • Lowell • Lunenburg	• Marlborough • Maynard • Merrimac • Methuen • Natick • Newbury • Newburyport • North Andover • North Reading • Northborough • Paxton • Pepperell • Rutland • Salisbury • Sherborn • Shirley • Shrewsbury • Southborough • Sterling • Stow • Sudbury • Tewksbury • Townsend • Tyngsborough • Upton • Wayland • West Boylston • West Newbury • Westborough • Westford • Westminster • Weston • Wilmington • Woburn	• Amherst • Atkinson • Auburn • Bedford • Chester • Danville • Derry • East Kingston • Goffstown • Hampstead • Hollis • Hooksett • Hudson • Kingston • Litchfield • Londonderry • Manchester • Milford • Nashua • Newbury • Newton • Pelham • Plaistow • Salem • Sandown • Seabrook • South Hampton • Windham

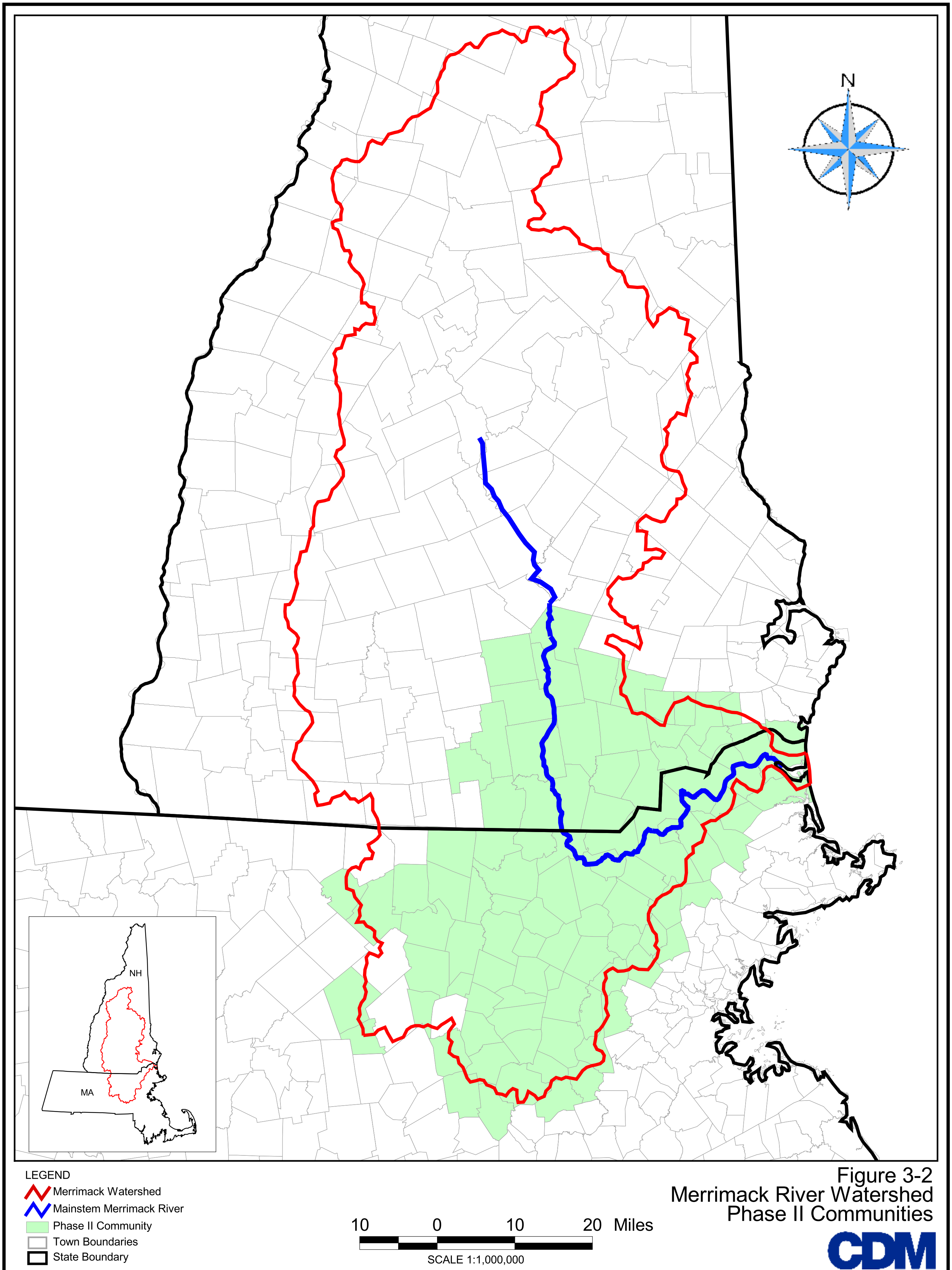


Figure 3-2
Merrimack River Watershed
Phase II Communities

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Section 4
Municipal and Privately-owned Wastewater Treatment Plants

This section of the report provides a summary of the quality and quantity of municipal and privately-owned wastewater treatment plant discharges in the Merrimack River watershed under average daily and storm conditions. Also provided is information on expected future changes in the discharge quality and quantity. This information will be used as input to the water quality models to be developed under subsequent tasks of this study.

Information presented in this section was obtained from the following sources:

- On-line at the US Environmental Protection Agency's (USEPA) Permit Compliance System (PCS) website, which provides information on permit issuance and expiration dates, allowable discharge limits, and limited monitoring data (http://www.epa.gov/enviro/html/pcs/index.html)

- Personal communication with Robin Neas, Environmental Protection Specialist, in the USEPA's Water Technical Unit (SEW), Office of Environmental Stewardship (OES) on March 31, 2003

- USGS. *Wastewater Collection and Return Flow in New England, 1990*. Water-Resources Investigations Report 95-4144.

4.1 Summary of Dischargers

A total of 46[1] municipal and privately owned wastewater treatment plants are permitted to discharge to the mainstem Merrimack River and its tributaries throughout the watershed. Of these, 32 (or 69.6-percent) are classified as "major" dischargers by the USEPA; the remaining 14 (or 30.4-percent) are classified as "minor" dischargers. The USEPA defines major municipal dischargers as those facilities with design flows greater than one million gallons per day.

Table 4-1 provides a summary of the municipal and privately-owned WWTP dischargers, as well as the NPDES permit number, plant location, communities served, receiving waterbody, date of permit issuance, and permit expiration date. The treatment facilities are separated into groups by the drainage area delineations presented in Table 3-2 and Figure 3-1. According to information downloaded from the USEPA's PCS website on January 8, 2003, six of the treatment plants are currently operating under expired NPDES permits.

[1] Note: Based on information obtained from the USEPA's PCS website, 47 WWTPs discharge to the Merrimack River and its tributaries. However, in information obtained from USEPA, no data was provided on the Hopkinton, NH WWTP; therefore, this WWTP has been excluded from this summary.

Table 4-1: Summary of Municipal Wastewater Treatment Facilities in the Merrimack River Watershed[1]

Category	Subwatershed	NPDES ID	Facility Name	Location	Communities Served[2]	Receiving Waters	Major?	Date Issued	Date Expired
Sponsor Communities	Manchester, NH	NH0100447	Manchester	Manchester, NH	Manchester, Goffstown, Londonderry, & Bedford, NH	Merrimack River & Piscataquog River	Yes	01/23/02	05/01/07
	Nashua, NH	NH0100170	Nashua	Nashua, NH	Nashua & Hudson, NH	Merrimack River & Nashua River	Yes	05/31/00	08/01/05
	Lowell, MA	MA0100633	Lowell Regional W&WW Utility	Lowell, MA	Lowell, Chelmsford, Dracut, Tewksbury, & Tyngsborough, MA	Merrimack River/Concord River/ Beaver Brook	Yes	08/14/97	**08/14/02**
	Lawrence, MA	MA0100447	Greater Lawrence Sanitary District (GLSD)	North Andover, MA	North Andover, Andover, Lawrence, & Methuen, MA; Salem, NH	Merrimack River	Yes	02/26/98	**03/26/02**
	Haverhill, MA	MA0101621	Haverhill WPAF	Haverhill, MA	Haverhill & Groveland, MA	Merrimack and Little River	Yes	06/26/03	09/30/06
Mainstem Merrimack River	Merrimack Corridor 1	NH0100129	Hooksett	Hooksett, NH	Hooksett	Merrimack River	Yes	09/02/99	10/02/04
	Merrimack Corridor 2	NH0100056	Derry WWTP	Derry, NH	Derry, NH	Merrimack River	Yes	09/22/98	09/22/03
		NH0100161	Merrimack	Merrimack, NH	Merrimack, NH	Merrimack River	Yes	06/14/01	07/14/06
	Merrimack Corridor 6	MA0101427	Newburyport WPCF	Newburyport, MA	Newburyport, MA	Tidal Creek Merrimack River Estuary	Yes	09/17/98	**10/17/02**
		MA0101745	Amesbury WWTP	Amesbury, MA	Amesbury, MA	Merrimack River	Yes	01/29/98	01/29/03
		MA0102873	Salisbury WWTP	Salisbury, MA	Salisbury, MA	Tidal Creek to Merrimack River	Yes	02/21/02	02/21/07
		MA0101150	Merrimac WWTF	Merrimac, MA	Merrimac, MA	Merrimack River	No	11/05/02	09/30/06
	Upper Merrimack	NH0100331	Concord-Penacook	Penacook, NH	Concord & Boscawen, NH	Merrimack River	Yes	07/14/00	09/12/05
		NH0100901	Concord- Hall Street	Concord, NH	Concord & Bow, NH	Merrimack River	Yes	09/30/98	10/30/03
		NH0100714	Suncook WWTF	Allenstown, NH	Allenstown & Pembroke, NH	Merrimack River	Yes	01/29/01	01/29/06
		NH0100935	Merrimack County Nursing Home	Merrimack County, NH		Merrimack River	No	09/28/95	**09/28/00**
		NH0100960	Winnipesaukee River Basin	Franklin, NH	Franklin, Belmont, Center Harbor, Gilford, Laconia, Meredith, Moultonboro, Northfield, Sanbornton, & Tilton, NH	Merrimack River	Yes	03/30/98	04/29/03
		NH0100986	Pittsfield	Pittsfield, NH	Pittsfield, NH	Suncook River	Yes	09/25/02	12/01/07
Major Tributaries	Assabet River	MA0100412	Westborough WWTP	Westborough, MA	Westborough, Hopkinton, & Shrewsbury, MA	Assabet River	Yes	12/14/00	01/31/04
		MA0100480	Marlborough Westerly WWTF	Marlborough, MA	Marlborough, MA	Assabet River	Yes	12/14/00	01/31/04
		MA0101001	Maynard WWTF	Maynard, MA	Maynard, Sudbury, & Wayland, MA	Assabet River	Yes	12/14/00	01/31/04
		MA0101788	Hudson WWTF	Hudson, MA	Hudson, MA	Assabet River	Yes	12/14/00	01/31/04
	Concord River	MA0100668	Concord WWTF	Concord, MA	Concord, MA	Concord River	Yes	08/06/01	01/31/05
		MA0101711	Billerica WWTP	Billerica, MA	Billerica, MA	Concord River	Yes	11/02/01	01/02/04
	Contoocook River	NH0100102	Henniker	Henniker, NH	Henniker, NH	Contoocook River	Yes	09/15/99	10/15/04
		NH0100111	Hillsboro WWTF	Hillsborough County, NH	Hillsboro, NH	Contoocook River	No	05/01/01	05/31/06
		NH0100498	Warner WWTF	Warner, NH	Warner, NH	Warner River	No	06/21/01	07/21/06
		NH0100561	Antrim	Antrim, NH	Antrim & Bennington, NH	Contoocook River	No	02/08/96	**02/08/01**
		NH0100595	Jaffrey	Jaffrey, NH	Jaffrey, NH	Contoocook River	Yes	07/30/01	10/01/06
		NH0100650	Peterborough	Peterborough, NH	Peterborough, NH	Contoocook River	Yes	09/28/00	11/27/05
	Lower Nashua River	MA0100013	Ayer WWTP	Ayer, MA	Ayer, MA	Nashua River	Yes	07/28/00	09/30/05
		MA0100404	MWRA- Clinton STP	Clinton, MA	Clinton & Lancaster, MA	Nashua River- South Branch	Yes	09/27/00	11/27/05
		MA0100617	Leominster WWTP	Leominster, MA	Leominster, MA	North Nashua River	Yes	07/28/00	09/30/05
		MA0100986	East Fitchburg WWTF	Fitchburg, MA	Fitchburg, MA	Nashua River- North Branch	Yes	09/13/02	09/30/05
		MA0101281	West Fitchburg WWTF	Fitchburg, MA	Fitchburg & Westminster, MA	Nashua River- North Branch	Yes	11/02/00	11/02/06
	Upper Nashua River	MA0100064	Pepperell WWTP	Pepperell, MA	Pepperell, MA	Nashua River	No	06/06/02	09/30/05
	Pemigewasset River	NH0021261	Cannon Mountain Railway Station	Franconia, NH		Tributary- Lafayette Brook/ Echo Lake	No	05/27/86	**05/27/91**
		NH0100005	Ashland	Ashland, NH	Ashland, NH	Squam River	No	03/30/00	05/14/05
		NH0100021	Bristol WWTP	Bristol, NH	Bristol, NH	Pemigewasset River	No	08/23/99	08/23/04
		NH0100242	Plymouth Village WWTF	Plymouth, NH	Plymouth & Holderness, NH	Pemigewasset River	No	09/30/99	10/30/04
		NH0100293	Woodstock	North Woodstock, NH	Woodstock, NH	Pemigewasset River	No	09/18/98	09/18/03
		NH0100706	Lincoln	Lincoln, NH	Lincoln	Pemigewasset River- East Branch	No	09/22/98	10/22/03
		NH0100781	Waterville Valley	Waterville Valley, NH	Waterville Valley	Mad River	No	02/18/00	04/03/05
	Souhegan River	NH0100471	Milford	Milford, NH	Milford & Wilton, NH	Souhegan River	Yes	02/08/00	03/24/05
		NH0100919	Greenville WWTF	Greenville, NH	Greenville, NH	Souhegan River	No	01/31/02	03/03/07
	Sudbury River	MA0100498	Marlborough Easterly WWTF	Marlborough, MA	Marlborough, MA	Hop Brook to Sudbury River	Yes	07/30/99	08/31/04

No WWTPs: Merrimack River Corridor 3, 4, 5; Beaver Brook, Cohas Brook, Piscataquog River, Powwow River, Salmon Brook, Shawsheen River, Spickett River, Stony Brook, Winnipesaukee River

4.2 Quantity and Quality of WWTP Discharges on the Mainstem Merrimack River

The following section provides a summary of the permitted effluent limits and the effluent quantity and quality for the municipal and privately-owned WWTPs discharging directly to the Merrimack River.

Table 4-2 provides a summary of the permitted effluent limits for the five sponsor communities. This information was obtained from the most current NPDES discharge permits for each community.

Table 4-3 provides a summary of the permitted effluent limits for the other discharges along the mainstem Merrimack River (with the exception of the five sponsor communities). Information for these dischargers was compiled from a database of results from monthly monitoring reports submitted to USEPA by each of the respective dischargers in accordance with their NPDES permits. The USEPA supplied CDM with this database of monthly reports submitted between 1997 and 2002; however, in some cases, only information from a limited number of years was available.

The database provided a single monthly value for each water quality constituent under the following categories where information was available:

- Reported value for the quantity average (as appropriate)
- Reported value for the quantity maximum (as appropriate)
- Reported value for the concentration minimum
- Reported value for the concentration average
- Reported value for the concentration maximum

Table 4-4 provides a summary of the reported average, maximum, and minimum effluent quantity and quality for each of the WWTPs for the available data between 1997 and 2002. All information for this table was compiled from information supplied by the USEPA, as discussed above.

Table 4-2: Summary of Permitted Effluent Limits for WWTPs in the Sponsor Communities

NPDES ID	Permit Facility Name	Parameter	Units	Ave. Monthly[1]	Ave. Weekly[1]	Max. Daily[1]
NH0100447	Manchester WWTF	BOD, 5-Day (20 Deg. C)	mg/L	25	40	45
		pH	SU	Range: 6.5 to 8		
		Solids, Total Suspended	mg/L	30	45	50
		Nitrogen, Ammonia Total (as N)	---	DELMON	DELMON	DELMON
		Hardness, Total (as CaCO3)	---	DELMON	DELMON	DELMON
		Nickel, Total Recoverable	---	DELMON	DELMON	DELMON
		Zinc, Total Recoverable	---	DELMON	DELMON	DELMON
		Aluminum, Total Recoverable	---	DELMON	DELMON	DELMON
		Cadmium, Total Recoverable	---	DELMON	DELMON	DELMON
		Lead, Total Recoverable	---	DELMON	DELMON	DELMON
		Chromium, Total Recoverable	---	DELMON	DELMON	DELMON
		Copper, Total Recoverable	---	DELMON	DELMON	DELMON
		E. coli, Thermotol, MF. M-Tec	#/100mL	126	DELMON	406
		Flow, in conduit or thru treatment plant	MGD	ADDMON	ADDMON	ADDMON
		Chlorine, Total Residual	mg/L	0.133	DELMON	0.23
NH0100170	Nashua WWTF	BOD, 5-Day (20 Deg. C)	mg/L	30	45	50
		pH	SU	Range: 6.5 to 8		
		Solids, Total Suspended	mg/L	30	45	50
		Nitrogen, Ammonia Total (as N)	---	DELMON	DELMON	DELMON
		Hardness, Total (as CaCO3)	---	DELMON	DELMON	DELMON
		Nickel, Total Recoverable	---	DELMON	DELMON	DELMON
		Zinc, Total Recoverable	---	DELMON	DELMON	DELMON
		Aluminum, Total Recoverable	---	DELMON	DELMON	DELMON
		Cadmium, Total Recoverable	---	DELMON	DELMON	DELMON
		Lead, Total Recoverable	---	DELMON	DELMON	DELMON
		Chromium, Total Recoverable	---	DELMON	DELMON	DELMON
		Copper, Total Recoverable	---	ADDMON	DELMON	ADDMON
		E. coli, Thermotol, MF. M-Tec	#/100mL	126	DELMON	406
		Flow, in conduit or thru treatment plant	MGD	16	---	---
		Chlorine, Total Residual	mg/L	0.31	DELMON	0.53
MA0100633	Lowell Regional W&WW Utility	BOD, 5-Day (20 Deg. C)	mg/L	30	45	50
		pH	SU	Range: 6.5 to 8		
		Solids, Total Suspended	mg/L	30	45	50
		Flow, in conduit or thru treatment plant	MGD	ADDMON	ADDMON	ADDMON
		Chlorine, Total Residual	mg/L	0.22	DELMON	0.38
		Coliform, Fecal General	#/100mL	200	400	400
MA0100447	GLSD	BOD, 5-Day (20 Deg. C)	mg/L	30	45	50
		pH	SU	Range: 6.5 to 8.3		
		Total Suspended Solids	mg/L	30	45	50
		Flow, in conduit or thru treatment plant	MGD	52	---	---
		Chlorine, Total Residual	mg/L	0.15	---	0.26
		Coliform, Fecal General	#/100mL	200	400	400
MA0101621	Haverhill WPAF	BOD, 5-Day (20 Deg. C)	mg/L	30	45	Report mg/L
		pH	SU	Range: 6.5 to 8.5		
		Solids, Total Suspended	mg/L	30	45	Report mg/L
		Flow, in conduit or thru treatment plant[2]	MGD	18.1	---	Report MGD
		Chlorine, Total Residual	mg/L	0.4	---	0.7
		Coliform, Fecal General	#/100mL	200	400	400

[1]ADDMON= Monitoring/ reporting without limit
DELMON= Monitoring/ reporting not required

[2]The flow limit is an average annual, which is reported monthly as a rolling average and shall be calculated using the monthly average flow from the reporting month and monthly average flows from the preceding 11 months.

Unit Abbreviations:

MGD= Million gallons per day
mg/L= Milligrams per liter
#/100mL= Number per 100 milliliters

Table 4.3- Summary of Pollutant Effluent Limits for Municipal and Privately-owned WWTPs along the Mainstem Merrimack River

NPDES ID	Permit Facility Name	Parameter	Ave. Quantity Limit[1]	Max. Quantity Limit[1]	Quantity Unit	Min. Concentration Limit[1]	Ave. Concentration Limit[1]	Max. Concentration Limit[1]	Concentration Unit
MA0101427	Newburyport WPCF	BOD, 5-Day (20 Deg. C)	---	---	---	30	45	ADDMON	mg/L
		pH	---	---	---	6.5	---	8.5	Standard Units
		Solids, Total Suspended	---	---	---	30	45	ADDMON	mg/L
		Copper, Total (as Cu)	---	---		DELMON	113	113	µg/L
		Flow, in conduit or thru treatment plant	3.4	ADDMON	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	DELMON	DELMON	0.3	mg/L
		Coliform, Fecal General	---	---	---	200	400	400	#/100mL
MA0101745	Amesbury WWTP	BOD, 5-Day (20 Deg. C)	---	---	---	30	45	50	mg/L
		pH	---	---	---	6.5	---	8.5	Standard Units
		Solids, Total Suspended	---	---	---	30	45	50	mg/L
		Cyanide, Total (as Cn)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Chromium, Total (as Cr)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Flow, in conduit or thru treatment plant	1.9	ADDMON	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	DELMON	DELMON	1	mg/L
		Coliform, Fecal General	---	---	---	200	400	400	#/100mL
MA0101150	Merrimac WWTP	BOD, 5-Day (20 Deg. C)	---	---	---	30	45	50	mg/L
		pH	---	---	---	6.5	DELMON	8.5	Standard Units
		Solids, Total Suspended	---	---	---	30	45	50	mg/L
		Chlorine, Total Residual	---	---	---	DELMON	1	1	mg/L
		Coliform, Fecal General	---	---	---	200	400	400	#/100mL
		Flow, in conduit or thru treatment plant	0.45	DELMON	MGD	---	---	---	---
MA0102873	Salisbury WWTF	BOD, 5-Day (20 Deg. C)	54	DELMON	lbs/day	5	7	10	mg/L
		pH	---	---	---	6.5	---	8.5	Standard Units
		Solids, Total Suspended	54	76	lbs/day	5	7	ADDMON	mg/L
		Nitrogen, Ammonia Total (as N)	---	---	---	5/ADDMON	7/ADDMON	10/ADDMON	mg/L
		Copper, Total (as Cu)	---	---	---	DELMON	DELMON	ADDMON	µg/L
		Flow, in conduit or thru treatment plant	1.3	DELMON	MGD	---	---	---	---
		Coliform, Fecal General	---	---	---	50	75	100	#/100mL
NH0100056	Derry WWTP	pH	---	---	---	6.5	DELMON	8	Standard Units
		Solids, Total Suspended	1024	1707	lbs/day	30	45	50	mg/L
		Nitrogen, Ammonia Total (as N)	---	---	---	ADDMON	DELMON	ADDMON	mg/L
		Hardness, Total (as CaCO3)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Nickel, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Zinc, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Aluminum, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Cadmium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Lead, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Chromium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Copper, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		E. coli, Thermotol, MF. M-Tec	---	---	---	126	DELMON	406	#/100mL
		Flow, in conduit or thru treatment plant	ADDMON	ADDMON	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	1	DELMON	1	mg/L
		BOD, Carbonaceous 5-Day, 20C	853	1536	lbs/day	25	40	45	mg/L
NH0100129	Hooksett WWTF	BOD, 5-Day (20 Deg. C)	275	460	lbs/day	30	45	50	mg/L
		pH	---	---	---	6.5		8	Standard Units
		Solids, Total Suspended	275	460	lbs/day	30	45	50	mg/L
		Nitrogen, Ammonia Total (as N)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Hardness, Total (as CaCO3)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Nickel, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Zinc, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Aluminum, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Cadmium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Lead, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Chromium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Copper, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		E. coli, Thermotol, MF. M-Tec	---	---	---	126	DELMON	406	#/100mL
		Flow, in conduit or thru treatment plant	ADDMON	ADDMON	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	1	DELMON	1	mg/L

NPDES ID	Permit Facility Name	Parameter	Ave. Quantity Limit[1]	Max. Quantity Limit[1]	Quantity Unit	Min. Concentration Limit[1]	Ave. Concentration Limit[1]	Max. Concentration Limit[1]	Concentration Unit
NH0100161	Merrimack WWTF	BOD, 5-Day (20 Deg. C)	1351	2767	lbs/day	ADDMON	DELMON	ADDMON	mg/L
		pH	---	---	---	6.5	DELMON	9	Standard Units
		Solids, Total Suspended	1594	3363	lbs/day	ADDMON	DELMON	ADDMON	mg/L
		Nitrogen, Ammonia Total (as N)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Hardness, Total (as CaCO3)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Nickel, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Zinc, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Aluminum, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Cadmium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Lead, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Chromium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Copper, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		E. coli, Thermotol, MF. M-Tec	---	---	---	126	DELMON	406	#/100mL
		Flow, in conduit or thru treatment plant	5	ADDMON	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	0.84	DELMON	1	mg/L
NH0100331	Concord-Penacook WWTP	BOD, 5-Day (20 Deg. C)	1050	1750	lbs/day	30	45	50	mg/L
		pH	---	---	---	6.5	---	8	Standard Units
		Solids, Total Suspended	1050	1750	lbs/day	30	45	50	mg/L
		Nitrogen, Ammonia Total (as N)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Hardness, Total (as CaCO3)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Nickel, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Zinc, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Aluminum, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Cadmium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Lead, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Chromium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Copper, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		E. coli, Thermotol, MF. M-Tec	---	---	---	126	DELMON	406	#/100mL
		Flow, in conduit or thru treatment plant	ADDMON	ADDMON	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	1	DELMON	1	mg/L
NH0100714	Suncook WWTF	BOD, 5-Day (20 Deg. C)	263	438	lbs/day	30	45	50	mg/L
		pH	---	---	---	6.5	---	8	Standard Units
		Solids, Total Suspended	263	438	lbs/day	30	45	50	mg/L
		Nitrogen, Ammonia Total (as N)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Hardness, Total (as CaCO3)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Nickel, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Zinc, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Aluminum, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Cadmium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Lead, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Chromium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Copper, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		E. coli, Thermotol, MF. M-Tec	---	---	---	126	DELMON	406	#/100mL
		Flow, in conduit or thru treatment plant	ADDMON	ADDMON	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	1	DELMON	1	mg/L
NH0100901	Concord-Hall Street WWTF	BOD, 5-Day (20 Deg. C)	2529	4214	lbs/day	30	45	50	mg/L
		pH	---	---	---	6.5	DELMON	8	Standard Units
		Solids, Total Suspended	2529	4214	lbs/day	30	45	50	mg/L
		Nitrogen, Ammonia Total (as N)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Hardness, Total (as CaCO3)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Nickel, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Zinc, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Aluminum, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Cadmium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Lead, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
	Concord-Hall Street WWTF (cont'd)	Chromium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Copper, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		E. coli, Thermotol, MF. M-Tec	---	---	---	126	DELMON	406	#/100mL
		Flow, in conduit or thru treatment plant	ADDMON	ADDMON	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	0.41	DELMON	0.7	mg/L

NPDES ID	Permit Facility Name	Parameter	Ave. Quantity Limit[1]	Max. Quantity Limit[1]	Quantity Unit	Min. Concentration Limit[1]	Ave. Concentration Limit[1]	Max. Concentration Limit[1]	Concentration Unit
NH0100960	Winnipesaukee River Basin	BOD, 5-Day (20 Deg. C)	2900	4800	lbs/day	30	45	50	mg/L
		pH	---	---	---	6.5	---	8	Standard Units
		Solids, Total Suspended	2880	4800	lbs/day	30	45	50	mg/L
		Nitrogen, Ammonia Total (as N)	---	---	---	ADDMON	DELMON	ADDMON	mg/L
		Hardness, Total (as CaCO3)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Nickel, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Zinc, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Cadmium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Lead, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Chromium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Copper, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		E. coli, Thermotol, MF. M-Tec	---	---	---	126	DELMON	406	#/100mL
		Flow, in conduit or thru treatment plant	ADDMON	ADDMON	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	0.32	DELMON	0.55	mg/L
		BOD, Carbonaceous 5-Day, 20C	2400	4320	lbs/day	25	40	45	mg/L
NH0100935	Merrimack County Nursing Home	BOD, 5-Day (20 Deg. C)	20	33.4	lbs/day	30	45	50	mg/L
		Solids, Total Suspended	20	33.4	lbs/day	30	45	50	mg/L
NH0100986	Pittsfield WWTF	BOD, 5-Day (20 Deg. C)	100	167	lbs/day	30	45	50	mg/L
		pH	---	---	---	6.5	---	8	Standard Units
		Solids, Total Suspended	100	167	lbs/day	30	45	50	mg/L
		Nitrogen, Ammonia Total (as N)	---	---	---	ADDMON	DELMON	ADDMON	mg/L
		Hardness, Total (as CaCO3)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Nickel, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Zinc, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Cadmium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Lead, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Chromium, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Copper, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		E. coli, Thermotol, MF. M-Tec	---	---	---	126	DELMON	406	#/100mL
		Nitrogen, Ammonia Total (as NH3)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Flow, in conduit or thru treatment plant	ADDMON	ADDMON	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	0.074	DELMON	0.127	mg/L
		BOD, Carbonaceous 5-Day, 20C	83	150	lbs/day	25	40	45	mg/L

[1]ADDMON= Monitoring/ reporting without limit
DELMON= Monitoring/ reporting not required

Unit Abbreviations:

MGD= Million gallons per day
mg/L= Milligrams per liter
µg/l= Micrograms per liter
#/100mL= Number per 100 milliliters
lbs/day= Pounds per day

Table 4-4: Concentration and Discharge Statistics for Municipal and Privately-owned WWTPs Discharging to the Mainstem Merrimack River

NPDES Permit #	Facility Name	Water Quality Parameter[1]	Major/Minor	No. of monitoring reports that average is based on	Merasurement monitoring report frequency	Reported value for the quantity average	Reported value for the quantity maximum	Quantity Unit	Reported value for the concentration minimum	Reported value for the concentration average	Reported value for the concentration maximum	Concentration Unit
MA0100447	Greater Lawrence Sanitary District	BOD, 5-day (20 Deg. C)	Major	72	monthly 1/31/97 to 12/31/02	---	---	---	12.23	14.96	24.49	mg/L
		pH		72	monthly 1/31/97- 12/31/02	---	---	---	7.17	---	7.65	Standard Units
		Total Suspended Solids		72	monthly 1/31/97- 12/31/02	---	---	---	6.54	9.13	16.35	mg/L
		Flow, in conduit or thru treatment plant		72	monthly 1/31/03- 12/31/02	30.29	---	MGD	---	---	---	---
		Chlorine, Total residual		57	monthly 4/30/98- 12/31/02	---	---	---	0.002	---	0.11	mg/L
		Fecal Coliform		72	monthly 1/31/97- 12/31/02	---	---	---	8.29	14.51	29.22	#/100mL
MA0100633	Lowell Regional W&WW Utility	BOD, 5-day (20 Deg. C)	Major	72	monthly 1/31/97- 12/31/02	---	---	---	12.48	16.29	30.82	mg/L
		pH		72	monthly 1/31/97- 12/31/02	---	---	---	6.47	---	7.02	Standard Units
		Total Suspended Solids		72	monthly 1/31/97- 12/31/02	---	---	---	11.83	15.22	30.56	mg/L
		Flow, in conduit or thru treatment plant		72	monthly 1/31/97- 12/31/02	31.83	52.37	MGD	---	---	---	---
		Chlorine, Total residual		63	monthly 10/31/97- 12/31/02	---	---	---	0.01	---	0.28	mg/L
		Fecal Coliform		72	monthly 1/31/97- 12/31/02	---	---	---	6.06	12.32	60.97	#/100mL
MA0101427	Newburyport WPCF	BOD, 5-day (20 Deg. C)	Major	72	monthly 1/31/97- 12/31/02	---	---	---	15.84	20.75	27.69	mg/L
		pH		72	monthly 1/31/97- 12/31/02	---	---	---	6.67	---	7.14	Standard Units
		Total Suspended Solids		72	monthly 1/31/97- 12/31/02	---	---	---	10.35	14.79	23.63	mg/L
		Copper, Total (as Cu)		22	monthly 1/31/97- 10/31/98	---	---	---	---	18.72	23.90	µg/L
		Flow, in conduit or thru treatment plant		72	monthly 1/31/97- 10/31/98	3.19	---	MGD	---	---	---	---
		Chlorine, Total residual		72	monthly 1/31/97- 12/31/02	---	---	---	---	---	0.30	mg/L
		Fecal Coliform		72	monthly 1/31/97- 12/31/02	---	---	---	42.48	95.17	263.68	#/100mL
MA0101621	Haverhill WPAF	BOD, 5-day (20 Deg. C)	Major	72	monthly 1/31/97- 12/31/02	---	---	---	9.95	13.91	28.29	mg/L
		pH		72	monthly 1/31/97- 12/31/02	---	---	---	6.64	---	7.23	Standard Units
		Total Suspended Solids		72	monthly 1/31/97- 12/31/02	---	---	---	6.48	11.07	29.30	mg/L
		Flow, in conduit or thru treatment plant		72	monthly 1/31/97- 12/31/02	9.58	---	MGD	---	---	---	---
		Chlorine, Total residual		56	monthly 1/31/97- 12/31/02	---	---	---	0.19	---	0.64	mg/L
		Fecal Coliform		72	monthly 1/31/97- 12/31/02	---	---	---	2.12	5.21	68.54	#/100mL
MA0101745	Amesbury WWTP	BOD, 5-day (20 Deg. C)	Major	72	monthly 1/31/97- 12/31/02	---	---	---	13.42	23.38	23.42	mg/L
		pH		72	monthly 1/31/97- 12/31/02	---	---	---	6.78	---	7.34	Standard Units
		Total Suspended Solids		72	monthly 1/31/97- 12/31/02	---	---	---	17.79	24.48	33.21	mg/L
		Flow, in conduit or thru treatment plant		72	monthly 1/31/97- 12/31/02	1.82	2.68	MGD	---	---	---	---
		Chlorine, Total residual		59	monthly 2/28/98- 12/31/02	---	---	---	0.63	---	0.88	mg/L
		Fecal Coliform		72	monthly 1/31/97- 12/31/02	---	---	---	30.29	89.99	89.99	#/100mL
		Chromium, Total (as Cr)		4	every 3 months 3/31/97- 12/31/97	---	---	---	---	---	0.0003	mg/L
		Copper, Total (as Cu)		4	every 3 months 3/31/97- 12/31/97	---	---	---	---	---	0.02	mg/L
		Lead, Total (as Pb)		4	every 3 months 3/31/97- 12/31/97	---	---	---	---	---	0.0004	mg/L
		Nickel, Total (as Ni)		4	every 3 months 3/31/97- 12/31/97	---	---	---	---	---	0.0028	mg/L
MA0102873	Salisbury WWTF	BOD, 5-day (20 Deg. C)	Major	70	monthly 1/31/97- 12/31/02	9.88	---	---	1.99	2.96	3.51	mg/L
		pH		70	monthly 1/31/97- 12/31/02	---	---	---	6.27	---	6.62	Standard Units
		Total Suspended Solids		70	monthly 1/31/97- 12/21/02	4.50	---	---	0.98	1.31	1.53	mg/L
		Nitrogen, Ammonia Total (as N)		70	monthly 1/31/97- 12/31/02	---	---	---	5.21	7.00	7.00	mg/L
		Flow, in conduit or thru treatment plant		70	monthly 1/31/97- 12/31/02	0.55	---	MGD	---	---	---	---
		Fecal Coliform		70	monthly 1/31/97- 12/31/02	---	---	---	1.26	4.22	14.16	#/100mL
		Copper, Total (as Cu)		10	monthly 3/31/02- 12/31/02	---	---	---	---	---	0.07	µg/L
NH0100056	Derry WWTP	pH	Major	71	monthly 1/31/03- 12/31/02	---	---	---	6.52	---	7.41	Standard Units
		Total Suspended Solids		71	monthly 1/31/03- 12/31/02	138.65	236.15	lbs/day	9.32	13.73	14.04	---
		Nitrogen, Ammonia Total (as N)[2]		9	bi-annual 12/31/98- 12/31/02	---	---	---	---	---	13.55	mg/L
		Hardness, Total (as CaCO3)[2]		9	bi-annual 12/31/98- 12/31/02	---	---	---	---	---	64.44	mg/L
		Nickel, Total recoverable[2]		9	bi-annual 12/31/98- 12/31/02	---	---	---	---	---	0.04	mg/L
		Zinc, Total recoverable[2]		9	bi-annual 12/31/98- 12/31/02	---	---	---	---	---	0.10	mg/L
		Cadmium, Total recoverable[2]		9	bi-annual 12/31/98- 12/31/02	---	---	---	---	---	0.00	mg/L
		Lead, Total recoverable[2]		9	bi-annual 12/31/98- 12/31/02	---	---	---	---	---	0.00	mg/L
		Chromium, Total recoverable[2]		9	bi-annual 12/31/98- 12/31/02	---	---	---	---	---	0.00	mg/L
		Copper, Total recoverable[2]		9	bi-annual 12/31/98- 12/31/02	---	---	---	---	---	0.03	mg/L
		E.coli (Thermotol, MF, M-TEC)		71	monthly 1/31/97- 12/31/02	---	---	---	10.61	---	80.27	#/100mL
		Flow, in conduit or thru treatment plant		71	monthly 1/31/97- 12/31/02	1.80	2.72	MGD	---	---	---	---
		Chlorine, Total residual		71	monthly 10/31/98- 12/31/02	---	---	---	0.47	---	0.89	mg/L
		BOD, Carbonaceous 5-day, 20C		71	monthly 1/31/97- 12/31/02	192.33	292.13	lbs/day	12.45	16.57	17.03	---
NH0100129	Hooksett WWTF	BOD, 5-day (20 Deg. C)	Major	72	monthly 1/31/97- 12/31/02	61.78	106.66	lbs/day	11.83	16.51	20.42	mg/L
		pH		72	monthly 1/31/97- 12/31/02	---	---	---	6.61	---	7.19	Standard Units
		Total Suspended Solids		72	monthly 1/31/97- 12/31/02	70.93	147.22	lbs/day	13.88	19.87	25.48	---
		Nitrogen, Ammonia Total (as N)[2]		6	bi-annual 6/30/00-9/30/02	---	---	---	---	---	24.88	mg/L

NPDES Permit #	Facility Name	Water Quality Parameter[1]	Major/Minor	No. of monitoring reports that average is based on	Merasurement monitoring report frequency	Reported value for the quantity average	Reported value for the quantity maximum	Quantity Unit	Reported value for the concentration minimum	Reported value for the concentration average	Reported value for the concentration maximum	Concentration Unit
	Hooksett WWTF (cont'd)	Hardness, Total (as CaCO3)[2]		6	bi-annual 6/30/00-9/30/02	---	---	---	---	---	39.33	mg/L
		Nickel, Total recoverable[2]		6	bi-annual 6/30/00-9/30/02	---	---	---	---	---	0.00	mg/L
		Zinc, Total recoverable[2]		6	bi-annual 6/30/00-9/30/02	---	---	---	---	---	0.05	mg/L
		Cadmium, Total recoverable[2]		6	bi-annual 6/30/00-9/30/02	---	---	---	---	---	0.00	mg/L
		Lead, Total recoverable[2]		6	bi-annual 6/30/00-9/30/02	---	---	---	---	---	---	mg/L
		Chromium, Total recoverable[2]		6	bi-annual 6/30/00-9/30/02	---	---	---	---	---	0.00	mg/L
		Copper, Total recoverable[2]		6	bi-annual 6/30/00-9/30/02	---	---	---	---	---	0.01	mg/L
		E.coli (Thermotol, MF, M-TEC)		72	monthly 1/31/97-12/31/02	---	---	---	14.50	---	79.03	#/100mL
		Flow, in conduit or thru treatment plant		72	monthly 1/31/97-12/31/02	0.63	8.64	MGD	---	---	---	---
		Chlorine, Total residual		72	monthly 10/31/99-12/31/02	---	---	---	0.45	---	0.87	mg/L
NH0100161	Merrimack WWTF	BOD, 5-day (20 Deg. C)	Major	72	monthly 1/31/97-12/31/02	447.28	844.43	lbs/day	14.83	---	27.38	---
		pH		72	monthly 1/31/97- 12/31/02	---	---	---	6.85	---	7.57	Standard Units
		Total Suspended Solids		72	monthly 1/31/97-12/31/02	367.88	736.20	lbs/day	12.39	16.49	23.56	---
		E.coli (Thermotol, MF, M-TEC)		72	monthly 1/31/97- 12/31/02	---	---	---	17.54	---	154.10	#/100mL
		Flow, in conduit or thru treatment plant		72	monthly 1/31/97- 12/31/02	3.53	4.25	MGD	---	---	---	---
		Chlorine, Total residual		72	monthly 1/31/97- 12/31/02	---	---	---	0.66	---	0.95	mg/L
		Nitrogen, Ammonia Total (as N)[2]		2	once per year 9/30/01 & 9/30/02	---	---	---	---	---	1.38	mg/L
		Hardness, Total (as CaCO3)[2]		2	once per year 9/30/01 & 9/30/02	---	---	---	---	---	91.50	mg/L
		Nickel, Total recoverable[2]		2	once per year 9/30/01 & 9/30/02	---	---	---	---	---	0.01	mg/L
		Zinc, Total recoverable[2]		2	once per year 9/30/01 & 9/30/02	---	---	---	---	---	0.17	mg/L
		Cadmium, Total recoverable[2]		2	once per year 9/30/01 & 9/30/02	---	---	---	---	---	0.00	mg/L
		Lead, Total recoverable[2]		2	once per year 9/30/01 & 9/30/02	---	---	---	---	---	0.00	mg/L
		Chromium, Total recoverable[2]		2	once per year 9/30/01 & 9/30/02	---	---	---	---	---	0.01	mg/L
		Copper, Total recoverable[2]		2	once per year 9/30/01 & 9/30/02	---	---	---	---	---	0.00	mg/L
NH0100170	Nashua WWTF	BOD, 5-day (20 Deg. C)	Major	72	monthly 1/31/97- 12/31/02	1738.88	2243.53	lbs/day	15.43	34.77	28.89	---
		pH		72	monthly 1/31/97- 12/31/02	---	---	---	6.92	---	7.44	Standard Units
		Total Suspended Solids		72	monthly 1/31/97- 12/31/02	1323.10	1758.97	lbs/day	11.21	14.06	25.86	---
		Nitrogen, Ammonia Total (as N)[2]		10	every 3 months 9/30/00- 12/31/02	---	---	---	---	---	23.32	mg/L
		Hardness, Total (as CaCO3)[2]		10	every 3 months 9/30/00- 12/31/02	---	---	---	---	---	75.21	mg/L
		Nickel, Total recoverable[2]		10	every 3 months 9/30/00- 12/31/02	---	---	---	---	---	0.00	mg/L
		Zinc, Total recoverable[2]		10	every 3 months 9/30/00- 12/31/02	---	---	---	---	---	0.07	mg/L
		Cadmium, Total recoverable[2]		10	every 3 months 9/30/00- 12/31/02	---	---	---	---	---	0.00	mg/L
		Lead, Total recoverable[2]		10	every 3 months 9/30/00- 12/31/02	---	---	---	---	---	0.01	mg/L
		Chromium, Total recoverable[2]		10	every 3 months 9/30/00- 12/31/02	---	---	---	---	---	0.00	mg/L
		Copper, Total recoverable[2]		29	monthly 8/31/00- 12/31/02	---	---	---	0.03	---	0.04	mg/L
		E.coli (Thermotol, MF, M-TEC)		72	monthly 1/31/97- 12/31/02	---	---	---	9.63	---	229.71	#/100mL
		Flow, in conduit or thru treatment plant		72	monthly 1/31/97-12/31/02	13.58	22.02	MGD	---	---	---	---
		Chlorine, Total residual		29	monthly 08/31/00-12/31/02	---	---	---	0.05	---	0.43	mg/L
NH0100331	Conccord- Penacook WWTP	BOD, 5-day (20 Deg. C)	Major	72	monthly 1/31/97-12/31/02	27.34	46.07	lbs/day	7.27	8.23	9.11	---
		pH		72	monthly 1/31/97- 12/31/02	---	---	---	6.94	---	7.37	Standard Units
		Total Suspended Solids		72	monthly 1/31/97- 12/31/02	17.63	31.32	lbs/day	4.13	5.99	7.06	---
		Nitrogen, Ammonia Total (as N)[2]		13	twice per year 6/30/97- 9/30/02	---	---	---	---	---	4.63	mg/L
		Hardness, Total (as CaCO3)[2]		13	twice per year 6/30/97- 9/30/02	---	---	---	---	---	48.54	mg/L
		Nickel, Total recoverable[2]		13	twice per year 6/30/97- 9/30/02	---	---	---	---	---	0.01	mg/L
		Zinc, Total recoverable[2]		13	twice per year 6/30/97- 9/30/02	---	---	---	---	---	0.04	mg/L
		Cadmium, Total recoverable[2]		13	twice per year 6/30/97- 9/30/02	---	---	---	---	---	0.01	mg/L
		Lead, Total recoverable[2]		13	twice per year 6/30/97- 9/30/02	---	---	---	---	---	0.01	mg/L
		Chromium, Total recoverable[2]		13	twice per year 6/30/97- 9/30/02	---	---	---	---	---	0.01	mg/L
		Copper, Total recoverable[2]		13	twice per year 6/30/97- 9/30/02	---	---	---	---	---	0.01	mg/L
		E.coli (Thermotol, MF, M-TEC)		72	monthly 1/31/97-12/31/02	---	---	---	9.01	---	69.88	#/100mL
		Flow, in conduit or thru treatment plant		72	monthly 1/31/97-12/31/02	0.54	0.91	MGD	---	---	---	---
		Chlorine, Total residual		28	monthly 9/30/00-12/31/02	---	---	---	0.46	---	0.69	mg/L
NH0100447	Manchester WWTF	BOD, 5-day (20 Deg. C)	Major	64	monthly 1/31/97- 4/30/02	3199.91	4543.72	lbs/day	17.40	23.58	40.80	mg/L
		pH		72	monthly 1/31/97- 12/31/02	---	---	---	6.57	---	7.14	Standard Units
		Total Suspended Solids		72	monthly 1/31/97- 12/31/02	2351.76	3653.32	lbs/day	11.79	16.94	33.92	mg/L
		E.coli (Thermotol, MF, M-TEC)		72	monthly 1/31/97- 12/31/02	---	---	---	6.08	---	181.30	#/100mL
		BOD, Carbonaceous 5-day, 20C		8	monthly 5/31/02- 12/31/02	1081.50	3716.38	lbs/day	5.43	7.96	14.04	mg/L
		Flow, in conduit or thru treatment plant		72	monthly 1/31/97- 12/31/02	22.56	37.81	MGD	---	---	---	---
		Chlorine, Total residual		72	monthly 1/31/97- 12/31/02	---	---	---	---	---	0.07	mg/L
		Nitrogen, Ammonia Total (as N)[2]		2	every 3 months 9/30/02 & 12/31/02	---	---	---	---	---	12.53	mg/L
		Hardness, Total (as CaCO3)[2]		2	every 3 months 9/30/02 & 12/31/02	---	---	---	---	---	52.50	mg/L

NPDES Permit #	Facility Name	Water Quality Parameter[1]	Major/Minor	No. of monitoring reports that average is based on	Merasurement monitoring report frequency	Reported value for the quantity average	Reported value for the quantity maximum	Quantity Unit	Reported value for the concentration minimum	Reported value for the concentration average	Reported value for the concentration maximum	Concentration Unit
	Manchester WWTF (cont'd)	Nickel, Total recoverable[2]		2	every 3 months 9/30/02 & 12/31/02	---	---	---	---	---	0.00	mg/L
		Zinc, Total recoverable[2]		2	every 3 months 9/30/02 & 12/31/02	---	---	---	---	---	0.07	mg/L
		Cadmium, Total recoverable[2]		2	every 3 months 9/30/02 & 12/31/02	---	---	---	---	---	0.00	mg/L
		Lead, Total recoverable[2]		2	every 3 months 9/30/02 & 12/31/02	---	---	---	---	---	0.00	mg/L
		Chromium, Total recoverable[2]		2	every 3 months 9/30/02 & 12/31/02	---	---	---	---	---	0.00	mg/L
		Copper, Total recoverable[2]		2	every 3 months 9/30/02 & 12/31/02	---	---	---	---	---	0.01	mg/L
NH0100714	Suncook WWTF	BOD, 5-day (20 Deg. C)	Major	72	monthly 1/31/97- 12/31/02	100.48	164.72	lbs/day	18.01	23.91	27.45	mg/L
		pH		72	monthly 1/31/97- 12/31/02	---	---	---	6.81	---	7.49	Standard Units
		Total Suspended Solids		72	monthly 1/31/97- 12/31/02	72.97	134.22	lbs/day	13.37	19.63	22.89	mg/L
		Nitrogen, Ammonia Total (as N)[2]		4	twice per year 9/30/01- 12/31/02	---	---	---	---	---	17.75	mg/L
		Hardness, Total (as CaCO3)[2]		4	twice per year 9/30/01- 12/31/02	---	---	---	---	---	55.25	mg/L
		Nickel, Total recoverable[2]		4	twice per year 9/30/01- 12/31/02	---	---	---	---	---	0.00	mg/L
		Zinc, Total recoverable[2]		4	twice per year 9/30/01- 12/31/02	---	---	---	---	---	0.07	mg/L
		Cadmium, Total recoverable[2]		4	twice per year 9/30/01- 12/31/02	---	---	---	---	---	3.45	mg/L
		Lead, Total recoverable[2]		4	twice per year 9/30/01- 12/31/02	---	---	---	---	---	0.00	mg/L
		Chromium, Total recoverable[2]		4	twice per year 9/30/01- 12/31/02	---	---	---	---	---	0.00	mg/L
		Copper, Total recoverable[2]		4	twice per year 9/30/01- 12/31/02	---	---	---	---	---	0.05	mg/L
		E.coli (Thermotol, MF, M-TEC)		72	monthly 1/31/97- 12/31/02	---	---	---	46.31	---	291.03	#/100mL
		Flow, in conduit or thru treatment plant		72	monthly 1/31/97- 12/31/02	0.66	0.96	MGD	---	---	---	---
		Chlorine, Total residual		72	monthly 2/28/01- 12/31/02	---	---	---	0.43		0.82	mg/L
NH0100901	Concord-Hall Street WWTF	BOD, 5-day (20 Deg. C)	Major	72	monthly 1/31/97- 12/31/02	535.43	831.82	lbs/day	14.11	16.72	20.97	mg/L
		pH		72	monthly 1/31/97- 12/31/02	---	---	---	7.14	---	7.69	Standard Units
		Total Suspended Solids		72	monthly 1/31/97- 12/31/02	453.94	759.68	lbs/day	11.90	14.28	19.36	mg/L
		Nitrogen, Ammonia Total (as N)[2]		18	every 3 months 3/31/99- 12/31/02	---	---	---	---	---	19.11	mg/L
		Hardness, Total (as CaCO3)[2]		18	every 3 months 3/31/99- 12/31/02	---	---	---	---	---	81.60	mg/L
		Nickel, Total recoverable[2]		17	every 3 months 3/31/99- 12/31/02	---	---	---	---	---	0.01	mg/L
		Zinc, Total recoverable[2]		17	every 3 months 3/31/99- 12/31/02	---	---	---	---	---	0.03	mg/L
		Cadmium, Total recoverable[2]		17	every 3 months 3/31/99- 12/31/02	---	---	---	---	---	<0.001	mg/L
		Lead, Total recoverable[2]		17	every 3 months 3/31/99- 12/31/02	---	---	---	---	---	0.00	mg/L
		Chromium, Total recoverable[2]		17	every 3 months 3/31/99- 12/31/02	---	---	---	---	---	0.00	mg/L
		Copper, Total recoverable[2]		17	every 3 months 3/31/99- 12/31/02	---	---	---	---	---	0.01	mg/L
		E.coli (Thermotol, MF, M-TEC)		72	monthly 1/31/97- 12/31/02	---	---	---	45.24	---	186.99	#/100mL
		Flow, in conduit or thru treatment plant		72	monthly 1/31/97- 12/31/02	4.39	5.69	MGD	---	---	---	---
		Chlorine, Total residual		50	monthly 11/30/98- 12/31/02	---	---	---	0.30	---	0.49	mg/L
NH0100960	Winnipesaukee River Basin	BOD, 5-day (20 Deg. C)	Major	15	monthly 1/31/97- 3/31/98	856.00	1878.62	lbs/day	20.07	26.20	36.93	mg/L
		pH		72	monthly 1/31/97- 12/31/02	---	---	---	6.93	---	7.40	Standard Units
		Total Suspended Solids		72	monthly 1/31/97- 12/31/02	735.38	1622.11	lbs/day	16.08	22.48	32.39	mg/L
		Nitrogen, Ammonia Total (as N)		57	monthly 4/30/98- 12/31/02	---	---	---	21.97	---	31.08	mg/L
		Hardness, Total (as CaCO3)[2]		19	every 3 months 6/30/98- 12/31/02	---	---	---	---	---	84.74	mg/L
		Nickel, Total recoverable[2]		19	every 3 months 6/30/98- 12/31/02	---	---	---	---	---	0.00	mg/L
		Zinc, Total recoverable[2]		19	every 3 months 6/30/98- 12/31/02	---	---	---	---	---	0.04	mg/L
		Cadmium, Total recoverable[2]		19	every 3 months 6/30/98- 12/31/02	---	---	---	---	---	0.00	mg/L
		Lead, Total recoverable[2]		19	every 3 months 6/30/98- 12/31/02	---	---	---	---	---	0.00	mg/L
		Chromium, Total recoverable[2]		19	every 3 months 6/30/98- 12/31/02	---	---	---	---	---	0.00	mg/L
		Copper, Total recoverable[2]		19	every 3 months 6/30/98- 12/31/02	---	---	---	---	---	0.04	mg/L
		E.coli (Thermotol, MF, M-TEC)		72	monthly 1/31/97- 12/31/02	---	---	---	27.74	---	1179.19	#/100mL
		Flow, in conduit or thru treatment plant		72	monthly 1/31/97- 12/31/02	5.50	7.30	MGD	---	---	---	---
		Chlorine, Total residual		72	monthly 1/31/97- 12/31/02	---	---	---	0.10	---	0.22	mg/L
		BOD, Carbonaceous 5-day, 20C		57	monthly 4/30/98- 12/31/02	560.50	1042.65	lbs/day	12.38	16.25	22.18	mg/L

NPDES Permit #	Facility Name	Water Quality Parameter[1]	Major/Minor	No. of monitoring reports that average is based on	Merasurement monitoring report frequency	Reported value for the quantity average	Reported value for the quantity maximum	Quantity Unit	Reported value for the concentration minimum	Reported value for the concentration average	Reported value for the concentration maximum	Concentration Unit
NH0100986	Pittsfield WWTF	BOD, 5-day (20 Deg. C)	Major	8	monthly 1/31/97- 8/31/97	32.00	49.50	lbs/day	13.75	20.38	20.38	mg/L
		pH		72	monthly 1/31/97- 12/31/02	---	---	---	6.91	---	7.63	Standard Units
		Total Suspended Solids		72	monthly 1/31/97- 12/31/02	51.39	75.22	lbs/day	23.72	33.27	33.52	mg/L
		Nitrogen, Ammonia Total (as N)		27	five tiems per year 9/30/97- 10/31/0	---	---	---	1.79	---	3.38	mg/L
		Hardness, Total (as CaCO3)[2]		21	hree times per year 12/31/97- 9/30/0	---	---	---	---	---	111.76	mg/L
		Nickel, Total recoverable[2]		22	hree times per year 12/31/97- 9/30/0	---	---	---	---	---	5.59	mg/L
		Zinc, Total recoverable[2]		22	hree times per year 12/31/97- 9/30/0	---	---	---	---	---	0.05	mg/L
		Cadmium, Total recoverable[2]		22	hree times per year 12/31/97- 9/30/0	---	---	---	---	---	0.00	mg/L
		Lead, Total recoverable[2]		22	hree times per year 12/31/97- 9/30/0	---	---	---	---	---	0.00	mg/L
		Chromium, Total recoverable[2]		22	hree times per year 12/31/97- 9/30/0	---	---	---	---	---	0.03	mg/L
		Copper, Total recoverable[2]		22	hree times per year 12/31/97- 9/30/0	---	---	---	---	---	0.01	mg/L
		E.coli (Thermotol, MF, M-TEC)		72	monthly 1/31/97- 12/31/02	---	---	---	49.91	---	236.67	#/100mL
		Nitrogen, Ammonia Total (as NH3)[2]		22	every 3 months 12/31/97- 12/31/02	---	---	---	---	---	10.60	mg/L
		Flow, in conduit or thru treatment plant		72	monthly 1/31/97- 12/31/02	0.25	0.35	MGD	---	---	---	---
		Chlorine, Total residual		64	monthly 9/30/97- 12/31/02	---	---	---	0.04	---	0.08	mg/L
		BOD, Carbonaceous 5-day, 20C		64	monthly 9/30/97- 12/31/02	24.82	38.70	lbs/day	11.98	16.41	16.25	mg/L
MA0101150	Merrimac WWTP	BOD, 5-day (20 Deg. C)	Minor	33	monthly 1/31/00- 8/31/02	---	---	---	34.15	41.90	49.73	mg/L
		pH		33	monthly 1/31/00- 8/31/02	---	---	---	6.84	---	7.20	Standard Units
		Total Suspended Solids		32	monthly 1/31/00- 8/31/02	---	---	---	9.26	23.33	43.40	mg/L
		Flow, in conduit or thru treatment plant		33	monthly 1/31/00- 8/31/02	0.38	---	MGD	---	---	---	---
		Chlorine, Total residual		20	7x per year- 4/30/00- 8/31/02	---	---	---	---	0.33	0.65	mg/L
		Fecal Coliform		20	7x per year- 4/30/00- 8/31/02	---	---	---	9.75	35.65	281.15	#/100mL
NH0100935	Merrimack County Nursing Home	BOD, 5-day (20 Deg. C)	Minor	30	monthly 1/31/00- 8/31/02	3.91	4.70	lbs/day	10.63	13.60	13.60	mg/L
		pH		31	monthly 1/31/00- 8/31/02	---	---	---	7.08	---	7.79	Standard Units
		Total Suspended Solids		31	monthly 1/31/00- 8/31/02	7.48	10.19	lbs/day	18.82	27.84	27.84	mg/L
		E.coli (Thermotol, MF, M-TEC)		31	monthly 1/31/00- 8/31/02	---	---	---	10.68	---	258.94	#/100mL
		Flow, in conduit or thru treatment plant		31	monthly 1/31/00- 8/31/02	0.04	0.05	MGD	---	---	---	---
		Chlorine, Total residual		31	monthly 1/31/00- 8/31/02	---	---	---	---	---	0.79	mg/L

[1] All discharges through outfall 001A, except as noted

[2] Discharges through outfall 001B

Unit Abbreviations:

MGD= Million gallons per day
mg/L= Milligrams per liter
μg/l= Micrograms per liter
#/100mL= Number per 100 milliliters
lbs/day= Pounds per day

4.3 WWTP Discharge Quantity and Quality during Wet Weather Events

Daily records of wastewater treatment plant operations were collected from the sponsor communities, and the available data were analyzed to identify relationships between precipitation and the quality and quantity of treatment plant effluent. Data from the Nashua plant was the most comprehensive, and so it was used as representative data in the analysis described below.

The period of record analyzed was January 2001 through December 2002. The analysis consisted of two exercises:

- Determine if any empirical correlation can be identified between daily precipitation volume and either daily effluent quantity or daily effluent quality (using BOD as the indicator of quality)

- Determine if a more general relationship can be identified to help quantify the impacts of precipitation on effluent volume and quality

The data yielded no apparent correlation between daily precipitation volume and daily effluent quantity or quality. Likewise, there was no apparent correlation between daily precipitation and the *change* in effluent quantity or quality from the previous day. Comparatively low and comparatively high values of effluent flow and BOD concentration were evident on days with high precipitation volume and on days with low precipitation volume.

A more generalized analysis produced the results listed in Table 4-5. Daily records over the two-year period were sorted into three categories:

- Days with no precipitation

- Days with precipitation less than 0.5 inches

- Days with precipitation greater than 0.5 inches

The results suggest that precipitation leads to increased volume of discharge at the treatment plant, but that total pollutant mass load does not increase commensurately. The highest mass loads appear to be associated with small-scale storms (less than 0.5-inches of precipitation).

Table 4-5: Summary of Nashua WWTP Effluent Records, 2001-2002

Precipitation Conditions	Number of Days in Record	Average Effluent Discharge (MGD)	Average Effluent BOD (lbs/day)
No precipitation	508	11.8	1,278
Precipitation <0.5-in	175	13.4	1,495
Precipitation >0.5-in	46	15.2	1,263

4.4 Summary

A total of 46 municipal and privately-owned WWTP were identified in the Merrimack River watershed. Of these, 32 are classified as major dischargers, with permitted discharges greater than one million gallons per day. Monthly monitoring data were collected from the USEPA for plant effluents from each of these treatment facilities between 1997 and 2002 (as available). Table 4-6 presents a summary of the total WWTP flows in the subwatershed areas defined for this study.

Table 4-6: Summary of Total WWTP Discharge Flows in the Merrimack River Watershed

Drainage Area Category	Total WWTP Flow (MGD)
Sponsor Communities	108
Mainstem Merrimack River	23.3
Major Tributaries	44.7
TOTAL=	**176**

MGD= Million gallons per day

The largest WWTP flows are discharged to the Merrimack River from the sponsor communities, at a total of 108 MGD or 167 cubic feet per second (cfs). This flow is relatively small in comparison to the average annual flow of the Merrimack River at 7697 cfs (as measured at the USGS gaging station in Lowell, Massachusetts). However, it represents a more significant portion of the flows during the summer months, when average August streamflow is 2802 cfs in Lowell, and at the more critical 7Q10 level of 950 cfs. For regulatory purposes in Massachusetts, the 7Q10 is defined as "*the lowest flow condition at and above which [water quality] criteria must be met is the lowest mean flow for seven consecutive days to be expected once every ten years*" (314 CMR 4.00).

Section 5
Industrial Point Sources

This section provides a summary of industrial point source dischargers in the Merrimack River watershed and provides information on the average quality and quantity of discharges to the mainstem Merrimack River. Information presented in this section was obtained from the following sources:

- Worldwide web at the US Environmental Protection Agency's (USEPA) Permit Compliance System (PCS) website, which provides information on permit issuance and expiration dates, allowable discharge limits, and limited monitoring data (http://www.epa.gov/enviro/html/pcs/index.html)
- Personal communication with Robin Neas, Environmental Protection Specialist, in the USEPA's Water Technical Unit (SEW), Office of Environmental Stewardship (OES) on March 21, 2003

5.1 Summary of Dischargers

According to information received from the USEPA on March 21, 2003, there are 48 industrial facilities that currently discharge in the Merrimack River watershed. Of these, 11 (or 23-percent) are classified as "major" dischargers by the USEPA; the remaining 37 are classified as "minor" dischargers. The USEPA defines major dischargers as those facilities with design flows greater than one million gallons per day.

Table 5-1 provides a summary of the industrial dischargers in the basin, as well as the NPDES permit number, SIC code, facility location, receiving waterbody, date of permit issuance, and permit expiration date. The dischargers are separated into categories based on the drainage area delineations provided in Table 3-2 and Figure 3-1. According to information downloaded from the USEPA's PCS website on January 8, 2002, six of the dischargers are currently operating under expired NPDES permits.

Table 5-1: Summary of Industrial Point Source Discharges in the Merrimack River Watershed [1]

Category	Subwatershed	NPDES ID	SIC Code	Facility Name	Location	Receiving Waters	Major?	Date Issued	Date Expired
Sponsor Communities	Manchester, NH	NH0020532	3641	Osram Sylvania Inc.	Manchester, NH	Nutt Pond		10/21/1975	**8/1/1980**
		NH0000116	2821	Nylon Corporation of America	Manchester, NH	Merrimack River		6/1/2001	7/1/2006
	Nashua, NH	NH0000591	2899	Hampshire Chemical Corp.	Nashua, NH	Merrimack River	Yes	9/28/1993	**1/1/1900**
	Lowell, MA	MAG250011	2295	Majilite Manufacturing Inc.	Lowell, MA	River Meadow Brook to Concord RWS		2/23/2001	4/25/2005
		MAG250163	4911	Eldred L. Field Powerhouse	Lowell, MA	Merrimack River		9/26/2000	4/25/2005
		MAG250732		Lowell National Historical Park	Lowell, MA	Merrimack River		11/21/2000	4/25/2005
		MAG250949	4911	Hamilton Power Station	Lowell, MA	Merrimack River		9/26/2000	4/25/2005
		MAG250950	4911	Boot Hydropower, Inc.	Lowell, MA	Merrimack River		9/26/2000	4/25/2005
		MAG640055	4941	Lowell Regional Water Utility	Lowell, MA	Merrimack River		6/19/2001	11/15/2005
	Lawrence, MA	MAG250813	3069	Newark Atlantic Paperboard Corp.	Lawrence, MA	Merrimack River		6/22/2001	4/25/2005
		MAG250948	4911	Lawrence Hydroelectric Assoc.	Lawrence, MA			9/26/2000	4/25/2005
	Haverhill, MA	MAG250961	2631	Haverhill Paperboard Corp.	Haverhill, MA	Merrimack River		9/8/2000	4/25/2005
Mainstem Merrimack River	Upper Merrimack	NH0001465	4911	Public Service of New Hampshire	Bow, NH	Merrimack River	Yes	6/25/1992	**7/25/1997**
		NH0000230	2621	Monadnock Paper Mills Inc.	Bennington, NH	Contoocook River	Yes	10/23/2000	12/21/2005
		NH0021652	4911	Bio-Energy Corporation	West Hopkinton, NH	Contoocook River via Hydro Raceway	Yes	2/18/2000	4/3/2005
		NH0100820	8211	Kearsage Regional High School	North Sutton, NH	Warner River		12/23/1986	**12/23/1991**
	Merrimack Corridor 3	MA0020231	1411	Fletcher Granite Co, Inc.	Westford, MA	Trib-Stony Brook to Gilsum Brook		9/30/1997	**9/30/2001**
		MAG250954	2033	Stickney & Poor Spice Co.	Chelmsford, MA	River Meadow Brook		9/8/2000	4/25/2005
		MAG640057	4941	East Chelmsford WTF	Chelmsford, MA	Unnamed tributary to River Meadow		7/20/2001	11/15/2005
		MA0030066	4212	Browning-Ferris Industries, Inc.	Tynsborough, MA	Bridge Meadown Brook/ Deep Brook		9/26/1997	9/26/2002
	Merrimack Corridor 4	MAG640058	4941	Andover WTP	Andover, MA	Haggetts Pond		8/30/2001	11/15/2005
	Merrimack Corridor 5	MA0001261	3661	Lucent Technologies, Inc.	North Andover, MA	Merrimack River		7/2/2002	8/2/2006
		MAG250012	3089	Sweetheart Cup Co., Inc.	North Andover, MA	Unnamed tributary to River Meadow		4/27/2001	4/25/2005
	Merrimack Corridor 6	MA0000281	3613	Ferraz Shawmut, Inc.	Newburyport, MA	Merrimack River	Yes	9/30/2002	9/30/2006
		MAG640018	4941	Newburyport WTP	Newburyport, MA	Merrimack River Basin		8/29/2001	11/15/2005
		MAG640030	4941	Merrimac Water Treatment Plant	Merrimac, MA	Lake Attitask		10/10/2001	11/15/2005
Major Tributaries	Assabet River	MAG250006	2295	Haartz Corporation	Acton, MA	Stormdrain Conant Brook Assabet River		10/27/2000	4/25/2005
		MAG640007	4941	Westborough WPF	Westborough, MA	Hocomonco Pond- Assabet to Concord		6/28/2001	11/15/2005
	Concord River	MAG250970	8731	Aerodyne Research Inc.	Billerica, MA	Wetland Nutting Lake Concord RWS		6/13/2001	4/25/2005
		MAG640049	4941	Howe Street Regional WTF	Ashland, MA	Hopkinton Reservior- Concord River		3/26/2002	11/15/2005
		MAG640056	4941	Sudbury Greensand FTP Well 8	Sudbury, MA	Hop Brook- Concord River		8/6/2001	11/15/2005
	Lower Nashua	MA0000108	3291	Bay State/Sterling Inc.	Westborough, MA	Rutters Brook to Sudbury River		3/31/1975	**3/31/1980**
		MA0022799	3471	ECC Corporation	Holden, MA	Asnebemskit Brook		8/13/2002	10/13/2005
		MA0028801	8733	Alden Reseach Laboratory	Holden, MA	Chaffins Brook		11/1/2001	10/31/2005
		MA0025763	8051	River Terrace Healthcare	Lancaster, MA	North Nashua via Stormdrain		9/11/1995	10/11/2000
		MAG250864	2821	BF Goodrich Performance Mat.	Leominster, MA	Storm Sewer Monoosnoc Brook N. Branch		9/15/2000	4/25/2005
	Upper Nashua	MAG640061		Pepperell Paper Co. Inc.	Pepperell, MA	Nashua River		8/8/2002	11/15/2005
		MA0032034	4931	Indeck Pepperell Power Assoc.	Pepperell, MA	Nashua River- James River WWTP		9/26/1995	9/26/2000
		MA0004561	2621	Hollingsworth & Vose	Groton, MA	Squannacook River	Yes	9/11/1995	10/11/2000
		MA0033324	8211	Groten School	Groton, MA	Nashua River		6/21/2002	9/30/2005
	Pemigewasset River	NH0022021	4911	Bridgewater Power Company	Ashland, NH	Pemigewasset River	Yes	9/15/2000	9/15/2005
	Piscataquog River	NH0090077	9711	New Boston Air Station	New Boston, NH	Beaver Pond via Unnamed Stream	Yes	4/7/2000	5/22/2005
	Stony Brook	MA0004936	2033	Veryfine Products, Inc.	Littleton, MA	Reedy Meadow Brook	Yes	3/22/2000	3/22/2005
		MA0024414	3471	Westford Anodizing Corp.	Graniteville, MA	Stony Brook	Yes	8/8/2002	7/31/2006
	Sudbury River	MAG250016	2893	Superior Printing Ink Co. Inc.	Marlborough, MA	Sudbury Reservoir		4/5/2002	4/25/2005
		MAG250830	2893	Gotham Ink	Marlborough, MA	Mowry Brook to SuAsCo		8/7/2001	4/25/2005
		MA0039853	7389	Wayland WWTP	Wayland, MA	Wetland to Sudbury River		9/4/1998	10/4/2003
	Winnipesaukee River	NH0001023	3621	Wyman-Gordon	Northfileld, NH	Winnipesaukee River	Yes	8/23/2001	8/23/2006

[1]Source: USEPA PCS (http://www.epa.gov/enviro/html/pcs/) or Robin Neas (personal communication), except as noted

No Industrial Discharges: Merrimack River Corridor 1 & 2, Beaver Brook, Cohas Brook, Powwow River, Salmon Brook, Shawsheen River, Souhegan River, Spickett River

5.2 Quantity and Quality of Industrial Point Sources on the Mainstem Merrimack River

The following section provides a summary of the permitted effluent limits and the effluent quantity and quality for industrial point sources discharging to the mainstem Merrimack River. As with the WWTP data, this information was compiled from a database of results from monthly monitoring reports submitted to USEPA by each of the respective dischargers in accordance with their NPDES permits. The USEPA supplied CDM with this database for monthly reports generally submitted between 1997 and 2002; however, in some cases, only information from a limited number of years was available.

The database provided a single monthly value for each water quality constituent under the following categories where information was available:

- Reported value for the quantity average (as appropriate)
- Reported value for the quantity maximum (as appropriate)
- Reported value for the concentration minimum
- Reported value for the concentration average
- Reported value for the concentration maximum

Table 5-2 provides a summary of the permit effluent limits for each of the industrial point sources which discharge to the mainstem Merrimack River. Table 5-3 provides a summary of the average, maximum, and minimum effluent quantity and quality for each of the industrial dischargers.

Table 5.2- Summary of Pollutant Effluent Limits for Industrial Dischargers along the Merrimack River Mainstem

NPDES ID	Permit Facility Name	Parameter	Ave. Quantity Limit[1]	Max. Quantity Limit[1]	Quantity Unit	Min. Conc. Limit[1]	Ave. Conc. Limit[1]	Max. Conc. Limit[1]	Concentration Unit
MA0000281	Ferraz Shawmut, Inc.	Temperature, deg F	---	---	---	DELMON	DELMON	85	deg F
		pH	---	---	---	6.5	DELMON	8.5	Standard Units
		Solids, Total Suspended	---	---	---	DELMON	20	30	mg/L
		Cyanide, Total (As Cn)	---	---	---	---	0.25	0.65	mg/L
		Chromium, Total (As Cr)	---	---	---	---	1.71	2.77	mg/L
		Copper, Total (As Cu)	---	---	---	DELMON	2.07	3.38	mg/L
		Zinc, Total (as Zn)	---	---	---	DELMON	1.48	2.61	mg/L
		Flow, in conduit or thru treatment plant	20,000	30,000	GPD	---	---	---	---
NH0000591	Hampshire Chemical Corporation	BOD, 5-Day (20 Deg. C)	119	318	lbs/day	DELMON	ADDMON	ADDMON	mg/L
		pH	---	---	---	6.5	---	9	Standard Units
		Solids, Total Suspended	151	485	lbs/day	DELMON	ADDMON	ADDMON	mg/L
		Nitrogen, Ammonia Total (as N)	730&146	1720&459	lbs/day	DELMON	ADDMON	ADDMON	mg/L
		Phosphorus, Total (as P)	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Cyanide, Total (As Cn)	2.54	8.64	lbs/day	DELMON	ADDMON	ADDMON	mg/L
		Chromium, Total (As Cr)	0.55	1.79	lbs/day	DELMON	ADDMON	ADDMON	mg/L
		Copper, Total (As Cu)	0.6	0.9	lbs/day	DELMON	ADDMON	ADDMON	mg/L
		Zinc, Total (as Zn)	2.9	4.3	lbs/day	DELMON	ADDMON	ADDMON	mg/L
		Flow, in conduit or thru treatment plant	ADDMON	0.55	MGD	---	---	---	---
NH0001465	P.S. of NH-Merrimack Station	Oxygen, Dissolved (Percent Saturation)	---	---	---	75	DELMON	DELMON	Percent
		pH	---	---	---	6.5	DELMON	8	Standard Units
		Solids, Total Suspended	---	---	---	DELMON	30	100	mg/L
		Copper, Total (As Cu)	---	---	---	DELMON	DELMON	0.2	mg/L
		Flow, in conduit or thru treatment plant	265.3	275.4	MGD	---	---	---	---
MAG250011	Majilite Manufacturing Inc.	Temperature, deg F	---	---	---	DELMON	ADDMON	83	deg F
		pH	---	---	---	6.5	---	8.3	Standard Units
		Flow, in conduit or thru treatment plant	DELMON	1	MGD	---	---	---	---
MAG250012	Sweetheart Cup Company	Temperature, deg F	---	---	---	---	ADDMON	83	deg F
		pH	---	---	---	6.5	---	8.3	Standard Units
		Flow, in conduit or thru treatment plant	DELMON	1	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	DELMON	ADDMON	ADDMON	µg/L
MAG250163	Boott Hydropowe- E.L. Field	Temperature, deg F	---	---	---	DELMON	ADDMON	83	deg F
		pH	---	---	---	6.5	---	8.3	Standard Units
		Flow, in conduit or thru treatment plant	DELMON	1	MGD	---	---	---	---
MAG250732	Lowell National Historic Park	Temperature, deg F	---	---	---	DELMON	ADDMON	83	deg F
		pH	---	---	---	6.5	---	8.3	Standard Units
		Flow, in conduit or thru treatment plant	DELMON	1	MGD	---	---	---	---
MAG250813	Newark Atlantic Paperboard	Temperature, deg F	---	---	---	DELMON	ADDMON	83	deg F
		pH	---	---	---	6.5	---	8.3	Standard Units
		Flow, in conduit or thru treatment plant	DELMON	0.5	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	DELMON	ADDMON	ADDMON	µg/L
MAG250948	Lawrence Hydroelectric Assoc.	Temperature, deg F	---	---	---	DELMON	ADDMON	83	deg F
		pH	---	---	---	6.5	---	8.3	Standard Units
		Flow, in conduit or thru treatment plant	DELMON	1	MGD	---	---	---	---
MAG250949	Boott Hydropower- Hamilton	Temperature, deg F	---	---	---	DELMON	ADDMON	83	deg F
		pH	---	---	---	6.5	---	8.3	Standard Units
		Flow, in conduit or thru treatment plant	DELMON	1	MGD	---	---	---	---
MAG250950	Boott Hydropower- John St. Station	Temperature, deg F	---	---	---	DELMON	ADDMON	83	deg F
		pH	---	---	---	6.5	---	8.3	Standard Units
		Flow, in conduit or thru treatment plant	DELMON	1	MGD	---	---	---	---
MAG250954	Stickney & Poor Spice Co.	Temperature, deg F	---	---	---	DELMON	ADDMON	83	deg F
		pH	---	---	---	6.5	---	8.3	Standard Units
		Flow, in conduit or thru treatment plant	DELMON	1	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	DELMON	ADDMON	ADDMON	µg/L
MAG250961	Haverhill Paperboard Corp.	Temperature, deg F	---	---	---	DELMON	ADDMON	83	deg F
		pH	---	---	---	6.5	---	8.3	Standard Units
		Flow, in conduit or thru treatment plant	DELMON	1	MGD	---	---	---	---
MAG640018	Newburyport WTP	pH	---	---	---	6.5	---	8.5	Standard Units
		Solids, Total Suspended	---	---	---	DELMON	30	50	mg/L
		Aluminum, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Flow, in conduit or thru treatment plant	DELMON	0.226	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	DELMON	ADDMON	ADDMON	µg/L

NPDES ID	Permit Facility Name	Parameter	Ave. Quantity Limit[1]	Max. Quantity Limit[1]	Quantity Unit	Min. Conc. Limit[1]	Ave. Conc. Limit[1]	Max. Conc. Limit[1]	Concentration Unit
MAG640030	Merrimac WTP	pH	---	---	---	6.5	---	8.3	Standard Units
		Solids, Total Suspended	---	---	---	DELMON	30	50	mg/L
		Flow, in conduit or thru treatment plant	DELMON	1	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	DELMON	ADDMON	ADDMON	µg/L
MAG640055	Lowell Regional WTF	pH	---	---	---	6.5	---	8.3	Standard Units
		Solids, Total Suspended	---	---	---	DELMON	30	50	mg/L
		Aluminum, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Flow, in conduit or thru treatment plant	DELMON	1	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	DELMON	ADDMON	ADDMON	µg/L
MAG640057	East Chelmsford WTP	pH	---	---	---	6.5	---	8.3	Standard Units
		Solids, Total Suspended	---	---	---	DELMON	30	50	mg/L
		Flow, in conduit or thru treatment plant	DELMON	1	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	DELMON	ADDMON	ADDMON	µg/L
MAG640058	Andover WTP	pH	---	---	---	6.5	---	8.3	Standard Units
		Solids, Total Suspended	---	---	---	DELMON	30	50	mg/L
		Aluminum, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Flow, in conduit or thru treatment plant	DELMON	0.83	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	DELMON	ADDMON	ADDMON	mg/L
		pH	---	---	---	8.3	---	6.5	Standard Units
		Solids, Total Suspended	---	---	---	DELMON	30	50	mg/L
		Aluminum, Total Recoverable	---	---	---	DELMON	DELMON	ADDMON	mg/L
		Flow, in conduit or thru treatment plant	DELMON	1.5	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	DELMON	ADDMON	ADDMON	mg/L
MA0001261	Lucent Technologies, Inc.	Temperature, deg F	---	---	---	DELMON	DELMON	90	deg F
		BOD, 5-Day (20 Deg. C)	---	---	---	30	45	50	mg/L
		BOD, 5-Day (20 Deg. C)	---	---	---	30	45	ADDMON	mg/L
		pH	---	---	---	6.5	---	8.5	Standard Units
		Solids, Total Suspended	---	---	---	30	45	ADDMON	mg/L
		Cyanide, Total (As Cn)	---	---	---	---	0.5	1	mg/L
		Chromium, Total (As Cr)	---	---	---	---	1.5	2	mg/L
		Copper, Total (As Cu)	---	---	---	---	1.5	2	mg/L
		Lead, Total (As Pb)	---	---	---	---	0.43	0.69	mg/L
		Nickel, Total (as Ni)	---	---	---	---	2.38	3	mg/L
		Flow, in conduit or thru treatment plant	1	1.3	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	DELMON	DELMON	1	mg/L
		Coliform, Fecal (General)	---	---	---	200	200	400	#/100mL
MA0020231	Fletcher Granite Company	pH	---	---	---	6.5	DELMON	8.3	Standard Units
		Solids, Total Suspended	---	---	---	DELMON	20	40	mg/L
		Flow, in conduit or thru treatment plant	ADDMON	ADDMON	MGD	---	---	---	---
MA0030066	Browning-Ferris Industries, Inc.	pH	---	---	---	DELMON	DELMON	ADDMON	Standard Units
		Solids, Total Suspended	---	---	---	DELMON	DELMON	60	mg/L
		Copper, Total (As Cu)	---	---	---	DELMON	DELMON	5	mg/L
		Lead, Total (As Pb)	---	---	---	DELMON	DELMON	5	mg/L
		Flow, in conduit or thru treatment plant	ADDMON	ADDMON	MGD	---	---	---	---
NH0020532	Osram Sylvania, Inc.	Temperature, deg F	---	---	---	---	---	83	deg F
		pH	---	---	---	6.5	---	8	Standard Units
		Flow, in conduit or thru treatment plant	0.2	DELMON	MGD	---	---	---	---
NH0000116	Nylon Corporation of America	Temperature, deg F	---	---	---	DELMON	ADDMON	83	deg F
		pH	---	---	---	ADDMON	DELMON	ADDMON	Standard Units
		Flow, in conduit or thru treatment plant	ADDMON	2	MGD	---	---	---	---
		Chlorine, Total Residual	---	---	---	DELMON	1	1	mg/L

[1]ADDMON= Monitoring/ reporting without limit
DELMON= Monitoring/ reporting not required

Unit Abbreviations:
MGD= Million gallons per day
GPD= Gallons per day
mg/L= Milligrams per liter
µg/l= Micrograms per liter
#/100mL= Number per 100 milliliters
lbs/day= Pounds per day

Table 5-3: Concentration and Discharge Statistics for Major and Minor Industrial Dischargers along the Mainstem Merrimack River

NPDES Permit #	Facility Name	WQ Parameter	No. of monitoring reports that average is based on	Merasurement monitoring report frequency	Reported value for the quantity average	Reported value for the quantity maximum	Quantity Unit	Reported value for the concentration minimum	Reported value for the concentration average	Reported value for the concentration maximum	Concentration Unit
MA0000281	Ferraz Shawmut, Inc.	Temperature, deg F	62	monthly 10/31/97-11/30/02	---	---	---	---	---	71.57	deg F
		pH	72	monthly 1/31/97- 12/31/02	---	---	---	6.75	---	7.47	Standard Units
		Total Suspended Solids	72	monthly 1/31/97- 12/31/02	---	---	---	---	1.20	1.81	mg/L
		Cyanide, Total (as Cn)	9	monthly 1/31/97-9/30/02	---	---	---	---	0	0	mg/L
		Chromium, Total (as Cr)	71	monthly 1/31/97- 11/30/02	---	---	---	---	0.002	0.002	mg/L
		Copper, Total (as Cu)	72	monthly 1/31/97- 11/30/02	---	---	---	---	0.11	0.11	mg/L
		Zinc, Total (as Zn)	72	monthly 1/31/97- 12/31/02	---	---	---	---	0.05	0.05	mg/L
		Flow, in conduit or thru treatment plant	72	monthly 1/31/97- 12/31/02	7,142.23	10,910	GPD	---	---	---	---
NH0000591	Hampshire Chemical Corporation	BOD, 5-day (20 Deg. C)	72	monthly 1/31/97- 12/31/02	50.76	108.12	lbs/day	---	24.15	49.93	mg/L
		pH	72	monthly 1/31/97- 12/31/02	---	---	---	7.25	---	8.43	Standard Units
		Total Suspended Solids	72	monthly 1/31/97- 12/31/02	94.97	181.01	lbs/day	---	43.55	81.55	mg/L
		Nitrogen, Ammonia Total (as N)	72	monthly 1/31/97- 12/31/02	130.54	208.74	lbs/day	---	56.05	86.15	mg/L
		Phosphorus, Total (as P)	72	monthly 1/31/97- 12/31/02	---	---	---	---	---	119.83	mg/L
		Chromium, Total (as Cr)	72	monthly 1/31/97- 12/31/02	0.14	0.21	lbs/day	---	0.06	0.09	mg/L
		Copper, Total (as Cu)	72	monthly 1/31/97- 12/31/02	0.14	0.22	lbs/day	---	0.07	0.09	mg/L
		Zinc, Total (as Zn)	72	monthly 1/31/97- 12/31/02	1.10	1.44	lbs/day	---	0.50	0.61	mg/L
		Flow, in conduit or thru treatment plant	72	monthly 1/31/97- 12/31/02	0.25	0.36	MGD	---	---	---	---
NH0001465	P.S. of NH- Merrimack Station	Oxygen, Dissolved (Percent Saturation)	72	monthly 1/31/97- 12/31/02	---	---	---	89.65	---	---	mg/L
		pH	72	monthly 1/31/97- 12/31/02	---	---	---	6.52	---	7.25	Standard Units
		Flow, in conduit or thru treatment plant	72	monthly 1/31/97- 12/31/02	237.77	253.73	MGD	---	---	---	---
MA0001261	Lucent Technologies, Inc.	Temperature, deg F	24	monthly 1/31/00- 12/31/01	---	---	---	---	---	63.02	deg F
		pH	24	monthly 1/31/00- 12/31/01	---	---	---	7.91	---	8.11	Standard Units
		Chromium, Total (as Cr)	24	monthly 1/31/00- 12/31/01	---	---	---	---	0.02	0.03	mg/L
		Copper, Total (as Cu)	24	monthly 1/31/00- 12/31/01	---	---	---	---	0.09	0.11	mg/L
		Flow, in conduit or thru treatment plant	24	monthly 1/31/00- 12/31/01	0.01	0.03	MGD	---	---	---	---
		Chlorine, Total Residual	24	monthly 1/31/00- 12/31/01	---	---	---	---	---	0.15	mg/L
MA0020231	Fletcher Granite Company	Turbidity	62	monthly 1/31/00- 8/31/02	---	---	---	---	5.39	5.79	mg/L
		pH	62	monthly 1/31/00- 8/31/02	---	---	---	7.22	---	7.46	Standard Units
		Total Suspended Solids	62	monthly 1/31/00- 8/31/02	---	---	---	---	6.49	6.80	mg/L
		Flow, in conduit or thru treatment plant	62	monthly 1/31/00- 8/31/02	1.09	1.12	MGD	---	---	---	---
MA0030066	Browning-Ferris Industries, Inc.	pH	69	twice per month 1/31/00- 8/31/02	---	---	---	---	---	6.04	Standard Units
		Total Suspended Solids	139	various 1/31/00- 8/31/02	---	---	---	---	---	26.96	mg/L
		Copper, Total (as Cu)	53	various 3/31/00- 8/31/02	---	---	---	---	---	2.75	mg/L
		Lead, Total (as Pb)	49	various 3/31/00- 8/31/02	---	---	---	---	---	6.80	mg/L
		Flow, in conduit or thru treatment plant	95	various 1/31/00- 8/31/02	---	2.01	MGD	---	---	---	---
NH0020532	Osram Sylvania Inc.	Temperature, deg F	5	bi-annual- 5/31/00- 5/31/02	---	---	---	55.00	65.20	74.60	deg F
		pH	5	bi-annual- 5/31/00- 5/31/02	---	---	---	6.44	---	6.90	Standard Units
		Flow, in conduit or thru treatment plant	5	bi-annual- 5/31/00- 5/31/02	0.03	---	MGD	---	---	---	---
NH0000116	Nylon Corporation of America	Temperature, deg F	14	monthly 7/31/01- 7/31/02	---	---	---	---	63.86	71.50	deg F
		pH	14	monthly 7/31/01- 7/31/02	---	---	---	6.37	---	6.81	Standard Units
		Flow, in conduit or thru treatment plant	14	monthly 7/31/01- 7/31/02	0.66	0.94	MGD	---	---	---	---
		Chlorine, Total residual	14	monthly 7/31/01- 7/31/02	---	---	---	---	0.21	0.50	mg/L
MAG250011	Majilite Manufacturing, Inc.	Temperature, deg F	15	monthly 3/31/01- 6/30/02	---	---	---	---	63.40	---	deg F
		pH	15	monthly 3/31/01- 6/30/02	---	---	---	7.50	---	7.22	Standard Units
		Flow, in conduit or thru treatment plant	10	approx. monthly 3/31/01- 6/30/02	---	4572	GPD	---	2300.00	---	---
MAG250012	Sweetheart Cup Company	Temperature, deg F	11	monthly 7/31/01-6/30/02	---	---	---	32.89	38.26	55.54	deg F
		pH	13	monthly 5/31/01-6/30/02	---	---	---	7.87	---	8.00	Standard Units
		Flow, in conduit or thru treatment plant	13	monthly 5/31/01-6/30/02	---	0.01	MGD	---	---	---	---
MAG250163	Boott Hydropower- E. L. Field	Temperature, deg F	21	monthly 10/31/00- 6/30/02	---	---	---	---	53.76	58.72	deg F
		pH	21	monthly 10/31/00- 6/30/02	---	---	---	7.06	---	7.46	Standard Units
		Flow, in conduit or thru treatment plant	21	monthly 10/31/00- 6/30/02	---	0.23	MGD	---	---	---	---
MAG250732	Lowell National Historic Park	Temperature, deg F	30	monthly 1/31/00- 6/30/02	---	---	---	---	71.15	76.00	deg F
		pH	30	monthly 1/31/00- 6/30/02	---	---	---	6.45	---	6.85	Standard Units
		Flow, in conduit or thru treatment plant	20	various 1/31/00- 6/30/02	---	1.00	MGD	---	---	---	---
MAG250813	Newark Atlantic Paperboard	Temperature, deg F	12	monthly 7/31/01- 6/30/02	---	---	---	---	47.57	573.89	deg F
		pH	12	monthly 7/31/01- 6/30/02	---	---	---	6.86	---	7.12	Standard Units
		Flow, in conduit or thru treatment plant	12	monthly 7/31/01- 6/30/02	---	0.16	MGD	---	---	---	---
MAG250948	Lawrence Hydroelectric Assoc.	Temperature, deg F	21	monthly 10/31/00- 7/15/02	---	---	---	---	53.71	58.72	deg F
		pH	21	monthly 10/31/00- 7/15/02	---	---	---	10.05	---	7.47	Standard Units
		Flow, in conduit or thru treatment plant	21	monthly 10/31/00- 7/15/02	---	0.73	MGD	---	---	---	---

NPDES Permit #	Facility Name	WQ Parameter	No. of monitoring reports that average is based on	Merasurement monitoring report frequency	Reported value for the quantity average	Reported value for the quantity maximum	Quantity Unit	Reported value for the concentration minimum	Reported value for the concentration average	Reported value for the concentration maximum	Concentration Unit
MAG250949	Boott Hydropower- Hamilton	Temperature, deg F	21	monthly 10/31/00- 6/30/02	---	---	---	---	54.50	57.20	deg F
		pH	21	monthly 10/31/00- 6/30/02	---	---	---	7.14	7.40	7.48	Standard Units
		Flow, in conduit or thru treatment plant	21	monthly 10/31/00- 6/30/02	---	0.00	MGD	---	---	---	---
MAG250950	Boott Hydropower- John St. Station	Temperature, deg F	21	monthly 10/31/00- 6/30/02	---	---	---	---	53.90	57.20	deg F
		pH	21	monthly 10/31/00- 6/30/02	---	---	---	7.11	7.62	7.49	Standard Units
		Flow, in conduit or thru treatment plant	21	monthly 10/31/00- 6/30/02	---	0.01	MGD	---	---	---	---
MAG250954	Stickney & Poor Spice Co.	Temperature, deg F	15	monthly 4/30/01- 6/30/02	---	---	---	---	75.07	81.80	deg F
		pH	15	monthly 4/30/01- 6/30/02	---	---	---	6.57	---	6.96	Standard Units
		Flow, in conduit or thru treatment plant	15	monthly 4/30/01- 6/30/02	---	0.004	MGD	---	---	---	---
MAG250961	Haverhill Paperboard Corp.	Temperature, deg F	16	various 9/30/00- 6/30/02	---	---	---	---	76.82	82.13	deg F
		pH	16	various 9/30/00- 6/30/02	---	---	---	7.00	---	7.55	Standard Units
		Flow, in conduit or thru treatment plant	16	various 9/30/00- 6/30/02	---	2.19	MGD	---	---	---	---
MAG640018	Newburyport Water Treatment Plant	pH	7	various 9/30/01- 6/30/02	---	---	---	6.27	---	6.89	Standard Units
		Total Suspended Solids	7	various 9/30/01- 6/30/02	---	---	---	---	0.00	0.00	mg/L
		Aluminum, Total recoverable	10	monthly 9/30/01- 6/30/02	---	---	---	---	---	0.22	mg/L
		Flow, in conduit or thru treatment plant	9	monthly 9/30/01- 6/30/02	---	0.06	MGD	---	---	---	---
MAG640030	Merrimac Water Treatment Plant	pH	7	monthly 12/31/01- 6/30/02	---	---	---	7.91	---	8.77	Standard Units
		Total Suspended Solids	6	monthly 1/31/02- 6/30/02	---	---	---	---	4.26	16.67	mg/L
		Flow, in conduit or thru treatment plant	9	monthly 10/31/01- 6/30/02	---	28,333	GPD	---	---	---	---
		Chlorine, Total Residual	7	monthly 12/31/01- 6/30/02	---	---	---	---	0.48	0.75	μg/L
MAG640055	Lowell Regional Water Treatment Facility	pH	12	monthly 7/31/01- 6/30/02	---	---	---	6.47	---	6.71	Standard Units
		Total Suspended Solids	12	monthly 7/31/01- 6/30/02	---	---	---	---	4.61	10.70	mg/L
		Aluminum, Total recoverable	12	monthly 7/31/01- 6/30/02	---	---	---	---	---	0.12	mg/L
		Flow, in conduit or thru treatment plant	12	monthly 7/31/01- 6/30/02	---	0.93	MGD	---	---	---	---
		Chlorine, Total Residual	12	monthly 7/31/01- 6/30/02	---	---	---	---	627.25	854.17	μg/L
MAG640057	East Chelmsford Water Treatment Plant	pH	9	monthly 10/31/01- 6/30/02	---	---	---	6.23	---	6.27	Standard Units
		Total Suspended Solids	9	monthly 10/31/01- 6/30/02	---	---	---	---	27.61	40.78	mg/L
		Flow, in conduit or thru treatment plant	9	monthly 10/31/01- 6/30/02	---	0.30	MGD	---	---	---	---
		Chlorine, Total Residual	9	monthly 10/31/01- 6/30/02	---	---	---	---	0.97	1.09	μg/L
MAG640058	Andover Water Treatment Plant	pH	10	various 10/31/01- 3/31/02	---	---	---	6.43	---	6.64	Standard Units
		Total Suspended Solids	10	various 10/31/01- 3/31/02	---	---	---	---	25.90	33.30	mg/L
		Aluminum, Total recoverable	9	various 12/31/01- 3/31/02	---	---	---	---	---	2.67	mg/L
		Flow, in conduit or thru treatment plant	10	various 10/31/01- 3/31/02	---	0.58	GPD	---	---	---	---
		Chlorine, Total Residual	10	various 10/31/01- 3/31/02	---	---	---	---	0.06	0.09	mg/L

Unit Abbreviations:

MGD= Million gallons per day
GPD= Gallons per day
mg/L= Milligrams per liter
μg/l= Micrograms per liter
#/100mL= Number per 100 milliliters
lbs/day= Pounds per day

5.3 Summary

A total of 48 industrial facilities currently discharge in the Merrimack River watershed. Of these, 11 are classified as major dischargers, with design flows greater than one million gallons per day. Monthly monitoring data was collected from the USEPA for plant effluents from each of these treatment facilities between 1997 and 2002 (as available). Table 5-4 presents a summary of the total industrial discharge flows in each of the drainage area categories developed for this project, which comprise the Merrimack River watershed. Values for maximum flows were used for those dischargers where average data was not available.

Table 5-4: Summary of Total Industrial Discharge Flows in the Merrimack River Watershed

Drainage Area Category	Total Flow (MGD)
Sponsor Communities	6.19
Mainstem Merrimack River[1]	243
Major Tributaries	4.10
TOTAL=	**253**

[1]Note: 238 MGD of flow is from a single discharger- P.S. of New Hampshire
MGD= Million gallons per day

As with the WWTPs, the largest industrial flows are discharged to the Merrimack River at approximately 253 MGD (392 cfs). It is important to note that 238 MGD of this total flow (or 94-percent) may be attributed to one discharger, the Public Service of New Hampshire (PSNH), which operates a hydropower facility on the mainstem Merrimack River; the permitted flow is a cooling water discharge.

Again, these industrial discharges are low in comparison to the average annual flow of the Merrimack River at 7697 cfs (as measured at the USGS gaging station in Lowell, Massachusetts). However, they are more significant when compared to the average August monthly flow of 2802 cfs at Lowell, Massachusetts or the 7Q10 of 950 cfs at this same location.

Section 6
Other Sources of Pollutants

This section of the report presents a summary of additional sources of pollutants in the Merrimack River watershed, including: sediments, air deposition, groundwater plumes from landfills, erosion along streambanks, areas with failing septic systems, pump station overflows, and illicit wastewater discharges to stormdrains.

6.1 Sediments

Sediments may be introduced to a river system through a variety of sources, including CSO discharges, industrial and municipal discharges, streambank erosion, and stormwater runoff. Pollutants such as heavy metals and other compounds, including polychlorinated biphenyls (PCBs), may attach to the sediment particles, and consequently enter the aquatic environment. Once in the river system, suspended sediments may be transported and transformed by a variety of mechanisms. A portion of the organic solids will be lost to decomposition, while some residual organic material is transported through the system along with the inorganic portion. In general, fine-grained sediments tend to collect in low-energy areas, such as behind impoundments, and in low-velocity areas, such as at bends in a river system. Sediments also tend to accumulate in the "null zone" of estuaries, where the inflowing river and the tidal action tend to reduce the net velocity (Chapra 1997).

In the Merrimack River, studies have documented primarily bedrock channels in the majority of the mainstem. It is expected that the majority of the sediment deposition occurs upstream of the major dams on the mainstem, including the Hooksett Dam in Hooksett, New Hampshire; the Amoskeag Dam in Manchester, New Hampshire; the Pawtucket Dam in Lowell, Massachusetts; and the Essex Dam in Lawrence, Massachusetts; as well as in the estuarine portion downstream of Haverhill, Massachusetts.

6.1.1 Sediment Quality in the Merrimack River Watershed

A review of available literature revealed a general lack of data on sediment quality in the mainstem Merrimack River and its major tributaries. However, the watershed's industrial past points to a strong potential for sediment contamination. The Merrimack River valley was at the heart of the American Industrial Revolution in the 1800's and early 1900's (Studer 1995). Emergent industries around this period included paper and textile mills, tanneries, and mining facilities. Industrial development in the watershed peaked in the 1920's as a result of the societal and economic changes brought on by the Great Depression and the two World Wars (Studer 1995). The economic depression persisted in the basin until the early 1960's when the area experienced a surge in electronics manufacturing and chemical and metal firms that grew in support of technologies in the Boston metropolitan area. By the 1960's, the Merrimack River was considered one of the top ten most polluted waterways in America as a result of the discharge of untreated sewage and wastes from various industrial facilities (Studer 1995). The passage of the Clean Water Act in the early 1970's ushered in an era of stricter controls on point source discharges to the basin, and hence, improved water quality in the River. However, many of the pollutants from the River's industrial past, such as heavy metals and PCB's, may remain trapped in the bed sediments of the River and its tributaries or may be buried by later sedimentation.

6.1.2 State and Local Sampling Programs

Limited sediment sampling was performed by the New Hampshire Department of Environmental Services (NHDES) at three marinas in the Lake Winnipesaukee watershed in 1993. Samples were analyzed for volatile organic compounds (VOCs) and bulk sediment toxicity using a benthic worm as the test organism. Limited sediment sampling in the Merrimack River was also performed by consultants in 1992 as part of the development of a CSO abatement plan for the City of Manchester, New Hampshire. Based on a review of the available literature, sediment quality results were not available for either study.

Sediment quality sampling was intended to be part of the Merrimack River Initiative sampling program conducted during the summer 1994 and fall 1995. However, the sediment sampling portion of the program was cancelled due to the Federal government's shut down and budgetary cutbacks.

6.1.3 USGS Sampling Program

The United States Geological Survey (USGS) collected streambed sediment and fish tissue samples at 14 river sites in eastern New England during low-flow conditions in 1998 and 1999 as part of the New England Coastal Basins (NECB) study unit of the National Water-Quality Assessment (NAWQA) Program. Sampling was performed at one station in the Merrimack River watershed adjacent to the USGS streamflow gaging station in the mainstem River below the confluence of the Concord River in Lowell, Massachusetts. The results of this assessment were published in a 2002 USGS Water Resources Investigation Report entitled "*Trace Elements and Organic Compounds in Streambed Sediment and Fish Tissue of Coastal New England Streams, 1998-99*" (WRIR 02-4179).

The streambed sediment samples were analyzed for a total of 141 contaminants, including 45 trace elements, 32 organochlorine compounds, and 64 semi- volatile organic compounds. Sediment concentrations in the NECB were compared to results from monitoring sites in other NAWQA study units across the county. In general, the median concentrations of selected trace elements (including arsenic, cadmium, chromium, copper, mercury, nickel, lead, selenium, and zinc) in the streambed sediments in the NECB were 1.5 to 8 times higher than the median concentrations of these constituents found in the 46 NAWQA study units. However, the results for the Merrimack River sampling location were consistently among the lowest in the NECB, though still typically above the wider median NAWQA study values. Similar trends were seen in the concentrations of total polycyclic aromatic hydrocarbons (PAHs) and total polychlorinated biphenyls (PCBs).

Table 6-1 presents a comparison of concentrations for select trace metals, total PCBs, and total PAHs at the Merrimack River sampling station to the NECB median concentrations and the national NAWQA median values.

Table 6-1: Comparison of streambed sediment trace metal concentrations

Parameter	Unit	Concentration		
		Merrimack River	*NECB Median*	*National Median*
Arsenic	µg/g	11	19	7.7
Cadmium	µg/g	1.6	2.1	0.45
Chromium	µg/g	78	99	63.5
Copper	µg/g	42	92.5	28
Lead	µg/g	82	190	25.9
Mercury	µg/g	0.32	0.64	0.0725
Nickel	µg/g	20	45	29
Zinc	µg/g	180	295	110
Total PCBs	µg/kg	45(e)	155	<50
Total PAHs	µg/kg	12,960	21,764	267

e= Estimated concentration (PCB reporting limit= 50µg/kg)

6.1.4 Other Sediment Monitoring

Sediment sampling was performed in the Merrimack River basin by Marie M. Studer, a doctoral candidate at the University of Massachusetts-Boston, in completion of her dissertation entitled "The chemistry and geochemistry of selected metals in the Merrimack River of New England and regulatory considerations of water quality". Studer undertook a two-year study between January 1989 and April 1991 to determine the geochemical behavior of select metals and the anthropogenic influences on water column metal concentrations in the mainstem Merrimack River and its headwaters, the Pemigewasset and Winnipesaukee Rivers.

Sample Collection

In completion of this study, two sediment cores were taken from the Indian River Shoals, a freshwater tidal marsh on the Merrimack River in West Newbury, Massachusetts. The Indian River, a small creek, discharges to the downstream portion of the marsh. There are no point sources discharging to the creek, and only residential land use exists in the area (Studer 1995). The marsh was chosen based on its downstream location in the Merrimack River, its relatively large size (1.5km long by 0.25km wide at its widest section), and its vegetative structure, which indicates its status as a relatively mature marsh (Studer 1995).

The two sediment cores were collected on October 20, 1991 and November 19, 1991, respectively, approximately five-meters apart at low-tide from an area within the vegetation line that is inundated daily by water (Studer 1995). A five-centimeter (cm) diameter, 160-cm long PVC coring tube fitted with a polycarbonate liner was used at each site. The cores were sectioned at one-centimeter intervals to a depth of 25-cm and at two-centimeter intervals below 25-cm. Core 1 was approximately 42-cm in length and Core 2 was 83-cm long (Studer 1995).

Sediment Sampling Results

Sediment samples were prepared and analyzed for select metals (silver (Ag), aluminum (Al), cadmium (Cd), copper (Cu), chromium (Cr), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb), and zinc (Zn)), radionuclides, organic carbon and grain-size distribution. The following section provides a summary of the results for each parameter.

Estimate of Marsh Accretion Rate and Geochronology

The geochronology of the West Newbury marsh could not be established using the radioisotope measurements due to low levels of radionuclides in the sediment samples. Thus, Studer (1995) established the approximate age of the vertical stratum largely based on the rate of local sea-level rise and historical information on human activity in the area. Based on this method, sediments at a depth of approximately 20-meters were dated to around the early 1800’s.

Sediment Porosity and Grain Size

Sediment porosity is defined as the ratio of volume of interstices of sediment to the total volume. The porosity was found to be relatively invariant with depth in both of the sediment cores, indicating constancy in the nature of depositional materials overtime (Studer 1995). Sediment grain-size distribution analysis was performed on only the upper eight-centimeters of Core 2. As was expected based on the porosity results, the grain-size distribution was relatively constant in the analyzed portion of the sample (Studer 1995).

Organic Carbon

Sediment organic carbon in Cores 1 and 2 was generally low, ranging from three to 25 mg/g, with higher concentrations occurring in the upper 15-cm of the core samples. Studer (1995) concluded that these concentrations were low in comparison to other marsh environments. For example, the maximum concentration observed in the West Newbury system was approximately three-percent, whereas many freshwater systems have organic matter ranging between 10 and 75-percent or higher (Studer 1995).

Metal Profiles

Sediment samples were analyzed for the following ten metals: Ag, Al, Cd, Cu, Cr, Fe, Mn, Ni, Pb, and Zn. Studer (1995) found that the metal concentrations fell into the following three different patterns based on the similarity of their profiles when plotted versus depth:

- Concentrations of abundant crust metals (aluminum, iron, and manganese), as well as nickel, were relatively constant with depth
- All other metals were found to have relative constant concentrations at depths greater than 20-cm; elevated levels were observed in the top 15 to 20-cm.
- Sharp increases in silver and cadmium were observed between 10 and 15-cm. More gradual increases in copper, chromium, lead, and zinc concentrations occurred starting deeper in the core.

Studer (1995) concluded that the relatively stable depth profiles of aluminum, iron, and manganese concentrations indicate that the bulk sediment composition in the marsh has not been significantly influenced by anthropogenic activities during the past 100 to 200 years. Thus, the primary source of these metals in the marsh sediments is apparently weathered rock material. Studer noted, that the stable nickel concentrations may not be indicative of a lack of industrial sources, as nickel is generally non-particle reactive and would be more prevalent in the dissolved form.

The depth profiles for the remaining sediments (Ag, Cd, Cu, Cr, Pb, and Zn) differ from those of the weathering-dominated metal profiles discussed above. Studer (1995) observed constant concentrations for this later group of metals in the deeper strata of each sediment core. However, as noted above, significant concentration increases for these metals were observed in the top 15 to 20-cm of the two sediment cores, corresponding to deposition occurring in the last 150 to 200 years. Thus, Studer concluded that the marsh sediment profiles indicated the anthropogenic mobilization of these metals over the past century or more.

The increase in silver and cadmium concentrations began at the 12 to 13-cm level, corresponding, on a temporal scale, to increased deposition the mid to late 1800's. The concentration increase for other metals occurred deeper in the cores, corresponding to the late 18^{th} and early 19^{th} century. These relative dates correlate with documented industrial activities beginning in the Merrimack River valley in the early 1800's. For example, lead was commonly used in infrastructure, canal, and shipbuilding; copper and zinc were used in the production of brass products; and chromium was used as dye pigments and in the leather tanning industries (Studer 1995). The use of silver and cadmium increased later in the basin as a result of the plating and photographic enterprise development.

Recent Metal Inputs

Studer (1995) generally observed a decline in metal concentrations for Ag, Cd, Cu, Cr, Pb, and Zn in the top two to three-centimeters of the sediment cores. On a temporal scale, this conforms to the passage of the Clean Water Act (CWA) in the early 1970's.

However, Studer was unable to determine conclusively if this decline was directly attributable to increased pollution controls implemented in response to the CWA or to other factors affecting metal accumulation, such as a change in the processes governing metals transport from the water column to the sediments or changes in the quantity and quality of organic material deposited in the marsh. Studer noted that the decrease may also be attributed to a change in the type and distribution of industrial facilities in the Merrimack River watershed. A summary of the current municipal wastewater treatment plant and industrial point source discharges is provided in Sections 4.0 and 5.0, respectively. Although not explicitly discussed by Studer, metals contamination may also result from un-permitted non-point sources, such as air deposition (see Section 6.2), groundwater contamination from landfills (Section 6.3), and stormwater runoff.

6.1.5 Sediment Impacts

Bed sediments may represent both a source and sink of potentially harmful pollutants within a river system. Traditionally, interest has focused on the magnitude of sediment contaminant from heavy metals and other compounds, such as PCBs and VOCs. These contaminants have been known to adversely affect aquatic life and bioaccumulate within the food chain. For example, statewide advisories exist in both Massachusetts and New Hampshire for fish consumption due to mercury contamination (see Section 6.2 for additional discussion). Recent guidance published by USEPA suggests that aquatic life is most susceptible to pollutants in the dissolved form, which they filter out of the water column. In general, these pollutants enter the water column through deposition, such as from stormwater runoff, industrial or municipal discharges, and atmospheric sources, as well as through the re-suspension of contaminated sediments.

In some river systems, bed sediments may also contribute to nutrient concentrations within the water column. As previously noted, bed sediments contain some portion of organic matter from the original sediment particle. This organic matter is decomposed by a variety of microorganisms. Through this process, nutrients such as nitrogen and phosphorus are liberated to the pore water, and consequently, to the water column through sediment-water interactions. The process is fairly straightforward for conservative nutrients, such as phosphorus, which is most important in freshwater systems. However, it is further complicated for reactive nutrients, such as nitrogen (the limiting nutrient in marine waters), where the nitrogen may change form within the pore water and the water column. In some systems, the release of nutrients from the bed sediments may be sufficient to contribute to eutrophication problems. In the Merrimack River, it is likely that releases from bed sediments play only a minor role in the overall nutrient balance. The largest impacts on nutrient concentrations are expected just upstream of the dams and in the estuary portion, where larger sediment deposits are expected. For that reason, a detailed model of the sediment nutrient fluxes is not expected to be developed for the Merrimack River during Phase I of the study.

In addition to serving as a source of nutrients, bed sediments may also serve as a potentially important sink of dissolved oxygen in many waterbodies. Sediment oxygen demand (SOD) is a combination of all the oxygen-consuming process that occur at or below the sediment-water interface, including both biological and chemical reactions. The majority of the SOD at the sediment surface is due to the biological decomposition of organic matter as discussed above. Conversely, chemical oxidation of species such as iron and manganese is the dominant process governing SOD a few centimeters into the bed sediments (USGS 1997). In some systems, SOD may have significant impacts on dissolved oxygen concentrations. In the mainstem Merrimack River, it likely that SOD is only a minor sink of dissolved oxygen. As with the nutrient fluxes, it is anticipated that SOD impacts are largest just upstream of the dams and with the estuary portion of the river. Because of the lack of SOD data, a detailed model of this parameter is not expected to be developed for the Merrimack River during Phase I of the study.

6.2 Atmospheric Deposition

Air deposition has been identified as a contributor to water quality problems throughout the United States. In 1995, the USEPA Office of Water established the "Air Deposition Initiative" to support research and cooperation on air-water issues. Currently, the USEPA specifies five categories of air pollutants most likely to degrade water quality through atmospheric deposition: nitrogen compounds, mercury, other metals, pesticides, and combustion emissions (excluding nitrogen compounds). The following section provides a brief description of each potential air deposition source.

6.2.1 Nitrogen

Nitrogen is an essential element to life on Earth; however, excessive inputs of nitrogen to a waterbody can lead to a condition called *eutrophication*, or unhealthy increases in the growth of phytoplankton. Estuaries and near-coastal oceans are particularly sensitive to increased inputs of nitrogen, as this is the limiting nutrient in marine waters. Several water quality problems can arise from excess nitrogen, including low dissolved oxygen concentrations, loss of seagrass beds, changes in species composition, and potentially increased algal blooms (USEPA 2003a). In other words, algal growth is limited by the nutrient that is least available relative to its needs; therefore, the easiest way to control eutrophication in marine waters is by limiting the amount of available nitrogen in the system.

Currently, human activities resulting in atmospheric deposition are causing increased loads of nitrogen to waterbodies (USEPA 2003b). According to a 2000 USEPA study, *Deposition of Air Pollutants to the Great Waters- 3rd Report to Congress*, between 22 and 30 million kilograms of total nitrogen load enters the Massachusetts Bay (as defined by the National Estuary Program) annually. Of this, between 1.6 and 6.0 million kilograms per year are attributed to atmospheric deposition; this translates into a fairly substantial source of between five and 27-percent of the total annual nitrogen load. It is important to note that this includes only deposition falling directly on the waterbody. It does not include that load which falls on the watershed and runs off into the Bay, which could further increase this estimate. Although the Merrimack River estuary is not included in the definition of the "Massachusetts Bay", it is assumed that the deposition rates may be similar due to its close proximity.

Sources of Nitrogen

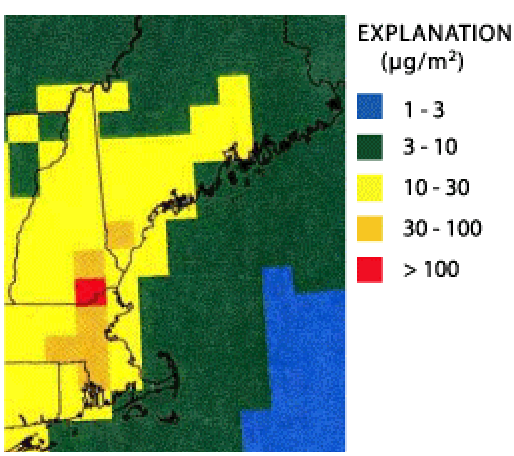
Nitrogen is found in various forms in the environment, such as nitrogen gas (N_2) and more bioavailable forms, including ammonia (NH_3), nitrogen oxides (NO_X), and organic nitrogen compounds. Anthropogenic sources currently dominate nitrogen emissions to the atmosphere; for example, anthropogenic sources of NO_X and NH_3 are estimated to equal the natural sources (Schlesinger 1997). The largest source of NO_X is the combustion of fossil fuels (such as coal, oil, and gas) by automobiles and power plants. The largest sources of NH_3 emissions are fertilizers and domesticated animals, such as hogs, chickens, and cows (USEPA 2003b).

6.2.2 Mercury

Atmospheric deposition of mercury has been identified as a major source of contamination in the Merrimack River basin and broader New England region. Recent investigations by the USGS through their National Mercury Pilot Study, showed some of the highest mercury concentrations in the country in the New England Coastal Basin (NECB) study unit (Krabbenhoft, *et al.* 1999), which encompasses 23,000 square miles in central Maine, the eastern portions of New Hampshire and Massachusetts, most of Rhode Island, and a small portion of Connecticut. The dominant source of mercury in the NECB was identified as atmospheric deposition.

Additionally, a recent air deposition model, the Regional Lagrangian Model of Air Pollution (RELMAP), developed by the Northeast States for Coordinated Air Use Management (NESCAUM) predicted the highest estimated annual wet and dry mercury atmospheric deposition levels in the New England region in the Merrimack River watershed at the New Hampshire-Massachusetts boarder (NESCAUM *et al*. 1998); the model results are presented in Figure 6-1.

Figure 6-1: RELMAP estimated annual wet and dry atmospheric deposition levels



Sources of Mercury

Mercury is an element that occurs naturally in the environment. It is also released into the atmosphere from a variety of man-made sources, such as the combustion (burning) of solid wastes. Once it is released, mercury can be carried long distances before falling back to the surface. Mercury settles in the bottom of lakes, rivers, ponds, and the ocean, where it is transferred to aquatic life through the sediments. As with most contaminants, the highest concentrations are typically found at the top of the food chain as a result of bioaccumulation.

No historic records of atmospheric mercury deposition exist for the New England area, however, past widespread burning of coal for domestic heat and industrial boilers in the nineteenth and first half of the twentieth centuries most likely contributed to the relatively high background concentrations in the area (MADEP 2001).

Currently, it is estimated that almost half (47-percent) of the mercury deposited in the northeast is a result of man-made sources within the region (New Hampshire DHHS 2001). According to the MADEP (2001), current man-made sources of atmospheric deposition in the Massachusetts portion of the Merrimack River basin include three municipal solid waste incinerators and one medical waste incinerator. These sources represent the state's largest concentration of atmospheric mercury point sources (MADEP 2001). Man-made pollution migrating from outside the New England region has also been identified as a major source of atmospheric deposition, contributing approximately 30-percent of the total mercury deposited in the region. The remaining 23-percent comes from natural sources in the environment (*i.e.* the global reservoir) (New Hampshire DHHS 2001).

Monitoring Programs

In January 2002, the USGS initiated a two-year atmospheric deposition monitoring program for mercury at four stations in the NECB, two of which are located in the Merrimack River watershed in Laconia and Manchester, New Hampshire. The goal of this data collection effort is to help define the levels of mercury in precipitation and identify how atmospheric mercury may be contributing to mercury in the aquatic ecosystem (USGS 2003). The monitoring station in Laconia, New Hampshire was chosen to reflect the regional atmospheric deposition rates, while the Manchester, New Hampshire site was chosen because of its location in an area of predicted high deposition. The New Hampshire Department of Environmental Services (NHDES) Air Resources Division is performing monitoring at these stations.

Statewide Advisories

As a result of the mercury contamination levels, both Massachusetts and New Hampshire have issued statewide advisories on fish consumption, as follows:

Massachusetts:
In July 2001, the Massachusetts Department of Public Health (MDPH) issued the following advisory: the MDPH "…. is advising pregnant women, women of childbearing age who may become pregnant, nursing mothers, and children under 12 years of age to refrain from eating the following marine fish: shark, swordfish, king mackerel, tuna steak, and tilefish. In addition, MDPH is expanding its previously issued statewide fish consumption advisory which cautioned pregnant women to avoid eating fish from all freshwater bodies due to concerns about mercury contamination to now include women of childbearing age who may become pregnant, nursing mothers, and children under 12 years of age."

Additionally, MDPH "…. is recommending that pregnant women, women of childbearing age who may become pregnant, nursing mothers, and children under 12 years of age limit their consumption of fish not covered by existing advisories to no more than 12 ounces (or about two meals) of cooked or uncooked fish per week. This recommendation includes canned tuna, the consumption of which should be limited to two cans per week. Very small children, including toddlers, should eat less. Consumers may wish to choose to eat light tuna rather than white or chunk white tuna, the latter of which may have higher levels of mercury" (MADEP 2002).

New Hampshire:
Since 1994, the New Hampshire Department of Health and Human Services (DHHS) has issued a general advisory for fish consumption from all inland freshwater bodies. New Hampshire's advisory recommends that women of childbearing age and nursing mothers limit their consumption of freshwater fish to no more than one eight-ounce meal per month. Children under the age of seven-years are advised to eat only one three-ounce meal per month. All other people are encouraged to limit their consumption to no more than four eight-ounce meals per month. The New Hampshire DHHS also recommends that people eat only smaller, younger fish, since mercury bioaccumulates in fish tissue over time, generally resulting in higher concentrations in older fish (New Hampshire DHHS, 2001).

6.2.3 Other Metals

Industrial processes have led to increased concentrations of numerous metals, including lead, cadmium, nickel, copper, and zinc, above background concentrations. The USEPA's *Deposition of Air Pollutants to the Great Waters- 3rd Report to Congress* (June 2000) focused on cadmium and lead as the primary metals of concern. Although no explicit information is available for the Merrimack River watershed, Table 6-2 provides a summary of the direct atmospheric deposition rate for each metal to the Massachusetts Bay. In general, the deposition of lead was found to be higher at monitoring locations closer to Boston. However, deposition of cadmium was found to be similar at both the urban and rural monitoring areas.

Table 6-2: Atmospheric Deposition of Cadmium and Lead to Massachusetts Bay

Trace Metals	Concentrations (µg/m²/yr)	
	Urban	*Rural*
Cadmium	260	280
Lead	2,300	1,400
Total	2,560	1,680

(USEPA 2000a)

Information was not available on the relative proportion of the atmospheric deposition loadings in relation to the total annual loads entering Massachusetts Bay. A study of the Chesapeake Bay indicates that atmospheric deposition of cadmium and lead contributes approximately 4.6 and 5.6-percent, respectively, to the total inputs of the Bay (USEPA 2001). However, it was noted that these percentages may be underestimates since the monitoring stations did not reflect the urban influences of Baltimore, Maryland. This assumption may be reasonable, as a study of Long Island Sound indicates that atmospheric deposition of lead accounts for between 70 and 90-percent of the total annual load to the sound.

Sources of Cadmium and Lead

In many urban areas, local rather than regional sources are primarily responsible for the atmospheric deposition of cadmium and lead. According to the USEPA (2000), the largest sources of lead air emissions include non-road vehicles and equipment (*e.g.* aircraft), on-road vehicles, steel manufacturing, coal combustion, non-ferrous metal production, and waste disposal. Lead emissions have greatly declined from over the past 30 years due to the elimination of lead in fuels. The largest sources of cadmium air emissions include coal combustion, solid waste and sewage sludge incineration, and copper and lead smelting/production (USEPA 2000a).

6.2.4 Pesticides

The atmospheric deposition of pesticides is a recognized source of toxic substances to waterbodies. The USEPA has linked the following six key pesticides to water quality problems, each of which may be potentially transported through the atmosphere (USEPA 2003b) www.epa.gov/owow/oceans/airdep/air2.html):

- Chlorande
- DDT/DDE
- Aldrin/Dieldrin
- Hexachlorobenzene
- a-Hexachlorocyclohexane

- Toxaphene

For most pesticides, the relative contribution of atmospheric deposition versus other sources, such as runoff from contaminated soils, to total annual loading is not yet known (USEPA 2000a). A review of the literature reveals no information on toxic pollutant concentrations or loadings to the Merrimack River or surrounding waterbodies.

Pesticide Sources

Since most of these substances are banned or restricted in the United State, the major sources include long-range transport from other countries, use of existing pesticide stock, and releases from contaminated sites and soils (USEPA 2000a).

6.2.5 Combustion Emissions (excluding Nitrogen Compounds)

The USEPA classifies pollutants that are released by the incineration of waste as "combustion emissions"; potentially harmful compounds include dioxins, furans, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) (USEPA 2003b). A review of the literature reveals that only limited monitoring of the these pollutants has been performed in the New England region to determine the relative contribution of atmospheric depositions as compared to other sources. However, studies in other areas of the country, particularly the Great Lakes region, indicate that these sources could be significant. For example, atmospheric deposition of dioxins and furans to Lake Superior was estimated to account for 100-percent of the total annual load to the waterbody.

Sources of Combustion Emissions

The USEPA (2000) cites the largest sources of dioxin and furan emissions in the United States as municipal waste combustion and medical waste incineration. Sediment accumulation rates in the Great Lakes region indicate a decline in dioxin and furan inputs over the past 30-years. PAHs are a family of over 100 compounds that are formed from the incomplete combustion of fuel, garbage, coal, and other materials (USEPA 2003b). Studies from the Great Lakes region have also indicated that vehicular emissions, coal-fired power plants, and coke and steel production are large sources of PAH emissions (USEPA 2000a).

6.3 Groundwater Plumes from Landfills

Landfills represent a significant potential source of non-point source pollution in the Merrimack River watershed, since in the past, landfills were not properly engineered to contain toxic materials that were disposed of in the facilities. Additionally, fewer regulations regarding the disposal of potentially toxic materials existed during the period of operation of these older landfills. Thus, landfills are a potential source of groundwater contamination for metals, nutrients, pathogens, and volatile organic compounds. Recharge rates can be high, which encourages the leaching of contaminants into the underlying groundwater (Witten and Horsley 1995).

Massachusetts and New Hampshire classify solid waste disposal sites differently, as shown in the figures and summarized below:

- Massachusetts Solid Waste Site – Active: Includes landfills, transfer stations, and combustions facilities
- Massachusetts Waste Disposal Site: Includes general waste disposal sites, landfills, and sewage lagoons
- Massachusetts Mine Site, Possible Old Landfill: Described by MassGIS to include mining areas (sand, gravel and rock)
- New Hampshire Solid Waste Site 2 – No further explanation is available from New Hampshire GRANIT
- New Hampshire Old Open Dump Site (non-landfill) – No further explanation is available from New Hampshire GRANIT
- New Hampshire Municipal or Commercial Stump or Demolition Dump – No further explanation is available from New Hampshire GRANIT
- New Hampshire Existing Landfill or Landfill Closure – No further explanation is available from New Hampshire GRANIT

Table 6-3 provides a summary of the number and type of waste disposal facilities with 100-feet, 500-feet, 1000-feet, and one-mile of the mainstem Merrimack River. The number, locations, total acreage, and containment conditions of solid waste disposal sites in Massachusetts and New Hampshire are summarized in Table 6-4 and 6-5, and in Figures 6-2 through 6-4. Information in Table 6-2 and 6-3 is summarized for each of the sponsor communities and sub-watersheds, as discussed in Section 3.2 and shown in Figure 3-1.

Table 6-3: Summary of landfills adjacent to the mainstem Merrimack River

Landfill Type	**Number of landfills within buffer distance**			
	100-feet	*500-feet*	*1000-feet*	*1-mile*
NH Old Dump	0	0	2	2
NH Stump/Demolition	0	0	1	1
NH Existing Landfill	0	0	0	4
MA Waste Disposal Site	0	3	6	26
MA Mine Site	0	0	2	49
MA Solid Waste Site	0	1	3	15
TOTAL	**0**	**4**	**14**	**97**

Recent regulations have sought to limit the impact of solid waste disposal sites on the environment by containing the solid waste and preventing dispersal of contaminants through groundwater conduits. Some landfills in the Merrimack River watershed are capped or lined in an effort to contain the waste, leachate, and rainfall that may otherwise flush contaminants into the groundwater (see Figures 6-2 and 6-3). Landfill caps are usually used to cover the top and side slopes of a landfill once it has reached full capacity or is no longer in service. Landfill liners are positioned around the bottom of the landfill following excavation and prior to the collection of waste. Liners can be either impervious soils, such as clay, that have very low hydraulic conductivity, or synthetic geo-membrane materials.

Solid waste disposal sites that are capped or lined pose a reduced threat of groundwater contamination compared with uncapped and unlined disposal sites. The impacts of the uncontained landfills on water quality in the Merrimack River watershed will be largely qualitative, since the status of many sites has not been fully catalogued. Using available Geographic Information System (GIS) data from MASSGIS and New Hampshire GRANIT, only a fraction of the capped or lined landfills could be identified.

Due to the lack of available landfill data and groundwater monitoring information, landfills will only be included in the detailed water quality models if the dry-weather sampling results point to a landfill as a likely source of pollution. In general, the detailed models will be focused on the evaluation of wet-weather water quality impacts. It is assumed that the water quality impacts from the landfills will be represented in the background, dry-weather concentrations in the mainstem Merrimack River.

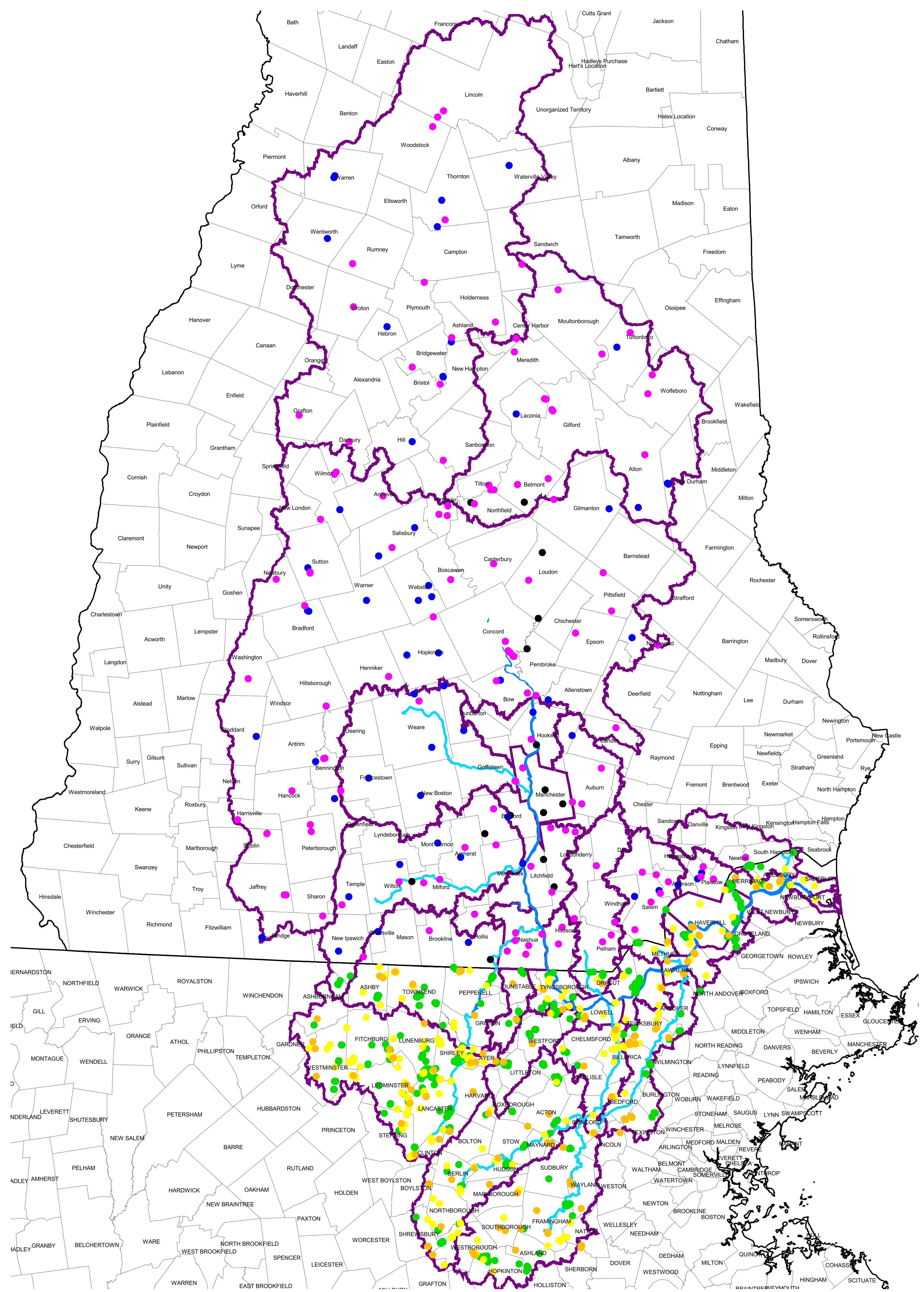
Table 6-4: Solid Waste Disposal Sites- Total Acreage

Subbasin Type	Subbasin Name	Total Area (acres)	Total Area of Solid Waste Disposal Sites (acres)
Sponsor Communities	Manchester, NH	22,360	65
	Nashua, NH	20,301	145
	Lowell, MA	9,301	104
	Lawrence, MA	4,749	18
	Haverhill, MA	22,805	313
Mainstem Merrimack River	Upper Merrimack River	826,007	311
	Merrimack Corridor 1	32,737	14
	Merrimack Corridor 2	56,161	42
	Merrimack Corridor 3	28,397	294
	Merrimack Corridor 4	31,134	292
	Merrimack Corridor 5	25,293	261
	Merrimack Corridor 6	39,111	277
Major Tributaries	Assabet River	120,286	858
	Beaver Brook	72,680	216
	Cohas Brook	36,614	12
	Concord River	52,378	202
	Nashua River (Lower)	141,654	1,934
	Nashua River (Upper)	115,934	338
	Pemigawasset River	650,559	64
	Piscataquog River	137,561	33
	Powwow River	35,425	52
	Salmon Brook	14,635	134
	Shawsheen River	47,950	459
	Souhegan River	140,054	71
	Spickett River	47,939	134
	Stony Brook	29,205	357
	Sudbury River	103,414	692
	Winnipesaukee River	308,390	116
TOTAL=		**3,173,034**	**7,808**

Table 6-5: Solid Waste Facility Summary

Subbasin	Total Sites	Lined Status			Capped Status			
		Lined	*Unlined*	*Unknown*	*Capped*	*Partially Capped*	*Uncapped*	*Unknown*
Manchester, NH[1]	1	0	0	1	1	0	0	0
Nashua, NH	4	1	0	3	0	0	0	4
Lowell, MA	16	0	0	16	0	0	3	13
Lawrence, MA	4	0	2	2	1	0	1	2
Haverhill, MA	27	1	1	25	0	1	1	25
Upper Merrimack River	63	2	0	61	0	0	0	63
Merrimack Corridor 1	3	0	0	3	0	0	0	3
Merrimack Corridor 2	4	0	0	4	0	0	0	4
Merrimack Corridor 3	43	0	5	38	1	0	3	39
Merrimack Corridor 4	34	0	4	30	0	4	0	30
Merrimack Corridor 5	24	0	2	22	0	0	2	22
Merrimack Corridor 6	27	1	5	21	4	1	1	21
Assabet River	97	2	12	83	9	2	2	84
Beaver Brook	11	0	1	10	0	0	1	10
Cohas Brook	3	0	0	3	0	0	0	3
Concord River	34	0	6	28	0	0	6	28
Nashua River (Lower)	296	0	29	267	18	0	8	270
Nashua River (Upper)	74	6	7	61	4	0	8	62
Pemigawasset River	27	0	0	27	0	0	0	27
Piscataquog River	10	0	0	10	0	0	0	10
Powwow River	12	0	1	11	0	1	0	11
Salmon Brook	12	1	2	9	0	3	0	9
Shawsheen River	41	0	13	28	2	0	8	31
Souhegan River	17	0	0	17	0	0	0	17
Spickett River	16	0	1	15	1	0	0	15
Stony Brook	27	0	2	25	2	0	0	25
Sudbury River	73	2	12	59	4	2	3	64
Winnipesaukee River	23	0	0	23	0	0	0	23

[1]Landfill capped status is based on information received from the City of Manchester, NH



LEGEND

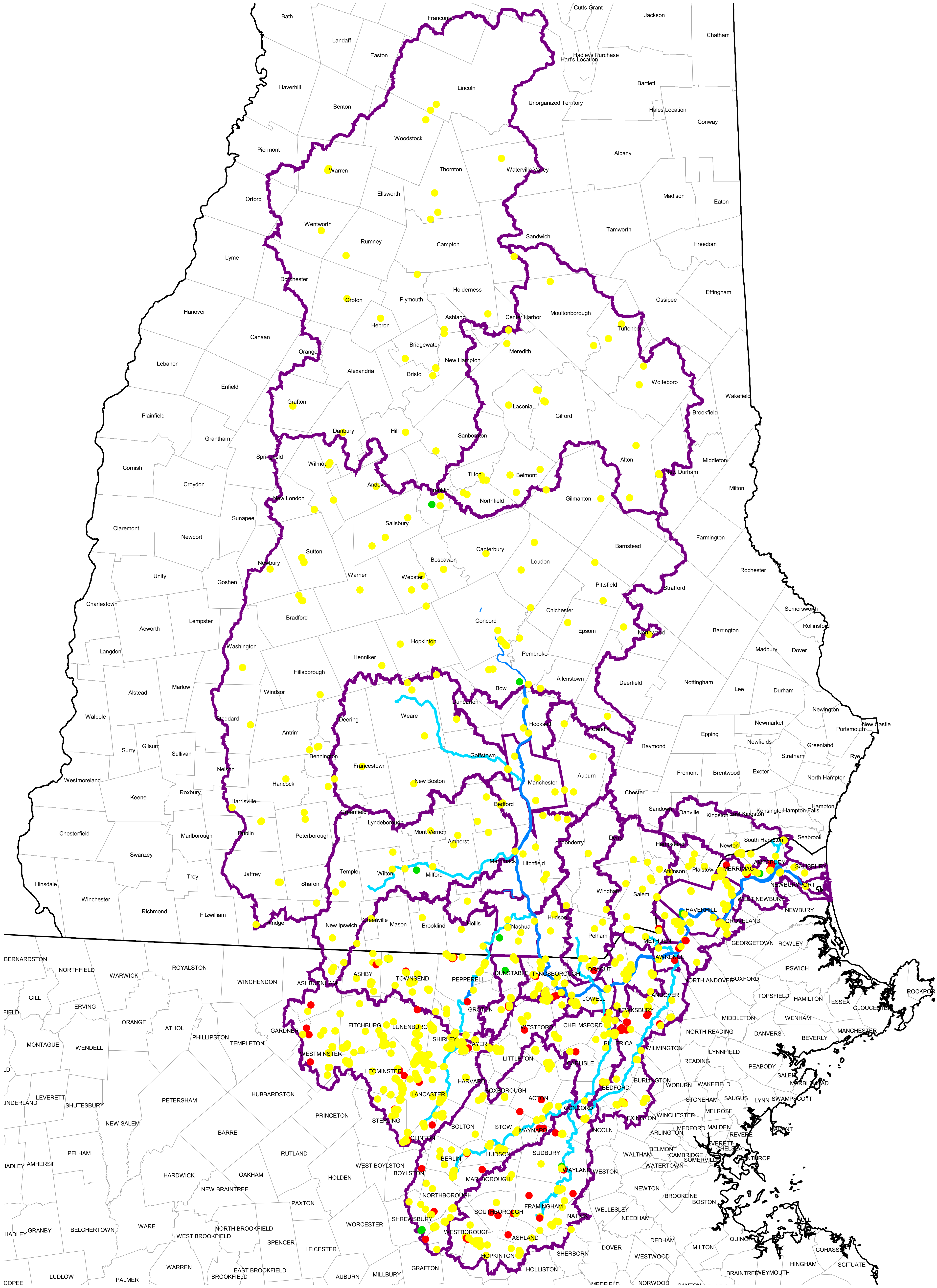
- Ma Solid Waste Site
- Ma Waste Disposal Site
- Ma Mine Site, Possible Old Landfill
- Nh Exisiting Landfill or Landfill Closure
- Nh Old Open Dump Site (Non-landfill)
- Nh Municipal or Commercial Stump or Demolition Dump
- Merrimack River Mainstem
- Merrimack River Tributary
- Merrimack Tributary Catchment
- State Boundary
- Town Boundary

N

50000 0 50000 Feet

CDM

Figure 6-2
Merrimack River Watershed
Current and Past Landfill Sites



LEGEND

- Lined
- Not Lined
- Unknown
- Merrimack River Mainstem
- Merrimack River Tributary
- Merrimack Tributary Catchment
- State Boundary
- Town Boundary

50000 0 50000 Feet

CDM

Figure 6-3
Merrimack River Watershed
Solid Waste Facilites Lining Status

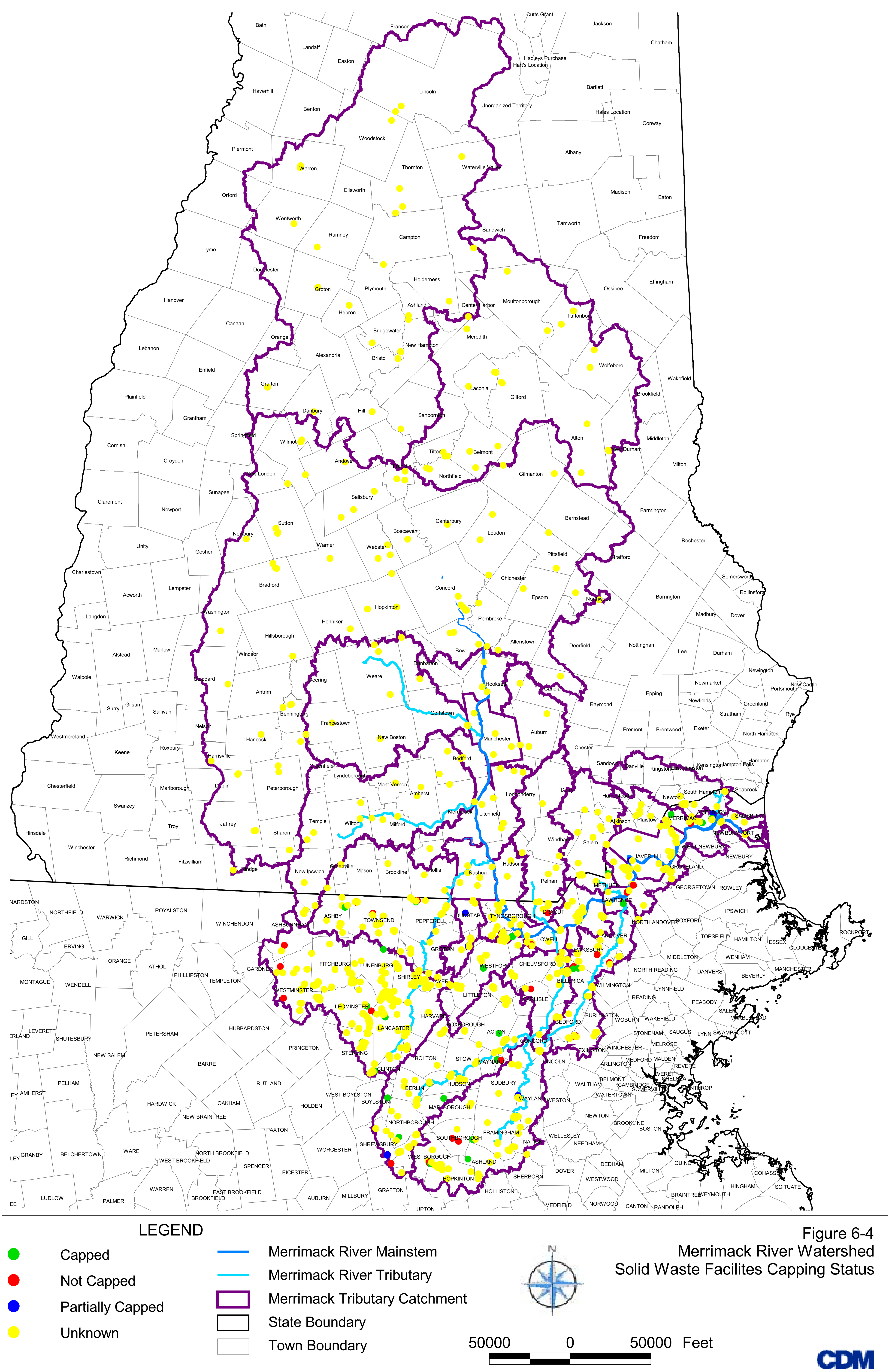


Figure 6-4
Merrimack River Watershed
Solid Waste Facilites Capping Status

6.4 Erosion Along Streambanks

During November and December 2002, Normandeau Associates conducted field surveys to identify areas along the Merrimack River mainstem streambank between Hooksett, New Hampshire and Newburyport, Massachusetts with areas of erosion greater than approximately 50-feet in length.

Eroded streambanks can result in significant total suspended solids (TSS) loads entering the Merrimack River, particularly during times of intense rainfall and high streamflows. High concentrations of particulate matter can cause increased sedimentation and siltation in the River, which can result in degraded habitat for fish and other aquatic life. Additionally, other pollutants, such as metals and bacteria, may become attached to suspended particles and enter the River through erosive processes. Thus, controlling TSS levels can result in decreased pollutant concentrations for other water quality constituents.

6.4.1 Field Methods

The Normandeau survey crew took notes and collected digital images on each identified eroded bank area meeting the criteria discussed above. The areas of erosion were documented by locating the upstream and downstream coordinates with sub-meter Global Positioning System (GPS) units.

6.4.2 Survey Results

The erosion survey revealed approximately 55 areas along the Merrimack River with erosion along the streambank or with undercut streambanks. These areas are depicted graphically in Figure 6-6, which is included as a fold-out map at the end of this report section. The callouts on this figure depict the length of eroded bank. Red callouts indicate erosion on the left side of the shore, while blue callouts indicate erosion on the right side. A limited number of eroded areas were identified as single points, such as those surrounding outfall locations; these points are indicated in purple callout boxes, with the applicable description.

No areas of erosion fitting the designated criteria were observed downstream of Haverhill, Massachusetts. This result is not unexpected due to the wider, estuarine nature of the Merrimack River in this area.

Example photos are provided in Figure 6-5, depicting the range of erosion problems noted along the bank of the Merrimack River. CDM has a CD containing the complete set of digital photos taken during the field surveys. Field notes and coordinates defining the upstream and downstream extent of the erosion are provided in Appendix B.

Figure 6-5: Example photos of erosion along the banks of the Merrimack River

6.4.3 USACE Erosion Control Project

The USACE is currently evaluating a potential erosion control project on the north bank of the Merrimack River in Haverhill, Massachusetts off of Riverside Avenue, downstream of Hale Island. The area proposed for protection covers a length of approximately 935-feet. Existing conditions at the site indicate extensive erosion along the riverbank, including significant erosion throughout the root zone. The USACE project is currently on hold, however, due to the need to assess endangered species habitat in this area, particularly for Bald Eagles.

6.5 Failing Septic Systems

Septic systems are used for the subsurface disposal of wastewater. They are generally comprised of two components- (1) a septic tank which provides for the separation of solids and liquids and some treatment, and (2) a leaching facility which disposes of the liquid wastes.

Septic systems typically have a limited useful life expectancy; failures are known to occur causing localized water quality problems. The causes of septic system failures are numerous and include:

- Inadequate soils, which impede proper infiltration
- Poor system design or siting
- Inadequate testing and maintenance

- Hydraulic overloading
- Tree growth in the drain field

Septic systems must be maintained in order to function properly. Systems should be pumped out by a professional every one to three years and the system should be inspected approximately once every seven years. Solids may pass into the leaching facility if septic tanks are not properly designed or maintained. This may result in plugging of the leaching facility, causing backups into the dwelling or breakouts of effluent on the land surface (Horsley and Witten 1998).

However, even well maintained septic systems may cause adverse impacts on water quality. Conventional septic systems are designed primarily for the removal of pathogens; thus, even properly maintained systems provide minimal treatment of other constituents, such as nutrients. As a result, a high-density of small septic systems, such as those in a residential development, may result in excessive nutrient concentrations in groundwater and downgradient surface waters (Witten and Horsley 1995).

The second factor affecting septic impacts is the distance of the system from the down-gradient receiving waterbody. In generally, there is significant pollutant attenuation that occurs as a result of bio-uptake and bio-filtration; thus, the water quality impacts from septic systems generally decrease the farther away a system is from the receiving waterbody. To this end, many towns have instituted minimum setback requirements for the installation of new septic systems; however, there is no easy way to control pollutant loads from existing systems installed inside this buffer.

6.5.1 Septic Systems in the Merrimack River Watershed

Information on the number of septic systems in the Merrimack River watershed was obtained from 1990 U.S. Census Bureau data at http://venus.census.gov/cdrom/lookup. Unfortunately, the more recent 2000 census study did not collect information regarding residential sewage disposal. The sewage disposal information was provided on a town-wide or county-wide basis. Of the 159 towns and cities in the Merrimack River watershed, sewage disposal information was available for only 59 communities; county-wide information was available for all of the nine counties that intersect the watershed. Table 6-6 provides a summary of the total population, number of housing units, and percentage of housing units served by public sewer and septic systems, respectively, for the 59 communities where sewage disposal information was available. Table 6-7 provides similar information for the nine counties intersecting the watershed.

Table 6-6: 1990 Sewage Disposal Information for 59 Communities in the Merrimack River Watershed

State	Town	Population	Housing Units	Public Sewer (%)	Septic (%)
MA	Amesbury	12,109	4,865	96.1%	3.9%
	Andover	8,242	3,672	94.0%	5.8%
	Ayer	2,871	1,315	95.6%	4.4%
	Boxford	1,963	680	0%	100%
	Burlington	23,302	8,054	94.6%	5.4%
	Chelmsford	32,388	11,817	22.3%	76.8%
	Clinton	7,943	3,486	99.4%	0.6%
	Fitchburg	41,194	16,665	95.0%	4.8%
	Framingham	64,994	26,404	96.5%	3.3%
	Gardner	20,125	8,654	93.0%	6.4%
	Groton	1,107	411	18.2%	81.8%
	Haverhill	51,418	21,321	88.7%	11.2%
	Hopkinton	2,225	955	50.6%	49.4%
	Hudson	14,267	5,570	92.4%	7.4%
	Lawrence	70,207	26,915	97.5%	1.0%
	Leominster	38,145	15,533	94.1%	5.8%
	Lexington	28,974	10,841	93.7%	6.1%
	Littleton	2,885	1,181	14.8%	84.7%
	Lowell	103,439	40,302	98.1%	1.2%
	Lunenburg	1,808	691	1.9%	98.1%
	Marlborough	31,813	13,027	91.3%	8.6%
	Maynard	10,325	4,211	93.3%	6.3%
	Newburyport	16,351	7,384	92.6%	7.0%
	Northborough	5,761	2,121	41.3%	58.2%
	Pepperell	2,454	927	60.8%	39.2%
	Rutland	2,157	753	77.4%	22.6%
	Salisbury	3,695	2,951	65.6%	33.5%
	Shirley	1,577	707	24.9%	73.7%
	Townsend	1,139	468	29.7%	70.3%
	Upton	2,327	1,018	61.5%	38.5%
	Westborough	3,937	1,738	91.1%	8.9%
	Wilmington	17,654	5,667	12.2%	87.6%
	Woburn	35,943	14,105	96.0%	4.0%
	Worcester	169,759	69,336	97.3%	2.4%
NH	Antrim	1,344	558	73.1%	26.9%
	Bristol	1,418	933	67.4%	31.3%
	Concord	36,006	15,697	86.4%	13.4%
	Derry	20,446	8,674	66.1%	33.7%
	Farmington	3,522	1,403	66.1%	33.2%
	Franklin	8,304	3,744	75.5%	24.5%

State	Town	Population	Housing Units	Public Sewer (%)	Septic (%)
NH (cont'd)	Greenville	1,135	479	83.1%	15.9%
	Henniker	1,734	523	84.3%	15.7%
	Hillsborough	1,782	751	95.1%	4.9%
	Hooksett	2,510	989	72.9%	25.5%
	Hudson	7,626	2,960	89.2%	10.8%
	Jaffrey	2,296	1,173	91.5%	8.5%
	Laconia	15,743	8,201	92.5%	7.5%
	Londonderry	10,114	3,472	14.2%	85.2%
	Manchester	99,567	44,361	94.5%	5.4%
	Meredith	1,530	834	89.3%	9.7%
	Milford	8,015	3,398	85.8%	14.2%
	Nashua	79,662	33,383	94.4%	5.5%
	Peterborough	2,656	1,211	79.8%	20.2%
	Pittsfield	1,620	763	94.4%	5.6%
	Plymouth	4,032	1,078	88.3%	11.7%
	Raymond	2,383	1,084	28.0%	72.0%
	Tilton	3,012	1,262	83.5%	16.5%
	Wilton	1,257	515	85.6%	13.6%
	Wolfeboro	2,843	1,784	50.6%	49.4%

Source: http://venus.census.gov/cdrom/lookup

Note: "Other" sewage disposal systems make up the remaining percentages in each community.

Table 6-7: 1990 Sewage Disposal Information for Nine Counties in the Merrimack River Watershed

State	County	Population	Housing Units	Public Sewer (%)	Septic (%)
MA	Essex	670,080	271,977	81.7%	18.0%
	Middlesex	1,398,468	543,796	80.7%	19.0%
	Worcester	709,705	279,428	68.0%	31.6%
NH	Belknap	49,216	30,306	43.9%	52.7%
	Carroll	35,410	32,146	12.3%	84.2%
	Cheshire	70,121	30,350	43.4%	54.8%
	Grafton	74,929	42,206	44.0%	54.4%
	Hillsborough	336,073	135,622	67.6%	32.0%
	Merrimack	120,005	50,870	49.7%	49.4%
	Rockingham	245,845	101,773	40.9%	58.1%
	Strafford	104,233	42,387	56.7%	42.8%
	Sullivan	38,592	19,532	42.2%	55.9%

Source: http://venus.census.gov/cdrom/lookup

Note: "Other" sewage disposal systems make up the remaining percentages in each county.

6.5.2 Septic System Failure Rates

A review of the available literature did not reveal any information regarding septic system failure rates for communities in the Merrimack River watershed. However, previous work performed as part of the Rouge River National Wet Weather Demonstration Project in the Detroit, Michigan metropolitan area provides a basis with which to develop a generalized failure rate for the watershed. The Rouge project estimated the average annual failure rate using a time series approach proposed by the 1986 USEPA report "Forecasting Onsite Soil Absorption System Failure Rates". This method considers an average annual failure rate (percent per year of operation), future population growth estimates, and system replacement rate to forecast the future overall failure rates (Rouge River National Wet Weather Demonstration Project 1998). According to the Rouge study (1998), annual septic tank failure rates reported for areas across the country range from approximately one to three-percent. For average annual conditions, the Rouge study makes the conservative assumption that septic tank failures would be unnoticed or ignored for five years before repair or replacement occurred. Therefore, the study concluded that during an average year, five to 15-percent of the septic tank systems in the watershed are assumed to be failing.

The 1998 Rouge report noted that this value is consistent with recent surveys conducted in Jacksonville, Florida by the Department of Health and Rehabilitative Services, where they detected 90 violations out of the 800 sites inspected (11.3-percent). The type of violations typically detected included (Rouge River National Wet Weather Demonstration Project 1998):

- Drain field located below groundwater table
- Direct connections between tile field and a stream
- Structural failures

The 11-percent failure rate is consistent with the assumed average year failure rate and period of failure before discovery/remediation, as discussed above.

6.6 Pump Station Overflows

Pump station overflows, and more generally sanitary sewer overflows (SSO's), occur as a result of unintentional discharges of raw sewage from municipal sanitary sewer systems. Most avoidable SSO's are caused by inadequate system operation or maintenance, inadequate system capacity, and improper system design and/or construction. Avoidable SSO discharges can generally be reduced or eliminated by (USEPA 2003c):

- Sewer system cleaning and maintenance

- Reduction of infiltration and inflow through septic system rehabilitation and repair of broken or leaking service lines (infiltration and inflow is a particular problem during spring high groundwater conditions and wet weather events)
- Enlargement or upgrading of sewer, pump station, or sewage treatment plant capacity and/or reliability
- Construction of wet-weather storage and treatment facilities to treat excess flows

SSO events may also be attributed to unavoidable circumstances, such as vandalism, blockages, or extreme weather conditions.

Currently, the USEPA is considering proposing National Pollutant Discharge Elimination System (NPDES) permit regulations to improve the capacity, management, operation, and maintenance of municipal-owned sanitary sewer systems, as well as to improve the public notification procedures of SSO events (USEPA 2003c). A draft notice of proposed rulemaking was signed by the EPA administrator on January 4, 2001; however, the notice was withdrawn on January 24, 2001 to allow time for the new administration to review it. Currently, the USEPA and states are addressing SSO problems in accordance with the Compliance and Enforcement Strategy Addressing Combined Sewer Overflows and Sanitary Sewer Overflows, issued April 27, 2000.

6.6.1 SSO's in the Merrimack River Watershed

A review of the literature reveals that sanitary sewer and pump station overflows have not been identified as major source of pollution in the Merrimack River watershed. SSO's were not listed as a major source of pollution in the watershed in the Merrimack River Initiative's (MRI's) report "Water Quality in the Merrimack River Watershed", published in January 1997. This report provided a final assessment of water quality conditions in the Merrimack River watershed based on available data, including 303(d) and 305(b) Reports from Massachusetts and New Hampshire and monitoring data collected by the MRI during summer 1994 and fall 1995. Furthermore, neither of the states' more recent water quality assessments, such as New Hampshire's 2002 Water Quality Assessment and Consolidated Assessment and Listing Methodology (CALM) and Massachusetts' Year 2002 Integrated List of Waters (Part 1 and 2), list SSO's as contributing sources to the current non-attainment of water quality standards.

However, to our knowledge, no studies have been conducted in the Merrimack River watershed to identify and quantify the impact of SSO discharges in the Merrimack River watershed. Most recently, the "Draft Bacteria TMDL for the Shawsheen River Basin", published by the MADEP on February 7, 2002, noted one pump station overflow during wet weather to Vine Brook, a tributary of the Shawsheen River. The study noted that bacteria concentrations from this overflow were suspected to be on the same order of magnitude as for CSO discharges. However, the study was not able to quantify the number of overflows at this pump station or the total load of bacteria entering the system as a result.

6.7 Illicit Wastewater Discharges to Stormdrains

Illicit connections are defined as "illegal and/or improper connections to storm drainage systems and receiving waters" (Center for Watershed Protection 1998). Sources of illicit discharges can include illegal sanitary sewer connections, effluent from septic systems, commercial carwash or other industrial wastewaters, and improper disposal of auto and household toxics. These illicit discharges represent a significant threat to public health, since they may result in the discharge of untreated sewage and other toxics to the receiving waterbodies. However, the extent and magnitude of discharges resulting from illicit connections is difficult to determine without field reconnaissance and monitoring work.

A review of the literature reveals few studies to date that have been conducted by communities in the Merrimack River watershed to identify and eliminate illicit connections. As part of the bacteria TMDL development for the Shawsheen River, volunteers from the Merrimack River Watershed Council discovered several illicit commercial discharges in Billerica, Massachusetts discharging to the Shawsheen River. However, the literature review reveals that illicit discharges have not been identified as a significant source of contamination in the Merrimack River watershed. For example, illicit connections were not listed as a significant pollutant source in the MRI's "Water Quality in the Merrimack River Watershed", published in January 1997 or in either New Hampshire or Massachusetts' most recent state water quality assessment reports.

6.7.1 Future Detection Programs

In an effort to control the quality of stormdrain discharges, the USEPA is currently implementing Phase II of its National Pollutant Discharge Elimination System (NPDES) Stormwater Regulations. A general description of the Phase II program is provided in Section 3.4.

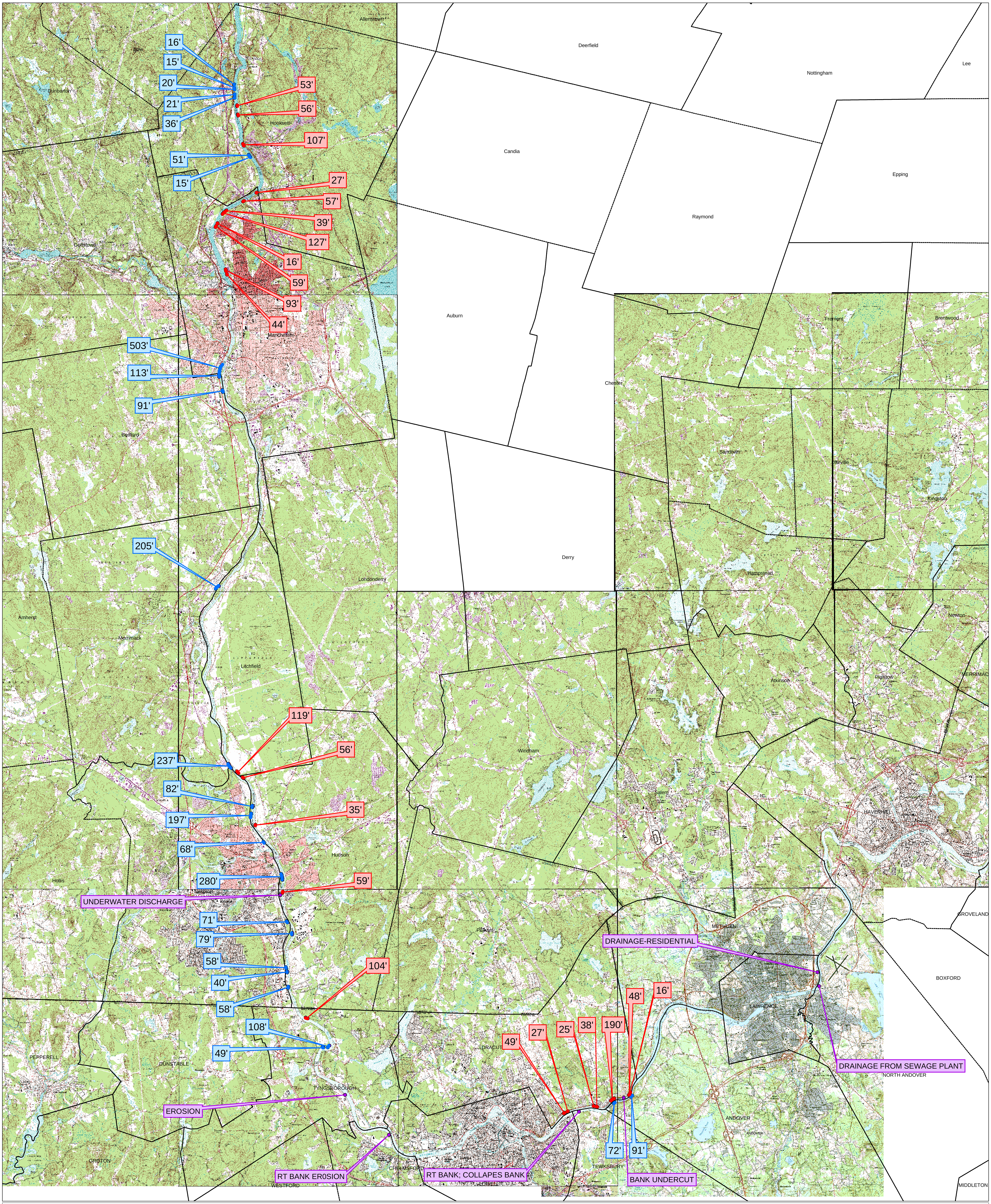
As part of this program, communities falling under the rule will be required to develop, implement, and enforce an illicit discharge detection and elimination program. The program must include the following components (USEPA 2000b):

- A storm sewer map showing the location of all outfalls and the names and locations of all receiving waterbodies
- A prohibition on non-stormwater discharges into MS4s (to the extent allowable under state, tribal, or local law) an applicable enforcement procedures through an ordinance or other regulatory mechanism
- A plan to detect and address non-stormwater discharges into the MS4, including illegal dumping

- The education of public employees, businesses, and the general public about the hazards associated with illegal discharges and improper disposal of waste

- The determination of appropriate best management practices (BMPs) and measurable goals for this program

The USEPA published the Phase II Final Rule in the Federal Register on December 8, 1999. It is anticipated that communities will begin implementing their respective stormwater management plans during summer or fall 2003; the implementation of plans must be completed over a five-year period.



Legend

Places of Erosion

Side of Shore

Left

Right

New Hampshire Towns

Massachusetts Towns

0 0.5 1 2 3 4 Miles

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Figure 6-6
Merrimack River Watershed
Results of Erosion Survey

CDM

Section 7
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Appendix A: Stormdrain Survey Field Notes

ID	DESCRIPTION	EASTING	NORTHING	COMMENTS
1	P < 36 "			24" CEMENT PIPE ROUND DRAIN
2	P < 36 "	202696.488	982568.977	24" CEMENT PIPE ROUND DRAIN
3	P > 36 "	202628.141	982036.875	3' CORRIGATED PIPE
10	P < 36 "	202651.629	981745.507	24" ROUND DRAIN
15	P < 36 "	202646.289	980636.616	24" PIPE
16	P < 36 "	202729.878	980255.809	24" PIPE
21	P < 36 "	203794.18	977698.658	18" PIPE
22	P > 36 "	203825.916	977557.748	3' PIPE
23	P < 36 "	202605.497	976442.257	24" CEMENT PIPE ROUND DRAIN
24	P < 36 "	202244.87	976284.825	CEMENT PIPE
25	P < 36 "	201476.223	974732.539	ROAD DRAIN
26	P > 36 "	201640.696	974333.243	CEMENT PIPE COMING FROM PRIVATE RESIDENCE
27	P < 36 "	202315.14	972743.391	CEMENT PIPE AT WATER LEVEL
40	misc.	202138.992	976000.892	SANDY BEACH
41	misc.	202161.233	976019.568	SANDY BEACH
58	P > 36 "	203177.556	982770.797	3' CEMENT PIPE POSSIBLE ROAD DRAIN
59	P < 36 "	202106.298	967553.900	RT BANK; 1ST DRAINAGE UPSTREAM OF SHORT FALLS; ERODED 2M AROUND PIPE
60	P < 36 "	202246.815	967734.685	LT BANK, PIC 2 CAN'T SEE PIPE
65	P < 36 "	202034.113	967826.188	RT BANK; DRAINAGE
66	P < 36 "	202026.255	967893.772	RT BANK; DRAINAGE
67	P < 36 "	202031.516	967930.475	RT BANK
68	P < 36 "	201932.264	968326.018	RT BANK
69	TRIBUTARY	201989.599	968112.282	RT BANK; STREAM
74	P < 36 " / WITH FLOW	201929.727	968563.341	RT BANK
77	P < 36 "	201988.043	968799.781	RT BANK; HIGHWAY DRAINAGE
78	P > 36 "	202246.176	969026.699	LT BANK; 2 PIPES
79	P > 36 "/ WITH FLOW	202278.646	969138.726	LT BANK; 2 PIPES
80	P < 36 " / WITH FLOW	202295.658	969166.628	LT BANK
81	P < 36 "	202306.510	969215.480	LT BANK; 2 PIPES
82	P > 36 "	202339.847	969247.090	LT BANK
83	TRIBUTARY	202331.770	969538.202	PISCATUAQUA RIVER SOUTH
84	TRIBUTARY	202366.719	969682.468	PISCATUAQUA RIVER NORTH
85	P < 36 "	202438.086	969429.882	LT BANK
86	P < 36 "	202363.561	969591.795	RT BANK
87	P < 36 "	202377.934	969662.652	RT BANK
88	P < 36 "	202400.945	969724.096	RT BANK
89	P > 36 "	202596.683	969816.588	LT BANK
90	P < 36 "	202458.536	969960.109	RT BANK
91	P > 36 "	202653.954	970077.812	LT BANK; BIG PIPE
92	P < 36 "	202648.351	970087.584	PHOTO32 MJ HEAD; SMALL PIPE
93	P < 36 "/HIGHWAY DRAINAGE	202468.263	970289.627	DRAINAGE FROM I93 EXIT5
94	P < 36 "/HIGHWAY DRAINAGE	202445.980	970375.371	DRAINAGE FROM I93 EXIT5
95	P < 36 "	203157.1007	966511.6583	24 " Drainage LT BANK
96	P < 36 "	203094.1584	966606.96	18 " Drainage RT BANK
97	P > 36 "	202253.6889	967738.0914	36 " DRAINAGE LT BANK
98	MISC.	202217.6445	967811.4255	12 ' DRAINAGE LT BANK
99	P < 36 "	202189.5876	967142.0026	12 ' DRAINAGE LT BANK
100	TRIBUTARY	202488.357	966694.2831	TRIB RT BANK NEAR EVERETT TRNPK
101	P < 36 "	202533.2023	966652.5626	24 " RT BANK
102	P < 36 "	213759.2629	932984.8361	PIPE
107	P < 36 "	202356.554	950224.667	24"METEL PIPE LOCATED IN STE52
108	P > 36 "	202168.575	950523.643	ROCK STORM DRAIN (RETAINING WALL ABOVE)
109	P > 36 "	202111.333	950666.248	3' STORM DRAIN
110	P > 36 "	202110.382	950686.408	3' ROCK STORM DRAIN
111	P < 36 "	202118.814	950856.769	24" STORM DRAIN (HEAVY EROSION)
112	P < 36 "	202125.409	950950.926	18" CEMENT PIPE
113	P > 36 "	201542.273	952225.032	3' * 3' OPENING (MAY BE A STREAM)
114	P > 36 "	201528.385	953235.285	3' CORRIGATED PIPE
115	P > 36 "	201348.798	953697.99	3' CEMENT STORM DRAIN
116	P < 36 "	201239.897	955965.662	12" CORRIGATED PIPE (PARKING LOT DRAIN)

ID	DESCRIPTION	EASTING	NORTHING	COMMENTS
117	P > 36 "	201127.118	956437.405	3' CEMENT PIPE
118	P < 36 "	202253.657	958904.081	24" PIPE
121	P > 36 "	201728.647	958385.801	3' PIPE
123	P < 36 "	201233.397	956532.324	24" PIPE
124	P > 36 "	201521.178	952479.93	3' PIPE
125	P < 36 "	NO GPS	NO GPS	12" PIPE
130	P < 36 "	203635.21	948604.011	18" CORRIGATED PIPE
133	P < 36 "	203453.218	948113.382	12" CONCRETE PIPE
140	P > 36 "	203401.815	947595.058	3' CONCRETE PIPE
143	P < 36 "	204113.008	946454.299	24" BRICK PIPE FROM HOUSING DEV
144	MISC.	204552.293	945862.649	3' OPENING BETWEEN BRIDGES
151	P > 36 "	204884.523	944779.183	3' PIPE WET WEATHER DISCHARGE OUTFALL 004
157	P > 36 "	205019.123	941534.484	3' CEMENT PIPE STORM DRAIN
158	P > 36 "	205048.816	940744.505	3' PLASTIC PIPE HALF SUBMERGED
163	P > 36 "	205101.138	940000.134	3' CEMENT STORM DRAIN
166	P > 36 "	205191.013	939537.315	3' CEMENT STORM DRAIN
167	P > 36 "	205301.256	939239.724	3' STORM DRAIN
168	P > 36 "	205323.432	939205.773	3' STORM DRAIN
175	P > 36 "	205616.29	938809.298	3' STORM DRAIN
176	P > 36 "	205318.395	939477.702	4' STORM DRAIN
177	P < 36 "	NO GPS	NO GPS	18"CEMENT PIPE
178	P < 36 "	205207.4	940789.624	BLACK 18" PIPE FROM GOLF COURSE
179	P > 36 "	205211.175	940881.893	3' CEMENT PIPE
180	P < 36 "	205146.206	941459.211	12" STORM DRAIN FROM ROADWAY
181	P < 36 "	205168.77	941595.685	12" STORM DRAIN FROM ROADWAY
182	P > 36 "	205191.245	942949.747	3' CEMENT STORM DRAIN
183	P < 36 "	204901.35	943988.757	18" CORRIGATED PIPE
186	P > 36 "	204822.352	945471.225	3' CEMENT PIPE FROM OLD BRIDGE
187	P > 36 "	204671.677	945877.885	3' BRIDGE DRAIN
188	P < 36 "	204693.029	945986.788	18" CEMENT ROAD DRAIN
189	P > 36 "	204500.274	946287.519	3' CEMENT PIPE
190	P < 36 "	204050.943	946776.754	18" PIPE
194	P > 36 "	208111.213	934040.9073	Stone Culvert
195	P < 36 "	207921.6792	934569.1198	CONCRETE
197	P < 36 "	207331.3129	935432.8465	PIPE
198	P < 36 "	206933.9268	935594.4882	PIPE
199		206596.3699	935616.9721	Stone Culvert
200	P < 36 "	206614.6562	935821.6755	CONCRETE
201	TRIBUTARY	209816.3471	933262.0714	IRON
202	TRIBUTARY	210250.1842	932001.07	STREAM
203	P < 36 "	212125.9638	932210.6616	IRON
204	P < 36 "	212267.6137	932231.1095	IRON
205	P < 36 "	212362.5796	932250.4167	IRON
206	P < 36 "	212577.0115	932293.5553	IRON
206	P < 36 "	221100.229	934774.513	DRAINAGE FOR RT110
209	TRIBUTARY	220294.114	934532.677	CREEK
210	TRIBUTARY	219291.587	934266.113	CREEK
211	P < 36 "	219158.311	934226.478	< 36 "
212	TRIBUTARY	218475.357	934086.822	TRIB CHANNEL
213	P > 36 "	218621.561	933934.477	36 "
214	P < 36 "	217807.803	933683.377	12 "
215	MISC.	217746.759	933640.831	MISC.
216	P > 36 "	217410.306	933279.381	36 "
217	MILL CANAL	215286.052	933521.129	MILL CANAL
218	TRIBUTARY	215337.621	933483.137	TRIB CHANNEL
219	P > 36 "	215527.895	933520.651	WASTE H20
220	P < 36 "	215623.390	933232.741	12 "
221	MISC.	215711.877	933170.283	DOUBLE ARM PIPE UPSTREAM; ADDITIONAL DISCHARGE
222	MISC.	215834.282	933096.574	MILL DISCHARGE\CANAL
223	MISC.	215902.991	933056.854	MILL DISCHARGE\CANAL
224	MISC.	215969.747	933012.778	MILL DISCHARGE\CANAL

ID	DESCRIPTION	EASTING	NORTHING	COMMENTS
225	MISC.	216006.358	932991.625	MILL DISCHARGE\CANAL
227	TRIBUTARY	216171.285	932919.748	CONFLEUNCE OF CONCORD RIVER
228	P > 36 "	216306.435	933024.809	36 "
229	P > 36 "	216375.545	933001.012	36 "
230	P > 36 "	216499.257	932972.697	36 "
231	P < 36 "	216490.510	932861.869	< 36 "
232	P < 36 "	216667.825	932899.422	< 36 "
233	P < 36 "	216820.667	932791.408	< 36 "
234	P < 36 "	217023.666	932777.671	< 36 "
235	P < 36 "	216997.085	932775.620	< 36 "
236	MISC.	217321.683	932770.756	INTAKE
237	P > 36 "	217207.406	932876.704	> 36 "
238	P < 36 "	217223.762	932878.086	< 36 "
239	P > 36 "	217413.612	933018.043	> 36 "
242	P > 36 "	218345.939	933814.666	> 36 "
249	P > 36 "	202533.2023	966652.5626	24 " RT BANK
250	TRIBUTARY	213759.2629	932984.8361	SM STREAM
251	CANAL	213515.7592	932809.7087	CANAL
252	P < 36 "	213215.3266	932283.9584	24 "
253	P < 36 "	213133.1444	932205.3434	18 "
254	P < 36 "	212807.509	932061.5444	12 "
255	P > 36 "	212055.9116	932208.0458	6 '
256	P < 36 "	212115.1054	932212.1782	12 " STEEL
257	P < 36 "	212270.1649	932234.4849	12 " STEEL
258	P < 36 "	212350.9701	932244.9345	DRAINAGE
259	P < 36 "	212505.9365	932278.5263	12 " STEEL
260	P < 36 "	212576.894	932280.9118	12 " STEEL
261	P < 36 "	212567.7247	932293.0722	12 " STEEL
262	P < 36 "	212699.6951	932315.5508	12 " STEEL
263	P < 36 "	212769.58	932331.001	12 " STEEL
264	P < 36 "	212800.3498	932339.2781	12 " STEEL
265	P < 36 "	212850.7824	932349.3371	18 " STEEL
266	P < 36 "	212894.8842	932358.7563	18 " STEEL
267	P < 36 "	213040.159	932402.9254	18 " STEEL
268	P < 36 "			12"CEMENT PIPE DRAIN
269	P > 36 "			4' CEMENT PIPE
270	P < 36 "	222006.404	936321.25	12" PIPE ROAD DRAIN
271	P > 36 "	221930.362	936182.814	3' PIPE HALF UNDERWATER
276	P < 36 "	221111.565	934758.577	12" ROAD PIPE
287	P < 36 "	219438.749	934237.509	12" PIPE AT END OF EROSION
288		218729.695	934120.405	
293	P > 36 "	217445.269	933277.117	4' PIPE- GPS 75' FROM PIPE
294	P > 36 "	218620.005	933940.858	3' CEMENT PIPE DRAIN FROM CONDOS
299	P < 36 "	223796.56	939013.142	24" CEMENT PIPE 3/4 SUBMERGED
301	TRIBUTARY	228915.651	939557.838	STREAM RUNOFF
302	P < 36 "	229375.605	939465.580	DRAINAGE PIPE
303	CANAL	229476.905	939470.103	RT BANK; SOUTHERN CANAL
304	P < 36 "	228692.170	939333.448	RT BANK; CANAL RUNOFF
307	P > 36 "	229804.146	940962.784	LT BANK; HIGHWAY DRAINAGE
308	P > 36 "	229814.584	941139.800	LT BANK; HIGHWAY DRAINAGE
309	P < 36 "	229991.775	941386.678	LT BANK DRAINAGE
310	P < 36 "	230223.317	941701.118	LT BANK DRAINAGE
311	P < 36 "	230503.405	942103.420	LT BANK DRAINAGE
312	P > 36 "	230543.378	942180.156	LT BANK DRAINAGE
313	P > 36 "	230712.970	942497.269	LT BANK DRAINAGE
314	P > 36 "	230807.668	942601.237	LT BANK DRAINAGE- RESIDENTIAL
315	P > 36 "	230909.628	942709.801	LT BANK DRAINAGE- RESIDENTIAL
316	P > 36 "	231088.350	944449.620	RT BANK
317	P > 36 "	234987.087	947169.26	3' PIPE FROM WALL
318	P > 36 "	234845.128	947182.138	3' STORM DRAIN
319	P < 36 "	234829.906	947180.659	12" PIPE STORM DRAIN
320	P < 36 "	234757.146	947184.499	24" + 18" PIPES PARKING LOT DRAINS

ID	DESCRIPTION	EASTING	NORTHING	COMMENTS
321	P > 36 "	234695.388	947175.97	3" PIPE FOR ROAD DRAIN
322	P < 36 "	234590.476	947148.481	24" PIPE
323	P > 36 "	234475.452	947106.615	3' PIPE PROBABLY STORM DRAIN
324	P > 36 "	234262.855	947030.785	3' PIPE
325	P < 36 "	234230.629	947001.239	24" PIPE
326	P < 36 "	234047.291	946932.998	24" PIPE
327	P < 36 "	233435.445	946476.937	12" PIPE
328	P > 36 "	233372.797	946397.831	3 PIPES DRAIN OF OLD FACTORY
329	P > 36 "	233299.609	946300.709	6" PIPE (EFFLUENT SMALL)
330	P > 36 "	233122.402	946066.092	3' PIPE
331	P > 36 "	233917.474	946745.382	3' PIPE PROBABLY STORM DRAIN
332	P > 36 "	234508.41	947016.159	3' PIPE
333	P > 36 "	234723.776	947039.744	3' PIPE PROBABLY STORM DRAIN
334	P > 36 "	235201.397	947101.567	3' PIPE (WATER COMING OUT)
335	P > 36 "	237191.504	945456.57	3' PIPE
336	P > 36 "	237401.788	945395.043	3' STORM DRAIN
337	P > 36 "	238403.407	946777.224	3' PLASTIC PIPE OF PRIVATE PROPERTY
338	P < 36 "	240852.065	952357.547	2" CORRIGATED PIPE ROAD DRAIN
339	P < 36 "	241404.451	952342.855	18" METAL PIPE
340	P < 36 "	241523.293	952371.176	12" PIPE
341	P < 36 "	241544.236	952372.023	24" ROAD DRAIN
342	MISC.	230586.056	941929.870	LT BANK; DRAINAGE
343	P < 36 " / WITH FLOW	230760.220	944490.871	RT BANK; DRAINAGE
344	P < 36 "	230249.343	945200.697	LT BANK; DRAINAGE
345	P < 36 "	230161.890	945404.322	LT BANK; DRAINAGE
346	TRIBUTARY	230152.803	945710.345	LT BANK; STREAM/DRAIN
347	P < 36 "	230231.065	946183.783	LT BANK; 2 DRAIN PIPES
348	P > 36 "	230230.001	946275.363	LT BANK; DRAINAGE
349	P < 36 "	230229.222	946328.217	LT BANK; DRAINAGE
350	P < 36 "	230183.549	946441.485	2 PIPES; DRAIN FROM PARKING LOT
351	P < 36 "	230127.573	946587.245	LT DRAIN
352	P < 36 "	230114.408	946647.921	LT DRAIN
353	TRIBUTARY	230119.822	947036.538	STREAM LT BANK
354	TRIBUTARY	230459.339	947220.262	STREAM LT BANK
355	MISC.	230794.379	946829.590	WATER TOO SHALLOW TO GET CLOSE
356	P < 36 "	230824.135	946771.855	DRAIN, SAME AS P12
357	MISC.	231027.817	946593.236	HIGHWAY DRAINAGE
358	P > 36 "	248048.648	953784.378	RT BANK; HIGHWAY DRAINAGE
359	TRIBUTARY	247923.668	953878.208	RT BANK; DRAIN
360	P < 36 "	246498.757	953847.346	LT BANK; PVC DRAIN
361	P < 36 "	246566.559	953949.635	LT BANK;DRAIN
362	P > 36 "	246690.399	954091.672	LT BANK;DRAIN
363	TRIBUTARY	247038.003	954599.524	LT BANK; TRIBUTARY

Appendix B: Erosion Survey Field Notes

ID	DESCRIPTION	EASTING	NORTHING	COMMENTS
4	EROSION	202635.733	982010.775	EROSION AT WATER LEVEL
5	EROSION	202629.101	981994.769	EROSION AT WATER LEVEL
6	EROSION	202642.414	981854.251	EROSION TOP OF BANK TO WATER
7	EROSION	202645.58	981840.289	EROSION TOP OF BANK TO WATER
8	EROSION	202645.112	981789.964	EROSION TOP OF BANK TO WATER
9	EROSION	202647.937	981769.335	EROSION TOP OF BANK TO WATER
11	EROSION	202657.578	981545.905	EROSION TOP OF BANK TO WATER
12	EROSION	202656.882	981526.471	EROSION TOP OF BANK TO WATER
13		202651.016	981407.314	EROSION TOP OF BANK TO WATER
14	EROSION	202649.134	981370.246	EROSION TOP OF BANK TO WATER
17	EROSION	203312.024	978710.619	EROSION TOP OF BANK TO WATER
18	EROSION	203343.803	978668.717	EROSION TOP OF BANK TO WATER
19	EROSION	203387.577	978609.004	EROSION TOP OF BANK TO WATER
20	EROSION	203393.095	978599.963	EROSION TOP OF BANK TO WATER
28	Undercut bank	202302.39	973101.259	UNDERCUT BANK
29	Undercut bank	202291.068	973138.076	UNDERCUT BANK
30	Undercut bank	202251.269	973274.895	UNDERCUT BANK
31	Undercut bank	202246.55	973299.246	UNDERCUT BANK
32	Undercut bank	202242.86	973318.51	UNDERCUT BANK
33	Undercut bank	202233.976	973363.189	UNDERCUT BANK
34	EROSION	201760.427	975332.219	EROSION TOP OF BANK TO WATER
35	EROSION	201788.868	975385.416	EROSION TOP OF BANK TO WATER
36	EROSION	201847.061	975505.57	EROSION TOP OF BANK TO WATER
37	EROSION	201853.885	975518.159	EROSION TOP OF BANK TO WATER
38	EROSION	202089.245	975942.844	EROSION TOP OF BANK TO WATER
39	EROSION	202111.146	975972.887	EROSION TOP OF BANK TO WATER
42	EROSION	202176.268	976037.53	EROSION TOP OF BANK TO WATER
43	EROSION	202244.741	976093.5	EROSION TOP OF BANK TO WATER
44	EROSION	202260.122	976106.531	EROSION TOP OF BANK TO WATER
45	EROSION	202274.91	976114.851	EROSION TOP OF BANK TO WATER
46	EROSION	203049.482	976525.785	EROSION TOP OF BANK TO WATER
47	EROSION	203094.468	976558.308	EROSION TOP OF BANK TO WATER
48	EROSION	203667.937	976934.49	EROSION TOP OF BANK TO WATER
49	EROSION	203687.896	976954.374	EROSION TOP OF BANK TO WATER
50	EROSION	203085.016	979135.683	EROSION TOP OF BANK TO WATER
51	EROSION	203063.221	979190.815	EROSION TOP OF BANK TO WATER
52	EROSION	203054.769	979213.025	EROSION TOP OF BANK TO WATER
53	EROSION	203044.995	979228.817	EROSION TOP OF BANK TO WATER
54	EROSION	202820.383	980550.567	EROSION TOP OF BANK TO WATER
55	EROSION	202805.131	980600.888	EROSION TOP OF BANK TO WATER
56	EROSION	202761.339	980987.889	EROSION TOP OF BANK TO WATER
57	EROSION	202770.951	981037.435	(GPS 50' OFFSHORE)
61	EROSION	202099.424	967624.204	RT BANK; 200 FT
62	EROSION			RT BANK; 200 FT
63	EROSION	202078.148	967710.849	RT BANK; 50 FT
64	EROSION			RT BANK; 50 FT
70	EROSION	201930.625	968325.554	RT BANK; 200 FT
71	EROSION			RT BANK; 200 FT
72	EROSION	201921.563	968438.808	RT BANK

ID	DESCRIPTION	EASTING	NORTHING	COMMENTS
73	EROSION			RT BANK
75	EROSION	201969.867	968706.852	RT BANK; 500 FT
76	EROSION			RT BANK; 500 FT
103	Undercut bank	202481.827	950042.178	BANK UNDERCUT, SOME VEGETATION
104	Undercut bank	202428.12	950123.18	BANK UNDERCUT, SOME VEGETATION
105	Undercut bank	202393.339	950184.741	BANK UNDERCUT
106	Undercut bank	202360.778	950243.294	BANK UNDERCUT
119	Undercut bank	201917.727	958550.541	BANK UNDERCUT
120	Undercut bank	201772.129	958420.726	BANK UNDERCUT
126	Undercut bank	202761.76	949883.864	BANK UNDERCUT
127	Undercut bank	202832.787	949790.534	BANK UNDERCUT
128	Undercut bank	203026.656	949604.875	BANK UNDERCUT
129	Undercut bank	203069.098	949564.956	BANK UNDERCUT
131	Undercut bank	203494.501	948278.426	BANK UNDERCUT
132	Undercut bank	203483.254	948197.271	BANK UNDERCUT
134	EROSION	203428.404	947914.711	EROSION TOP OF BANK TO WATER
135	EROSION	203425.576	947893.499	EROSION TOP OF BANK TO WATER
136	EROSION	203420.877	947879.651	EROSION TOP OF BANK TO WATER
137	EROSION	203409.526	947805.03	UNDERCUT BANK + SOME VEGETATION
138	EROSION	203401.468	947764.032	EROSION TOP OF BANK TO WATER
139	EROSION	203399.099	947726.473	EROSION TOP OF BANK TO WATER
141	EROSION	203998.696	946595.776	EROSION TOP OF BANK TO WATER
142	EROSION	204037.282	946538.284	SOME VEGETATION
145	EROSION	204835.863	945087.698	EROSION TOP OF BANK TO WATER
146	EROSION	204851.06	945031.27	SOME VEGETATION
147	EROSION	204856.591	945018.546	EROSION TOP OF BANK TO WATER
148	EROSION	204880.2	944933.855	SOME VEGETATION
149	EROSION	204888.737	944871.084	EROSION TOP OF BANK TO WATER
150	EROSION	204886.421	944814.204	EROSION TOP OF BANK TO WATER
152	Undercut bank	204796.867	944100.8	UNDERWATER DISCHARGE
153	Undercut bank	205079.282	942873.043	UNDERCUT BANK
154	Undercut bank	205121.864	942817.247	UNDERCUT BANK
155	EROSION	205352.915	942331.534	EROSION TOP OF BANK TO WATER
156	EROSION	205349.541	942254.547	EROSION TOP OF BANK TO WATER
159	EROSION	205050.574	940728.664	EROSION MIDDLE OF BANK TO WATER
160	EROSION	205066.056	940676.628	EROSION MIDDLE OF BANK TO WATER
161	EROSION	205120.005	940522.577	EROSION TOP OF BANK TO WATER
162	EROSION	205114.812	940482.134	EROSION TOP OF BANK TO WATER
164	Undercut bank	205166.418	939818.343	UNDERCUT BANK
165	Undercut bank	205156.633	939762.088	UNDERCUT BANK
169	Undercut bank	207086.52	937059.273	UNDERCUT BANK
170	Undercut bank	207012.783	936970.788	UNDERCUT BANK
171	EROSION	206803.527	936966.633	EROSION TOP OF BANK TO WATER
172	EROSION	206766.042	936993.405	EROSION TOP OF BANK TO WATER
173	Undercut bank	206069.046	938329.941	UNDERCUTTING +TOP TO BOTTOM
174	Undercut bank	205976.072	938368.855	UNDERCUTTING +TOP TO BOTTOM
184	EROSION	204896.183	944206.284	EROSION TOP OF BANK TO WATER
185	EROSION	204907.664	944263.169	EROSION TOP OF BANK TO WATER
191	EROSION	203622.802	947350.25	EROSION TOP OF BANK TO WATER

ID	DESCRIPTION	EASTING	NORTHING	COMMENTS
192	EROSION	203627.321	947385.749	EROSION TOP OF BANK TO WATER
193	EROSION	209874.8475	932890.1211	RT BANK ER0SION
196	EROSION	207818.518	934754.5181	EROSION
240	EROSION	218089.127	933918.136	LT BANK; COLLAPES BANK
241	EROSION			LT BANK; COLLAPES BANK
243	EROSION	218761.415	933970.658	RT BANK; COLLAPES BANK
244	EROSION			RT BANK; COLLAPES BANK
245	EROSION	220246.196	934486.570	LT BANK; COLLAPES BANK
246	EROSION			LT BANK; COLLAPES BANK
247	EROSION	220394.403	934591.318	LT BANK; COLLAPES BANK
248	EROSION			LT BANK; COLLAPES BANK
272	Undercut bank	221161.897	934877.109	BANK UNDERCUT
273	Undercut bank	221157.415	934862.272	BANK UNDERCUT
274	EROSION	221131.343	934780.583	EROSION TOP OF BANK TO WATER
275	EROSION	221117.217	934767.754	EROSION TOP OF BANK TO WATER
277	Undercut bank	221096.371	934748.517	(5 PHOTOS) BANK UNDERCUT
278	Undercut bank	220854.733	934623.419	BANK UNDERCUT
279	EROSION	220407.594	934591.061	EROSION TOP OF BANK TO WATER
280	EROSION	220364.509	934566.502	EROSION TOP OF BANK TO WATER
281	EROSION	220322.442	934549.632	EROSION TOP OF BANK TO WATER
282	EROSION	220306.103	934529.505	EROSION TOP OF BANK TO WATER
283	Undercut bank	219612.769	934195.348	BANK UNDERCUT
284	Undercut bank	219579.173	934207.945	BANK UNDERCUT
285	Undercut bank	219463.823	934239.64	BANK UNDERCUT
286	Undercut bank	219440.311	934246.993	BANK UNDERCUT
289	EROSION	218246.642	933988.798	EROSION TOP OF BANK TO WATER
290	EROSION	218224.186	933976.027	EROSION TOP OF BANK TO WATER
291	EROSION	218086.037	933917.554	EROSION TOP OF BANK TO WATER
292	EROSION	218048.569	933892.131	EROSION TOP OF BANK TO WATER
295	EROSION	220381.095	934356.502	EROSION TOP OF BANK TO WATER
296	EROSION	220440.534	934402.681	EROSION TOP OF BANK TO WATER
297	EROSION	221194.623	934659.854	EROSION TOP OF BANK TO WATER
298	EROSION	221255.78	934727.849	EROSION TOP OF BANK TO WATER
305	EROSION	229988.935	939840.461	RT BANK; DRAINAGE FROM sewage PLANT
306	EROSION	229914.949	940493.538	LT BANK; DRAINAGE-RESIDENTIAL
Source: Normandeau Associates, field surveys. Fall 2002.				