

***2004 Water Quality Reports  
for the  
Nashua River and Tributaries***



**prepared by:  
Nashua River Watershed Association**

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# 2004 Water Quality Monitoring Report

## TABLE of CONTENTS

<b>Executive Summary .....</b>	<b>3</b>
<b>Introduction.....</b>	<b>4</b>
<b>Field and Lab Methods.....</b>	<b>4</b>
Sampling Dates: .....	4
Parameters:.....	4
Site Selection: .....	5
Data Collection in the Field: .....	5
Lab Methods: .....	5
<b>Descriptions of Waterbodies and Monitoring Sites.....</b>	<b>6</b>
Description of River Section 1: Nashua River Mainstem, Catacunamaug Brook, and the South Nashua River.....	6
Description of River Section 2: Nissitissit River and Gulf Brook.....	7
Description of River Section 3: Squannacook River and Willard Brook .....	8
Description of River Section 4: North Nashua River, Flag Brook, Wekepeke Brook, and Phillips Brook .....	8
<b>Results and Discussion of Monitoring (organized by parameter).....</b>	<b>9</b>
<u>BACTERIA</u> .....	9
<u>Bacteria on River Section 1: Nashua River Mainstem, Catacunamaug Brook, and the South Nashua River</u> .....	11
<u>Bacteria on River Section 2: Nissitissit River and Gulf Brook</u> .....	13
<u>Bacteria on River Section 3: Squannacook River and Willard Brook</u> .....	13
<u>Bacteria on River Section 4: North Nashua River, Flag Brook, and Phillips Brook</u> .....	14
<u>pH AND ALKALINITY (as CaCO<sub>3</sub>)</u> .....	15
<u>pH and Alkalinity on River Section 1: Nashua River Mainstem, Catacunamaug Brook, and the South Nashua River</u> .....	16
<u>pH and Alkalinity on River Section 2: Nissitissit River and Gulf Brook</u> .....	17
<u>pH and Alkalinity on River Section 3: Squannacook River and Willard Brook</u> .....	19
<u>pH and Alkalinity on River Section 4: North Nashua River, Flag Brook, and Phillips Brook</u> .....	19
<u>DISSOLVED OXYGEN</u> .....	19
<u>Dissolved Oxygen on River Section 1: Nashua River Mainstem, Catacunamaug Brook, and the South Nashua River</u> .....	20
<u>Dissolved Oxygen on River Section 2: Nissitissit River and Gulf Brook</u> .....	20
<u>Dissolved Oxygen on River Section 3: Squannacook River and Willard Brook</u> .....	21
<u>Dissolved Oxygen on River Section 4: North Nashua River, Flag Brook, and Phillips Brook</u> .....	21
<u>TOTAL PHOSPHORUS</u> .....	21
<u>TEMPERATURE</u> .....	22
<u>Temperature on River Section 1: Nashua River Mainstem, Catacunamaug Brook, and the South Nashua River</u> .....	22
<u>Temperature on River Section 2: Nissitissit River and Gulf Brook</u> .....	22

<u>Temperature River Section 3: Squannacook River and Willard Brook.....</u>	23
<u>Temperature on River Section 4: North Nashua River, Flag Brook, and Phillips Brook.....</u>	23
<b>Conclusion.....</b>	<b>23</b>
<b>Acknowledgements.....</b>	<b>24</b>
<b>Appendix A: Sampling Site Locations .....</b>	<b>25</b>
<b>Appendix B: Map of Watershed.....</b>	<b>26</b>
<b>Appendix C: Field Data Sheet sample .....</b>	<b>26</b>
<b>Appendix D: Data by Parameter .....</b>	<b>26</b>

## **Executive Summary**

The 2004 season marked the twelfth year that the Nashua River Watershed Association (NRWA), with the help of many volunteers, monitored the water quality of the Nashua River and its tributaries. From April through October, 33 field volunteers collected data once a month at 29 streamside sites throughout the watershed. The NRWA partnered with three laboratories to analyze the samples: the Devens Wastewater Treatment Facility operated by Earth Tech, the City of Leominster Fallbrook Water Treatment Facility, and the City of Nashua Wastewater Treatment Facility. Lab volunteers, lab staff, and the NRWA staff analyzed the samples for bacteria, dissolved oxygen, pH, alkalinity, and phosphorus. Temperature and habitat characteristics were recorded in the field. In both the field and the lab, quality control procedures were followed according to the NRWA water quality monitoring Quality Assurance Project Plan.

While once one of the most polluted rivers in the country due primarily to point-source pollution, the greatest challenge to the Nashua River and its tributaries now is non-point source pollution, which largely stems from increased development of the land in the watershed.

Because of the frequent rain, bacteria counts were high throughout the watershed in the 2004 season; they were highest on the North Nashua River. The North Nashua River, the mouth of the South Nashua River, and the first site on the Mainstem downstream of the meeting of the North and South Nashua experienced high bacteria counts regardless of the weather. This is most likely due to urbanization.

In April, every site that was tested throughout the watershed had low alkalinity and pH readings, probably due to the acids built-up in the melting snow and spring runoff. Alkalinity remained low throughout the 2004 season in the Squannacook River, Philips Brook (a tributary of the North Nashua River), and the headwaters of the Nissitissit River. pH was frequently below standards in Philips Brook, the headwaters of the Nissitissit River, and the mouth of the Nashua Mainstem. It was not low on the Squannacook River despite low alkalinity, indicating that the pH of the water entering the river was within range.

Dissolved oxygen readings were generally within an acceptable range with a few exceptions. Dissolved oxygen was very low at Pepperell Pond in September and October, partially due to the decomposition of the water chestnuts that blanketed the area earlier in the season. This popular bass fishing area could see a decrease in fish numbers if the water chestnuts continue to proliferate. On the Nissitissit River at the Bohannon Bridge, dissolved oxygen levels were below standards when measured as percent saturation every month except April, when it was at the minimum standard (75%). High temperatures and slow moving, murky water may be impacting the dissolved oxygen at this site.

The Mainstem and the North Nashua Rivers never exceeded standards for temperature (28.3°C for warm-water fisheries). The Nissitissit River frequently exceeded standards for cold-water fisheries (20°C) at all sites (except Gulf Brook, a tributary) and in August the Squannacook River exceeded cold-water fisheries at all sites except one (which was borderline at 20°C).

## **Introduction**

The Nashua River Watershed is located in the central highlands of southern New England within the Merrimack River Watershed. It covers 538 square miles and includes 31 towns in north central Massachusetts and south central New Hampshire. The mainstem of the Nashua River runs north and flows into the mainstem of the Merrimack River in Nashua, New Hampshire.

While once one of the most polluted rivers in the country due primarily to point-source pollution, the greatest challenge to the Nashua River and its tributaries now is non-point source pollution, which largely stems from increased development of the land in the watershed. Many of the stresses to the river and its wildlife are less visible today than they were 30 years ago. The river no longer changes color on a daily basis and raw sewage only occasionally floats downstream. However, the river does not meet Class B standards on every section and a continued commitment to cleaning it up and keeping it clean is still needed.

Since 1993 the Nashua River Watershed Association (NRWA), with the help of many volunteers, has been monitoring the quality of the water throughout the watershed. The goals of the volunteer monitoring program are to:

- Monitor waters in the watershed for recreational contact safety, trends, and “hotspot” issues;
- Serve as a basis for coordination with state and federal officials charged with evaluating the health of the basin’s waterways;
- Conduct public outreach and education about non-point source pollution impacts and other threats to water quality; and
- Promote stewardship of the waterbodies in the watershed.

The following report describes the methods and results of the 2004 monitoring season.

## **Field and Lab Methods**

### **Sampling Dates:**

The 2004 water quality monitoring season ran from April through October. The 2004 sampling dates were on the third Saturday of each month (except May): April 17, May 22, June 19, July 17, August 21, September 18, and October 16. For statewide consistency and laboratory quality control, the sampling dates were chosen according to the Massachusetts Water Watch Partnership (MassWWP) sampling dates.

### **Parameters:**

Parameters monitored were:

- Bacteria (fecal coliform or E. coli depending on site location)
- pH
- Alkalinity
- Dissolved oxygen
- Temperature
- Phosphorus (measured and recorded, but decided by the NRWA that the results were not accurate enough to report).

**Site Selection:**

Sites were chosen based on a number of factors including accessibility and safety, condition of waterbody, location of confluences, and continuity from previous years. The NRWA also chose many of the sites recommended by Maggie Lowry in her GIS-based master’s thesis, “*Site selection for the Nashua River Watershed Association volunteer water quality monitoring program*”. Through a detailed and well-designed analysis, she incorporated “site accessibility; the locations of river and stream confluences; land use; streams and ponds known to have exceptionally good or exceptionally bad water quality; and a set of other features that could affect or be affected by surface water quality, such as point discharges into streams and water-based recreation sites.”<sup>1</sup> Descriptions of the rivers and the sites can be found in the following section.

**Data Collection in the Field:**

During the 2004 season, 33 field volunteers collected data at 29 streamside sites along the Nashua River and its tributaries (Appendix A: Map of Watershed, Appendix B: Site Descriptions). In the field, the volunteers made notes about the stream habitat, wildlife sightings, pollution, weather, water level, and other observations on their field data sheets (Appendix C: Field Data Sheets). They recorded the temperature of the air and the water and collected water samples for bacteria, pH, alkalinity, dissolved oxygen, and phosphorus.

Water sampling techniques followed procedures adapted from the MassWWP. Volunteers were trained in sampling techniques at a workshop conducted at the Nashua River Watershed Association’s (NRWA) River Resource Center in Groton, Massachusetts. Volunteers were also provided with written protocols to follow in the field.

**Lab Methods:**

In 2004, the NRWA partnered with three laboratories: the Devens Wastewater Treatment Facility operated by Earth Tech, the City of Leominster Fallbrook Water Treatment Facility, and the City of Nashua Wastewater Treatment Facility. After completing sampling, field volunteers drove their samples and field data sheets to one of the three above labs where lab volunteers, NRWA staff, and lab staff analyzed the samples using the methods specified in Table 1. Many of the lab volunteers are professional laboratory scientists. All lab volunteers were trained in the specific protocols by NRWA and lab staff.

Table 1. Analysis methods

Parameter	Units	Analysis method
Temperature	°C	<i>in situ</i>
Dissolved Oxygen	mg/L	Winkler titration method using sodium thiosulfate
pH	std. Units	Laboratory pH/ion meter
Alkalinity	mg/l as CaCO	Double end point titration using sulfuric acid
Fecal coliform	colonies/100 mL	Membrane Filter Technique, Stand. Methods 9222-D.
E. coli	colonies/100 mL	Membrane Filter Technique, EPA 1103.1
Total Phosphorus	mg/L	Hach Test 'N Tube Procedure Method 8190

## **Descriptions of Waterbodies and Monitoring Sites**

### **Description of River Section 1: Nashua River Mainstem, Catacunamaug Brook, and the South Nashua River**

River section 1 includes the mainstem of the Nashua River, Catacunamaug Brook (a tributary of the Nashua River mainstem), and the South Nashua River. The mainstem of the Nashua River starts where the North and South Nashua Rivers merge in Lancaster, MA. The mainstem flows north from Lancaster, up through Bolton Flats Wildlife Management Area, past the former Fort Devens Military Reservation, the Oxbow National Wildlife Refuge, and the town of Shirley, into Groton and Pepperell Pond (an impoundment), through Pepperell and Hollis, and into Nashua. At its mouth in Nashua, NH, the Nashua River flows into the Merrimack River. The urbanization in and around the city of Nashua has some influence on the water quality for the lowest stretch of river. The towns of Pepperell and Ayer discharge treated wastewater to the mainstem, as does the Groton School. A wastewater treatment facility at Devens discharges to groundwater adjacent to the river. The mainstem of the Nashua River is considered a warm water fishery.

Catacunamaug Brook starts above Lake Shirley and flows southeast toward its confluence with the Nashua River in Shirley. It flows through forested land and a large wetland for approximately one mile after leaving Lake Shirley. It then enters the village of Shirley where it flows through open land and residential areas starting approximately where it crosses the Shirley-Leominster Road. It is dammed in Shirley to form Phoenix Pond. There are two outlets from Phoenix Pond, which converge again just upstream of Lovell Road, which is just upstream from the confluence with the Nashua River. The only monitoring site on Catacunamaug Brook (**CT01**) is at Lovell Road. Catacunamaug Brook enters the mainstem of the Nashua River about 100 ft downstream of the Hospital Road Bridge in Shirley.

The South Nashua River begins in Clinton, MA at the Wachusett Reservoir Dam outflow and flows northerly around the east side of Clinton. In South Lancaster, the South Nashua River joins the North Nashua River. One wastewater treatment plant is located on the South Nashua in Clinton. The one monitoring point on the South Nashua (**SN01**) is located downstream of the town of Clinton and upstream of South Lancaster.

Table 2. 2004 Monitoring Sites on River Section One

<b>Nashua River Mainstem, Catacunamaug Brook, and South Nashua River</b>		
<b>Site</b>	<b>Water Body, Town</b>	<b>Field Description of Site Location</b>
NM11	Nashua River, Nashua, NH	144 Canal Street. BAE parking lot behind Area Agency.
NM02	Nashua River, Nashua, NH	Mine Falls Park at boat launch.
NM03	Nashua River, Hollis, NH	At Route 111 – downstream of bridge.
NM04	Nashua River, Pepperell, MA	Upstream side of the covered bridge, north bank.
NM05	Nashua River, Pepperell/Groton, MA	Pepperell Pond at Pepperell/Groton town line- off the bike path.
NM06	Nashua River, Groton, MA	Petapawag- downstream of 119 at boat ramp.
NM08	Nashua River, Shirley/Devens, MA	Upstream of Hospital Road bridge on eastern shore.
NM09	Nashua River, Harvard, MA	Tank bridge at Still River Road
NM10	Nashua River, Lancaster, MA	Downstream of Route 117 bridge, west side.
CT01	Catacunamaug Brook, Shirley, MA	At Lovell Road- mouth of brook on south bank. Enters Mainstem downstream of upstream of site NM08.
SN01	South Nashua River, Lancaster, MA	Upstream of Mill Street bridge, south side. Enters Mainstem upstream of site NM10

Note: Sites ordered downstream to upstream. Tributaries listed at end.

### **Description of River Section 2: Nissitissit River and Gulf Brook**

The headwaters of the Nissitissit River are in Brookline, NH near Melendy Pond. The river flows south forming extensive wetlands through Brookline and then forms Potanipo Pond. The lower portion of the river is swift moving and contains many riffled areas that are well shaded. There are several adjacent farmlands. The Nissitissit River runs briefly through Hollis, NH before entering Massachusetts and joining the mainstem in Pepperell, MA. The river is a well-regarded cold-water fishery. In Massachusetts, the Nissitissit and its tributaries are designated “Outstanding Resource Waters”.

Gulf Brook flows north from Heald Pond in Pepperell, MA through a narrow, forested valley and joins the Nissitissit on the Hollis, NH/ Brookline, NH line just north of the Massachusetts/New Hampshire border. The Gulf Brook (**GB01**) sample is collected at Chestnut Street adjacent to a former water bottling plant.

Table 3. 2004 Monitoring Sites on River Section Two

<b>Nissitissit River and Gulf Brook</b>		
<b>Site</b>	<b>Water Body, Town</b>	<b>Field Description of Site Location</b>
NT01	Nissitissit River, Pepperell, MA	100 yds upstream from mouth of river. Behind Lomar Industrial Park
NT06	Nissitissit River, Pepperell, MA	Below Rt. 111 bridge
NT02	Nissitissit River, Pepperell, MA	Upstream of Prescott Street bridge
NT04	Nissitissit River, Brookline, NH	200 ft. downstream from Bohannon bridge at “fishing area”
NT05	Nissitissit River, Brookline, NH	100 ft. downstream from Potanipo Lighthouse
GB01	Gulf Brook, Pepperell, MA	Upstream of Chestnut Street. Enters Nissitissit downstream of site NT04.

Note: Sites ordered downstream to upstream. Tributaries at end of list.

### Description of River Section 3: Squannacook River and Willard Brook

The Squannacook River begins at the confluence of Mason and Willard Brooks in West Townsend, MA. Mason Brook begins in Mason, NH; Willard Brook begins in Ashby, MA. Both brooks flow through mostly forested lands with little residential or commercial development within their respective drainages. Willard Brook, just before it joins with Mason Brook, flows past homes with septic systems and agricultural concerns close to the brook.

The Squannacook River in West Townsend flows past several active agricultural fields and pastures, and then runs parallel to the more developed Rte. 119 corridor in Townsend and into Harbor Pond. The Squannacook is buffered on both sides by forested land as it flows through the Squannacook-Bertozzi Wildlife Management Area. Hollingsworth and Vose Co., a paper mill that produces specialized paper products, is located on the Squannacook in West Groton. Hollingsworth and Vose maintains a dam and has a small treatment plant that discharges to the river. The river forms the border between Shirley and Groton. The Groton Town Forest borders the river to the north until it joins the Nashua River near Route 2A. The Squannacook River and all tributaries to Hollingsworth and Vose in West Groton are considered “Outstanding Resource Waters”.

Table 4. 2004 Monitoring Sites on River Section Three

<b>Squannacook River and Willard Brook</b>		
<b>Site</b>	<b>Water Body, Town</b>	<b>Field Description of Site Location</b>
SQ03	Squannacook River, Groton	Opposite Candice Lane, off Townsend Road.
SQ04	Squannacook River, Townsend	Downstream from Shepard's Auto Body, below Harbor Pond.
SQ06	Squannacook River, Townsend	At Adams Dam
WB01	Willard Brook, West Townsend	Upstream of West Meadow Road Bridge.

Note: Sites ordered downstream to upstream. Tributaries at end of list.

### Description of River Section 4: North Nashua River, Flag Brook, Wekepeke Brook, and Phillips Brook

The North Nashua River begins at the confluence of the Whitman River and Flag Brook in West Fitchburg, MA. It flows southeasterly through the cities of Fitchburg and Leominster where it is affected by urban influences, including ten dams and three wastewater treatment facilities. A mixture of open and forested lands borders the river as it flows through Lancaster. In South Lancaster, the North Nashua River joins the South Nashua River at the “Meeting of the Waters” and flows north as the mainstem of the Nashua River.

Wekepeke Brook flows north from Sterling and Lancaster through mixed residential, forested and agricultural areas and into Bartlett Pond. It joins the North Nashua near the intersection of Route 190 and Route 117.

Phillips Brook begins at the outflow from Winnekeag Lake in Ashburnham, flows south through Westminster to join the North Nashua River in West Fitchburg. Phillips Brook runs through suburban development in Ashburnham, forested and agricultural lands in

Westminster, and urban development for a short, but influential stretch in Fitchburg where it joins the North Nashua River.

Table 5. 2004 Monitoring Sites on River Section Four

<b>North Nashua River, Phillips Brook, and Flag Brook</b>		
<b>Site</b>	<b>Water Body, Town</b>	<b>Field Description of Site Location</b>
NN01	North Nashua River, Lancaster, MA	Main Street railroad crossing. Access is a dirt road off of Route 70, on left after bridge over N. Nashua.
NN02	North Nashua River, Lancaster, MA	Cook Conservation Area power line crossing. Access is at Conservation Area-through gate.
NN03	North Nashua River, Lancaster	Rte 190. Accessed off Rt. 117 North Main Street.
NN12	North Nashua River, Leominster	Behind Gear Works Cyclery on Hamilton Street.
NN09	North Nashua River, Fitchburg	Behind McDonald's parking lot. Access behind large shrub.
NN11	North Nashua River, Fitchburg	Along Rt. 12 near the West Fitchburg Restaurant.
FB01	Flag Brook, Fitchburg	Opening just before RR overpass on Rt. 31
WE01	Wekepeke Brook, Lancaster, MA	South side of Route 117, DS of Bartlett Pond outlet; access through private yard.
PB03	Phillips Brook, Fitchburg, MA	Phillips Brook behind British-American club on Rt. 12 (Junction of Nashua and Phillips Brook)
PB02	Phillips Brook, Ashburnham, MA	Off River Street at former town swimming pond, upstream of dam.

Note: Sites ordered downstream to upstream. Tributaries at end of list.

## **Results and Discussion of Monitoring (organized by parameter)**

### **BACTERIA**

Fecal coliform bacteria are bacteria that primarily aid in digestion and are excreted by animals. Fecal coliform is a subset of total coliform bacteria. *E. coli* is a species of fecal coliform and is specific to warm blooded animals. Fecal coliform bacteria are not necessarily harmful to humans, but their presence is a good indicator of harmful, harder to measure pathogens. *E. coli* bacteria is a better indicator than the more general fecal coliform.

Since the Nashua River Watershed is shared by Massachusetts and New Hampshire, the NRWA analyzed bacterial data based on standards set by the state in which each sample was analyzed. New Hampshire's standards for bacteria are based on *E. coli*. Massachusetts bases its standards on fecal coliform, except its swimming beaches. *E. coli* has been the standard in Massachusetts for swimming beaches since 2002.

In New Hampshire, recreational waters that are not swimming beaches should not have more than 406 *E.coli* colonies/100mL in any one sample, or more than 126 col./100mL in a 60-day, three-sample geometric mean<sup>2</sup>. At swimming beaches, the *E.coli* should not exceed 88

colonies per 100 mL in any one sample, nor exceed a three-sample geometric mean of 47 col./100 mL over a 60-day period.

In Massachusetts, fecal coliform bacteria in areas that are not swimming beaches should not exceed a geometric mean of 200 colonies /100 ml in any representative set of samples, nor should 10% of the samples exceed 400 col./100 mL<sup>3</sup>. E. coli at swimming beaches should not spike greater than 235 col./100mL, nor should the geometric mean of five samples be over 126 col./100ml.<sup>4</sup>

In April, all ten sites in the watershed that were monitored by NRWA volunteers were tested for fecal coliform levels. In the remaining months, eight sites (four on the mainstem-**NM11** and **NM02** in Nashua, **NM03** in Hollis, and **NM04** in Pepperell- and four on the Nissitissit-**NT01** and **NT06** in Pepperell and **NT04** and **NT05** in Brookline) were tested for E. coli instead (because they were analyzed at the lab in New Hampshire). In 2005, all sites will be tested for E. coli.

Tests measuring fecal coliform and E. coli bacteria cannot identify the source of the bacteria (i.e. human, cow, raccoon, duck, etc.); therefore, it is not possible to know exactly what is causing the high bacteria counts. Using knowledge of the site and the weather conditions leading up to sampling, one can draw potential conclusions.

To identify any trends linked to increased precipitation, the bacteria data was separated into wet weather and dry weather sampling days. Although rain varied each day, April, June, and July were considered dry weather days and the sampling days in May, August, September, and October were considered wet weather days.

Bacteria counts are often higher during wet weather. Waste from animals (including farm, wild, and domestic animals) is flushed down storm drains and into the streams. Areas with large amounts of impervious surface, such as roads, parking lots, and buildings, generally have problems with run-off washing built-up debris into the waterways, even in small rain events.

In contrast, marshy areas with slow moving water tend to hold bacteria back from reaching sites downstream. In slow water, sediment particles drop out of the water column and settle on the stream bottom. Since bacteria binds more readily to sediment than to the water, the bacteria drops out of the water column as well. However, in the event of a flash flood or similar rain event, the sediment along with the bacteria can be flushed out of the wetland system and moved downstream.

In the Nashua River Watershed, the cities of Nashua on the Mainstem and Fitchburg on the North Nashua River both have “combined sewers”, which are designed to send both storm water run-off and sewage (combined) to the wastewater treatment plant in periods of low flow. During heavy rains (such as the rain from Hurricane Ivan in September) when there is more water than the wastewater treatment plant can handle, excess water (both storm water and untreated sewage) is diverted directly into the river. This generally causes high bacteria counts.

Wet weather is not the only time high bacteria counts are observed. During long periods of drought, bacteria levels can be high as well because the bacteria become concentrated as the amount of water in the streams decreases. Wildlife, and waterfowl in particular, can cause high bacteria counts even during dry weather when they defecate directly into the water. Another possible cause of high bacteria levels is old houses that have either sewer pipes straight to the river or cracked and leaky septic tanks and pipes.

### **Bacteria on River Section 1: Nashua River Mainstem, Catacunamaug Brook, and the South Nashua River**

All of the sites in River Section 1, except **NM08** in Shirley, exceeded standards (at least 10% of the samples exceeded 400 col./100 mL for fecal coliform or 406 col./ 100 mL for E. coli) during the 2004 sampling season.

#### ***Sites exceeding standard during both wet and dry weather sampling:***

Four sites- **SN01**, **NM10**, **CT01**, and **NM06**- exceeded standards on both wet and dry sampling days. Farthest upstream, site **SN01** on the South Nashua River exceeded fecal coliform standards on three of the four days sampled. The South Nashua sub-basin has 17 percent impervious cover, which, percentage wise, is the second most impervious basin in the watershed after the North Nashua sub-basin.

On the mainstem of the Nashua, site **NM10** in Lancaster gives the greatest cause for concern. Fecal coliform levels were not only consistently above the state standard throughout the season (on both wet and dry days); they were also among some of the highest numbers recorded this season on the mainstem. Counts ranged from 670 col./100 mL to 5,600 col./100 mL. A possible cause could be that just upstream of site **NM10**, the North Nashua River and the South Nashua River meet and form the mainstem. Fecal coliform on both of these rivers was consistently high, so it is perhaps not surprising that the mainstem would have high levels of coliform as well. In addition, **NM10** borders the Bolton Flats Wildlife Management Area. Listed wildlife found in the Management Area include stocked pheasant, aquatic fur-bearers, grouse, woodcock, deer, snowshoe hare, fox, waterfowl, herons, crows, raptors, and numerous non-game species<sup>5</sup>. Another possible cause could be cracked or leaky septic tanks or pipes.

Site **CT01** on Catacunamaug Brook only exceeded standards twice- in June (a dry weather event) with a count of 640 col./100 mL and in September (during the rains of Hurricane Ivan) with a count of 440 col./100 mL. The June bacteria level could be attributed to wildlife; ducks frequent the ponds upstream. In September, the heavy rains could impact the site by increasing run-off from the town of Shirley, which is upstream of the site. Since the site is not immediately adjacent to the town, lighter rains might not impact bacteria levels as much.

Downstream of **CT01**, site **NM06** in Groton exceeded fecal coliform standards in the dry weather June sampling and in the wet weather September and October samplings. A beaver has a lodge on the opposite bank of the sampling site, although its presence was not noted

until September. The bridge upstream of the site was completely blocked by a logjam just before the start of the sampling season and remained blocked throughout the season. It is not evident that this had any impact on the bacteria counts.

***Sites exceeding standards during wet weather sampling only:***

Four of the sites- **NM05** on the Groton/Pepperell line, **NM04** in Pepperell, and **NM11** and **NM02** in Nashua- exceeded bacteria standards during at least one wet weather sampling event and did not exceed standards during dry weather.

**NM05** on Pepperell Pond only exceeded the standards once (in September) out of the four times it was sampled and this was during wet weather. However, the wet weather most likely did not cause the increased levels of bacteria in the water. In July, a dry weather sampling day, the fecal coliform count was 280 col./100 mL. In August and September, both during wet weather, the fecal coliform count was zero colonies/ 100 ml and 560 col./100 mL respectively. Most likely the high coliform levels in September were due to the 12 Black Ducks that were observed flying off from nearby the sampling site.

Sites **NM02** at Mine Falls Park in Nashua, NH had very low bacteria counts every month except for August and September. In August and September, both days with heavy rain, the counts were 410 and 1,400 col./100 ml respectively. **NM11** on Canal Street in Nashua was also highest during August and September, although the contrast between these two months and the other months was not as great. Nashua is a highly urbanized area and the high E. coli counts are probably due to non-point source run-off that is intensified by the rain.

Non-point source run-off may also account for the higher levels of E. coli in September at **NM04** in Pepperell.

***Sites exceeding standards during dry weather sampling only:***

Site **NM03** in Hollis was the only site on the mainstem to exceed standards during a dry weather sampling day (June) and to meet standards during every wet weather sampling day. The number of E. coli colonies at **NM03** ranged from 20 colonies/100 ml in September (wet weather sampling) to 600 colonies/100 ml in June (dry weather sampling). Leaky septic tanks or pipes often have a greater impact during dry weather low flow; however, the second highest E. coli counts at **NM03** were 200 colonies/100 ml, recorded in both May and August (both wet weather sampling days). Given the variability of counts, wildlife in the water could have been the cause.

Several of the sites- **NM06**, **CT01**, and **NM03**- exceeded standards in June, but not other dry weather sampling days. One possible cause could be that in the eight days leading up to sampling event, the daily low air temperature steadily increased from 44 to 65 degrees Fahrenheit, the highest lows of the season to date. Perhaps the bacteria were less likely to die off on the June sampling day so there were more colonies.

***Sites never exceeding standards:***

Site **NM08** in Shirley never exceeded bacteria standards, even when **NM10**, which is the next site upstream (although by quite a distance), and Catacunamaug Brook, **CT01**, which

flows into the Nashua mainstem just upstream of the site, exceeded standards and despite evidence of beaver activity. The consistently low fecal coliform levels could possibly be linked to slow moving water of the Oxbow National Wildlife Refuge, which is upstream of the site.

### **Bacteria on River Section 2: Nissitissit River and Gulf Brook**

#### ***Sites exceeding standards during wet weather sampling only:***

Sites **NT01**, **NT06** and **NT02** in Pepperell and **NT04** in Brookline exceeded standards during wet weather, but not during dry weather. In general, wet weather seemed to play a role in raising bacteria levels on the Nissitissit. All the sites mentioned above exceeded standards in September during the heavy rains from Hurricane Ivan. Bacteria levels increased at every site on the Nissitissit during August and September, the two sampling days with the heaviest rains. **NT01** and **NT06** in Pepperell differed the most significantly between dry and wet events. They are the furthest sites downstream and in the most developed areas.

#### ***Sites exceeding standards during dry weather sampling only:***

Site **NT05** in Brookline near the outfall of Potanipo Lake had the lowest bacteria counts on the Nissitissit River, ranging from 20 to 200 col./100 mL (not including June). The site only exceeded standards in June with a count of 1000 col./100 mL. This was most likely due to the ducks seen in the area. Although **NT05** did not exceed during wet weather, the second and third highest counts (170 col./100 mL and 200 col./100 mL respectively) were during the heavy rains of August and September.

#### ***Sites never exceeding standards:***

Site **GB01** on Gulf Brook, which flows into the Nissitissit between **NT02** and **NT04**, did not seem affected by the rain. It never exceeded standards and fecal coliform counts stayed steady between 220 and 350 colonies/100mL regardless of the weather.

### **Bacteria on River Section 3: Squannacook River and Willard Brook**

#### ***Sites exceeding standards during wet weather sampling only:***

Fecal coliform counts on the Squannacook River and Willard Brook were generally within range. Three of the four sites- sites **SQ03** in Groton/Shirley, **SQ06** in Townsend, and **WB01** on Willard Brook in Townsend- exceeded standards during wet weather only. Each only exceeded standards during one sampling month.

Site **SQ03** exceeded standards during the rain from Hurricane Ivan in September, but was not affected by any other rain events. Because upstream of the site is slow moving and marshy, it is possible that the impacts of the less intense rain events were mitigated, but that during the rains from the Hurricane, the sediment that the bacteria had bound to were flushed downstream.

Site **SQ06** ranged from 0 col./100mL to 520 colonies/100mL, with both extremes recorded during rain events (August and October respectively). The cause of the fluctuation is not known. Site **WB01** on Willard Brook only exceeded standards in October.

**Sites never exceeding standards:**

Site **SQ04** by Townsend Harbor never exceeded standards.

**Bacteria on River Section 4: North Nashua River, Flag Brook, and Phillips Brook**

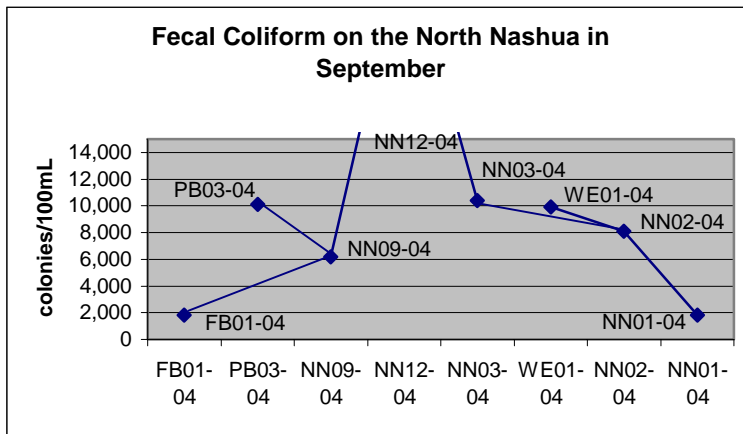
In the 2004 season, the North Nashua River had some of the highest fecal coliform counts in the watershed.

**Sites exceeding standard during both wet and dry sampling:**

All sites on the North Nashua (not including the tributary Phillips Brook) exceeded standards in both wet and dry weather. In May, June, and September all 5 sites on the North Nashua River exceeded standards. Counts ranged from 480 col./100mL (**NN01** in May) to 30,000 col./100mL (**NN12** in September). In April, August, and October, not all of the sites were tested; however, all sites that were tested exceeded standards (site **NN02** in April at 450 col./100mL, sites **NN12** and **NN09** in August at 60,000 col./100ml and 1,125 col./100 ml respectively, and sites **NN01** and **NN02** in September at 4,900 col./100mL and 12,500 col./100mL respectively). In July, counts were lower and only two of the five sites exceeded standards.

Twenty-three percent of the North Nashua River watershed is covered by impervious surface<sup>6</sup> so run-off is most likely a large contributor to high bacteria counts. The city of Fitchburg also has a number of CSOs, which in heavy rain will contribute to the problem. Site **NN12**, which had especially high counts, is downstream of the East Fitchburg Wastewater Treatment Plant. Not surprisingly high counts in Fitchburg appear to have a cumulative impact on sites downstream; however, upstream sites are not the only reason for high counts downstream (Figure 1).

Figure 1. Fecal coliform counts from one sampling day on the North Nashua River from headwaters to mouth.



Site **FB01** on Flag Brook, which joins with Whitman Brook to form the North Nashua River in West Fitchburg, exceeded standards every month it was tested (May- September). Counts at site **FB01** ranged from 450- 7,500 col./100mL. Site **FB01** is just above the West Fitchburg Wastewater Treatment Facility. The cause for the high bacteria counts is uncertain.

Wekepeke Brook enters the North Nashua just downstream of site **NN03**. The only month that **WE01** was known not to exceed standards was April (380 col./100mL). In October fecal coliform counts most likely exceeded standards since the colonies were too numerous to count. The site was not tested in August. It is unknown as to what is causing the high fecal coliform counts. The Wekepeke Brook watershed is largely forested, but also has an increasing number of single-family homes, as well as agricultural land and hobby farms. The Lancaster Conservation Commission has submitted a grant to look more closely into the potential sources of the high bacteria counts.

***Sites exceeding standards during wet weather sampling only:***

The upper site on Phillips Brook, site **PB02**, had very low fecal coliform counts. The only time it exceeded standards from June through October was during the heavy rains from Hurricane Ivan in September. Site **PB03** at the mouth of Phillips Brook just before it joins with the North Nashua River, did not exceed standards in June or July (both dry weather sampling months), but did exceed standards in August, September, and October (all wet weather sampling events). The factors influencing the high counts are probably similar to those causing high bacteria levels in Fitchburg.

### **pH AND ALKALINITY (as CaCO<sub>3</sub>)**

In the United States, the pH of most waters unaltered by humans ranges from 6.5 to 8.5. However, in some cases the bedrock and soil types over which the streams flow can naturally cause pH levels below these values. The amount of vegetation can also change pH levels. Since carbon dioxide mixed with water creates a slight acid, photosynthesis and respiration raises and lowers pH levels as the processes use and create CO<sub>2</sub>. Anthropogenic sources of low pH include sulfur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>), primarily from car exhaust and coal plants, that in the air combine with moisture in the atmosphere and create acid rain. pH values are generally low in the early spring when the snow (and associated SO<sub>2</sub> and NO<sub>x</sub>) that has accumulated during the winter melts.

Massachusetts State regulations state that waters should have pH values between 6.5 and 8.3. New Hampshire State regulations require pH values between 6.5 and 8.0, unless due to natural causes. Since pH is on a logarithmic scale, a decrease in pH from 7 to 6 means that the water has become 10 times more acidic. A decrease in pH from 7 to 5 means that the water has become 100 times more acidic. A change of pH by 0.5 units or greater in inland waters is classified as a significant change and can cause stress to river systems.

Low pH is a cause for concern for two primary reasons. Living organisms have certain pH ranges within which they can live and reproduce. As the pH level drops or fluctuates rapidly, fewer types of fish, clams, insects, and other stream life can survive and reproduce. In addition to reducing the inhabitants of the stream, low pH also increases the solubility of heavy metals. Metals that are either present geologically or are discharged from industrial facilities are more likely to leach out into the water and are, therefore, more readily available to bio-accumulate in fish and other aquatic organisms.

Alkalinity refers to the buffering (or acid neutralizing capacity) of the water against increases in pH. Alkalinity is measured as calcium carbonate (mg/l CaCO<sub>3</sub>). Streams in areas of limestone bedrock generally have high alkalinity since the bedrock leaches calcium carbonate as part of the natural erosion process. In contrast, streams with granite bedrock have low alkalinity due to the low levels of calcium carbonate and other buffering compounds in the granite. According to the Acid Rain Monitoring Project, water with alkalinity lower than 20 mg/l CaCO<sub>3</sub> is considered sensitive and less capable of buffering the effects of low pH (Table 4). Changes during the season in alkalinity are generally due to rainfall and evaporation. Overtime, the natural buffering capacity of streams can be depleted due to excessive amounts of acid entering the streams.

Table 6. Alkalinity ranges<sup>7</sup>

<0	acidified
0-2	critical
2 to 5	endangered
5 to 10	highly sensitive
10 to 20	sensitive
>20	not sensitive

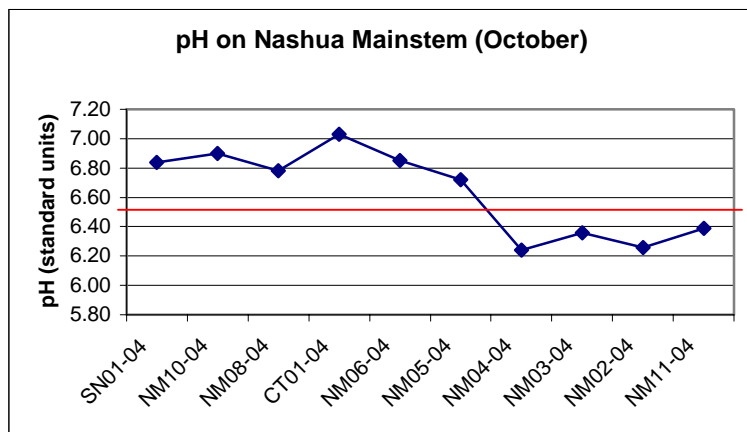
### **pH and Alkalinity on River Section 1: Nashua River Mainstem, Catacunamaug Brook, and the South Nashua River**

The Nashua Mainstem sites had pH values ranging from 6.04 to 7.38 standard units. In April, every site that was monitored on the Nashua River and its tributaries had values below 6.5. This was most likely due to the recent snowmelt releasing built-up acids. In contrast, in September after the heavy rains of Hurricane Ivan, every site on the mainstem, as well as Catacunamaug Brook (**CT01**) and the site on the South Nashua (**SN01**), were within acceptable range. Heavy rainfall increases turbulence and mixing with stream water, thus raising the pH.

Apart from April, sites on the mainstem upstream of **NM04** in Pepperell consistently had pH levels within acceptable range. These sites included **NM05** on Pepperell Pond, **NM06** in Groton, **NM08** in Shirley, and **NM10** in Lancaster. Moving downstream from **NM04**, the pH fell outside of the acceptable range more frequently. **NM04** was within range three of the seven monitoring days. **NM03** in Hollis and **NM02** and **NM11** in Nashua were outside of acceptable range every time they were sampled except for during the September rain event

discussed above. (Figure 2 shows October pH values as an example of the trend.) The Nissitissit River, which has a naturally low pH, joins the mainstem below **NM04**. This might partially account for the low pH at sites downstream. It is also possible that the bedrock and soils also account for the differences in pH and that all sites are within normal background ranges.

Figure 2. pH on the Nashua River Mainstem from headwaters to mouth



Alkalinity on the Nashua Mainstem was generally low in April at the four sites that were tested, ranging from 7.7 to 8.6 mg/L CaCO<sub>3</sub>. In contrast, alkalinity was generally high in October, ranging from 21.0 to 25.6 mg/L. In the middle months, values were generally in the upper teens and lower twenties.

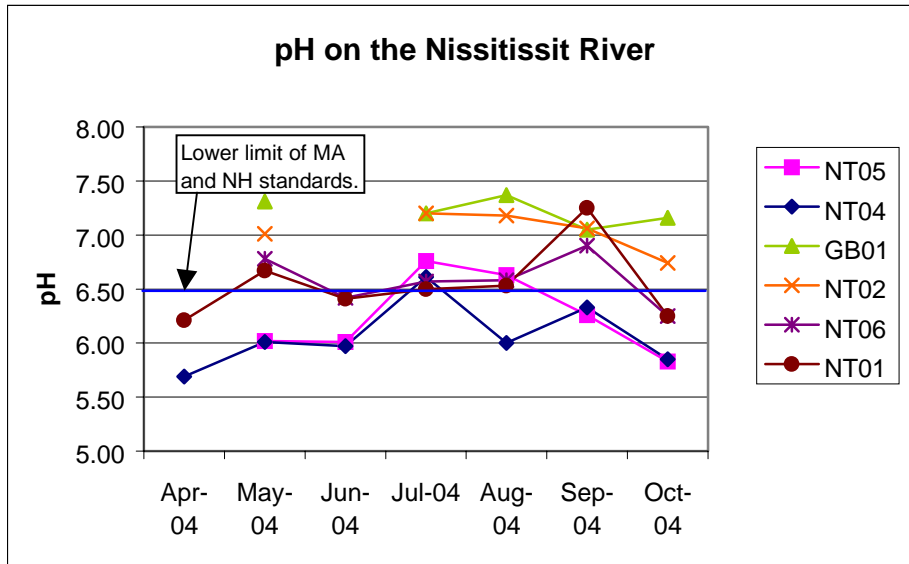
Catacunamaug Brook, **CT01**, was within range for pH in all months except April and the alkalinity was above 20 mg/L for four of the six months it was tested. In June, the alkalinity read as 6.1 mg/L. Given the high values during the other months and that the pH for June was well within range (7.35 standard units), this value may not be accurate.

The site on the South Nashua River, **SN01**, was not tested in April. Of the five months it was tested, pH was only out of range in June. Alkalinity at **SN01** fluctuated throughout the season. In May, June, and July it stayed around 10 mg/L (10, 10.2, and 8.0 mg/L). In September it jumped up to 18 mg/L and then in October it dropped to 0 mg/L.

### **pH and Alkalinity on River Section 2: Nissitissit River and Gulf Brook**

The pH of the Nissitissit River ranged from 5.69 to 7.25 and the pH of the one site on Gulf Brook, site **GB01**, ranged from 7.05 to 7.37 (Figure 3). (It should be noted that pH was not measured on Gulf Brook in April when pH is generally at its lowest.)

Figure 3. pH on the Nissitissit River



The two sites farthest upstream on the Nissitissit (**NT05** and **NT04** in Brookline) generally had the lowest pH readings of all the sites tested, not only along the Nissitissit River, but of all the sites in the Nashua River watershed. The pH values were well below standards in every month except July (**NT05** and **NT04**) and August (**NT05**). It is difficult to know to what degree the low pH is due to natural causes and to what degree it is due to anthropogenic sources. The wetlands and slow moving water around these sites most likely contribute to the low pH readings.

Sites **NT02** in Pepperell (the next site downstream from **NT04**) and **GB01**, which flows into the Nissitissit downstream of **NT04** and upstream of **NT02** had the highest pH values on the Nissitissit and never fell below the state standards. These two sites fluctuated less than the other sites as well. The water in these sites is faster moving, which may contribute to the higher, more consistent pH readings. The substrate composition is also possibly a factor.

Sites **NT06** and **NT01**, the two sites farthest downstream on the Nissitissit did fall below state pH standards, but not as low as the two sites farthest upstream. Site **NT01** at Lomar Park was the site of some beaver activity including the formation and breaking of a dam.

The alkalinity for both **NT05** and **NT04** (the two most upstream sites) was very low. The alkalinity of site **NT05** stayed in the “endangered” range (2-5 mg/L CaCO<sub>3</sub>) for the entire season and site **NT04** was in the “endangered” range from April through June and then within the “highly sensitive” range (5.1-10 mg/L) from July through October. Alkalinity of site **NT02**, **GB01**, **NT06**, and **NT01** ranged between 10 and 20 mg/L CaCO<sub>3</sub>, except for in April when the alkalinity of **NT01** (the only site of the four tested that month) was 5.4 mg/L. The low reading in April is most likely due to snowmelt.

### **pH and Alkalinity on River Section 3: Squannacook River and Willard Brook**

Although the maximum alkalinity reading on the Squannacook River and Willard Brook for entire season was 11.1 mg/L and fell as low as 2.5 mg/L, pH only dropped below 6.5 standard units twice in the season (6.38 in October at site **SQ03** and 5.82 in April at **SQ04**). This indicates that the pH of the precipitation and run-off entering the river is within an acceptable range.

### **pH and Alkalinity on River Section 4: North Nashua River, Flag Brook, and Phillips Brook**

Alkalinity was generally above 20 mg/L (not sensitive) on the North Nashua and Flag Brook. Alkalinity was lowest at the most upstream sites and increased moving downstream. Phillips Brook had particularly low alkalinity, ranging from 3.0 to 18.0 mg/L. The terrain is similar to the Nissitissit and Squannacook Rivers and the low alkalinity is most likely due to natural causes.

On the North Nashua River, pH was below standards at the two sites tested in April, **WE01** (6.18) and **NN02** (6.10) most likely due to snowmelt. All other samples over the season on the North Nashua were above 6.5 standard units. **PB03** on Phillips Brook in Fitchburg was below standard in August and September (6.39 both times) and **PB02** in Ashburnham was below standard in May (6.28), June (6.44), September (6.22), and October (6.35). Like the Squannacook and Nissitissit, the low pH is probably due to the bedrock and soils.

### **DISSOLVED OXYGEN**

Dissolved oxygen (D.O.), measured in mg/L, is the amount of dissolved oxygen in a liter of water. Dissolved oxygen measured as percent saturation reports the amount of dissolved oxygen in a liter of water relative to the total amount of oxygen that the water can hold at that temperature. This is why it is important to measure the water temperature immediately before or after collecting the dissolved oxygen sample.

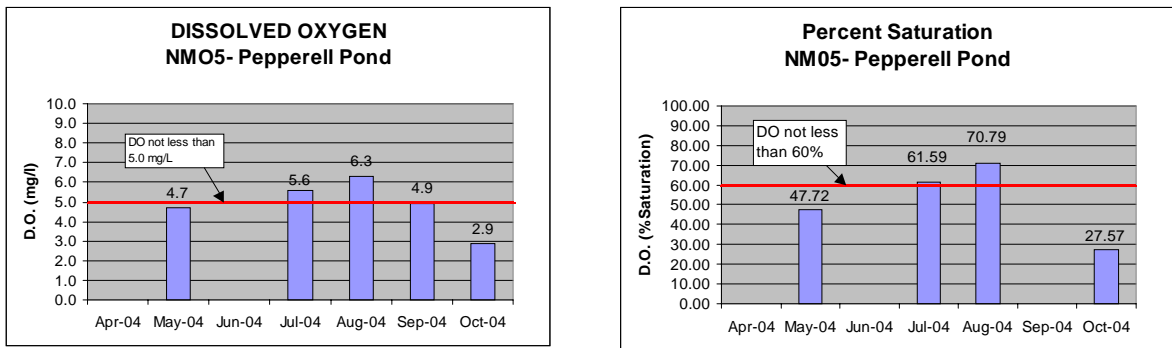
Dissolved oxygen is higher in areas and times of high water velocity and turbulence (because the water is mixing more with the air) and in fresh, cold water. Photosynthesis by aquatic plants puts oxygen into the water and respiration and decomposition removes it. Testing dissolved oxygen in the early morning just before sunrise captures the lowest dissolved oxygen levels because photosynthesis has not yet begun.

Massachusetts and New Hampshire standards require that in Class B waters dissolved oxygen levels are at a minimum of 5.0 mg/L and 60% saturation in warm-water fisheries waters and a minimum of 6.0 mg/L and 75% in cold-water fisheries. Dissolved oxygen below these levels can change the composition of aquatic species found in a body of water. When dissolved oxygen levels are low (the exact number varies depending on the species), the more sensitive species move away (if they can), become weak, or die. Fish living in cold waters such as brook trout tend to be more sensitive to dissolved oxygen than fish in warm waters, such as largemouth bass (a non-native fish to Massachusetts).

**Dissolved Oxygen on River Section 1: Nashua River Mainstem, Catacunamaug Brook, and the South Nashua River**

The Nashua Mainstem, Catacunamaug Brook, and the South Nashua River are considered warm-water fisheries. Although in general, dissolved oxygen levels were within standards in 2004, site **NM05** on Pepperell Pond had dissolved oxygen below standards at the beginning and the end of the season. In October, dissolved oxygen levels dropped to 2.9 mg/L and 27.57% saturation (Figures 4 and 5). Pepperell Pond is a slow moving impounded body of water. It also has a variety of aquatic plants growing in it; most noticeable at the monitoring site are the water chestnuts. By October, most of the plants were dying and dropping to the bottom where decomposition, an oxygen depleting activity, occurred. Pepperell Pond is an important recreational fishing area. If the water chestnuts continue to grow and expand, it is possible that dissolved oxygen levels will drop too low for fish to survive. Optimal growth for largemouth bass occurs at dissolved oxygen levels above 5 mg/L.<sup>8</sup>

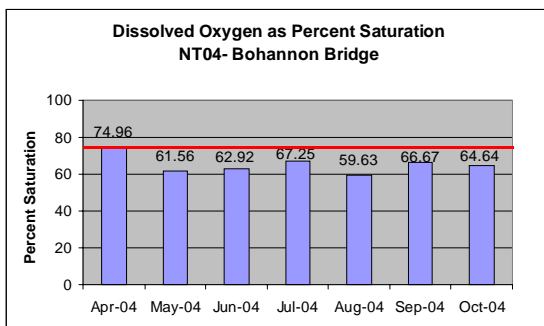
Figures 4 and 5. Dissolved oxygen levels on Pepperell Pond (NM05) expressed as mg/L and percent saturation.



**Dissolved Oxygen on River Section 2: Nissitissit River and Gulf Brook**

On the Nissitissit River, site **NT04** in Brookline was below standards (75%) for percent saturation of dissolved oxygen for every month of the season except for April when it was at 75%. It was below standards for dissolved oxygen measured as mg/L in May, June, and August. The site is open and slow moving and water temperatures rose to 20°C and above from June through August. The water was also brown throughout the season so possibly not much light penetrated for photosynthesis.

Figure 6. Dissolved oxygen at Bohannon Bridge (NT04)



Site **NT02** in Pepperell had low dissolved oxygen (4.9 mg/L and 50.5% saturation) in September. Aquatic plants were noted in August, but not in September. If the plants had died and dropped to the bottom by September, it is possible that the decomposition process played a role in the low dissolved oxygen.

### **Dissolved Oxygen on River Section 3: Squannacook River and Willard Brook**

Dissolved oxygen at site **SQ03** in Groton/Shirley fell to 5.8 mg/L (just below standards) in September. Apart from that one reading, dissolved oxygen measured as mg/L met standards for cold water fisheries at all sites on the Squannacook River and Willard Brook each month. Percent saturation of dissolved oxygen varied by site. Site **SQ03** started in May at 101.3% and ended in October at 55.4% saturation. This site is in a slow moving area and just downstream of wetlands. Site **SQ04** fluctuated throughout the season and ranged from 72.8% to 90.6% saturation. Site **SQ06** stayed fairly constant with an average percent saturation of 72.6%, slightly below standards for cold water fisheries.

Willard Brook, site **WB01**, had high dissolved oxygen levels measured as mg/L and percent saturation throughout the season.

### **Dissolved Oxygen on River Section 4: North Nashua River, Flag Brook, and Phillips Brook**

All of the sites on the North Nashua River, Flag Brook, and Phillips Brook were within standards for dissolved oxygen, measured as mg/L and percent saturation, for warm water fish. Phillips Brook, sites **PB02** and **PB03**, exceeded 100% saturation in July and August. August levels were particularly high (**PB02** was 121.3% and **PB03** was 127.8%). These sites are not unusually turbulent, which is generally the cause of supersaturation. The NRWA will continue to monitor these sites.

## **TOTAL PHOSPHORUS**

Phosphorus is a significant concern because a small increase in its concentration can greatly influence plant growth or overgrowth. Algae blooms and plant growth inhibit fish and other aquatic life and cause foul odors when the plants decay. Pepperell Pond, an impoundment on the Nashua River in Pepperell and Groton, and the area above Mine Falls Park dam in Nashua visually show signs of nutrient enrichment in the summer time. A TMDL is being prepared by the MADEP for phosphorus on Pepperell pond.

There are no numerical standards for nutrients, including phosphorus, stated in the Massachusetts or New Hampshire surface water quality standards. The EPA states that phosphorus is not to exceed 0.025mg/L in lakes or reservoirs, not to exceed 0.05mg/L in streams that discharge into a lake or reservoir, and not to exceed 0.1mg/L in streams that do not discharge into a lake or reservoir.

Total phosphorus was measured at many of the sites throughout the 2004 season; however, in reviewing the data the NRWA decided that the results were not accurate enough to report or to draw any conclusions. To measure phosphorus with accurate results takes a large amount of time and lab equipment dedicated solely to phosphorus analysis. In the 2005 season some samples will be sent to a lab for analysis.

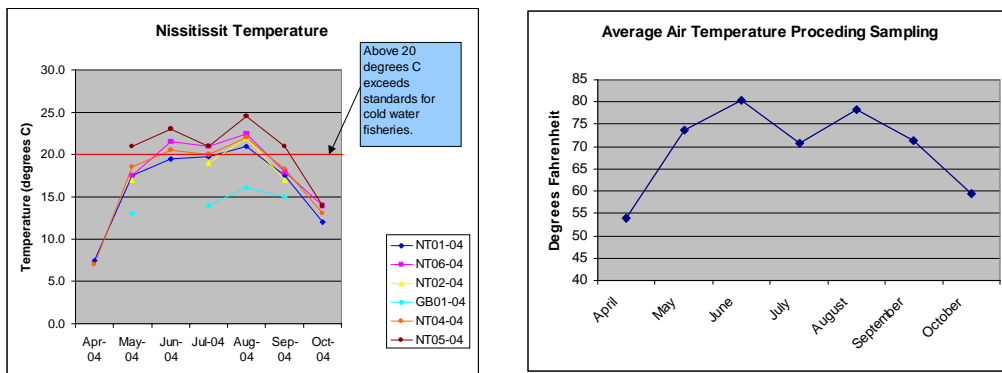
## **TEMPERATURE**

The temperature of the water is impacted by the weather, time of day, precipitation, amount of shade, run-off from hot pavement, industry cooling discharge, the velocity of the flow, and impoundments. Temperature is an important parameter to measure because it impacts so much of the functioning of the river ecosystem. Toxics in the water tend to be more soluble at high temperatures. Aquatic organisms, from bacteria to fish, all have a temperature range within which they can live and reproduce.

Temperature should not be above 28.3 degrees Celsius in warm-water fisheries and 20.0 degrees Celsius in cold-water fisheries.

In general, the temperature of the water followed the air temperature. Figures 7 and 8 show the monthly water temperature on the Nissitissit River (similar to the other reaches) compared with the monthly air temperature for the watershed.

Figures 7 and 8. Water temperature patterns compared with air temperature patterns.



### **Temperature on River Section 1: Nashua River Mainstem, Catacunamaug Brook, and the South Nashua River**

On the mainstem of the Nashua River, no individual measurements for temperature exceeded 28.3°C, and all mean temperatures for the season were below 20°C.

### **Temperature on River Section 2: Nissitissit River and Gulf Brook**

During the August sampling day, every site on the Nissitissit River exceeded the cold water fisheries standard of 20° C. Site NT05 in Brookline exceeded every month except October.

Although **NT05** is shaded and flows quickly, Potanipo Pond that drains into it is a still, open body of water. Sites **NT06** in Pepperell and **NT04** in Brookline, exceeded during June, July, and August.

Gulf Brook never exceeded standards for temperature.

### **Temperature River Section 3: Squannacook River and Willard Brook**

During the August sampling day, all sites on the Squannacook River and Willard Brook were either at 20°C (site **SQ06** in Townsend) or above (**SQ03** in Groton and **SQ04** in Townsend were both 22°C and **WB01** on Willard Brook in West Townsend was 21°C). In June and July both **SQ03** and **SQ04** were 20°C, just on the border of exceeding standards. The Squannacook River from below Harbor Pond to Hollingsworth and Vose (**SQ04** to below **SQ03**) is on Massachusetts's "alert status" due to high temperatures.

### **Temperature on River Section 4: North Nashua River, Flag Brook, and Phillips Brook**

On the North Nashua River and its tributaries, no individual measurements for temperature exceeded 28.3°C. The highest maximum temperature was 22°C, which was measured at **NN09** in Fitchburg in July and at **NN09**, **FB01** in Fitchburg, and **NN12** in Leominster in August.

### **Conclusion**

While water quality in the Nashua River Watershed was generally good during the 2004 season, bacteria counts throughout the watershed and especially in the North Nashua River were often above the standards set by Massachusetts and New Hampshire. This was partially a result of the frequent and sometimes heavy rainfall that fell throughout the season. Low dissolved oxygen may be a cause for concern on Pepperell Pond, especially given the popularity of bass fishing on the impoundment. High temperatures on the Nissitissit and Squannacook should also be watched.

## Acknowledgements

The NRWA would like to thank the water quality monitoring program volunteers for all the time they contributed to this program. They have enabled us to have an understanding of the health of the Nashua River Watershed that would not have been possible without them.

### Our 2004 Field and Lab Volunteers

Dave Armstrong	Don Kennedy
Trevor Bonilla	Tara Lambert
Mairead Curtis	Bob Leary
Valorie Daigle	Angel Lehtonen
Valerie DeNatale	Bob Lidstone
Tim Dinsmore	Maggie Lowry
Peter Farmer	Meredith Marcinkewicz
Steve Fitzgerald	Patty McCloy
Janet Flinkstrom	Dale McMullan
Peter Foster	Perley Mears
Mark Gilbert	Jane Metzger
Joe Hamelin	Dudley Moses
Mary Hamelin	Andy Padla
Anne Hard	Russ Schott
Hugh Hard	Joanne Shea
Jonas Insinga	Buddy Shorey
Merle Insinga	Sarah Spencer
Elizabeth Johnson	Deb Taylor
Rich Johnson	Gray Tuttle
	Joan Wotkowicz

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Matt Marro	Leominster Fallbrook Reservoir Water Treatment Facility
Jim Drapeau	Devens Wastewater Treatment Facility operated by Earth Tech
Casey Mellin	Nashua Wastewater Treatment Facility

And Carmen DePhillipo at Pepperell Waste Water Treatment Plant for answering our questions and providing us with information.

### Massachusetts Water Watch Partnership

Peter Kerr  
Jerry Schoen  
Marie-Françoise Walk

## Appendix A: Sampling Site Locations

<b>Nashua River Mainstem, Catacunamaug Brook, and South Nashua River</b>		
<b>Site</b>	<b>Water Body, Town</b>	<b>Field Description of Site Location</b>
NM11	Nashua River, Nashua, NH	144 Canal Street. BAE parking lot behind Area Agency.
NM02	Nashua River, Nashua, NH	Mine Falls Park at boat launch.
NM03	Nashua River, Hollis, NH	At Route 111 – downstream of bridge.
NM04	Nashua River, Pepperell, MA	Upstream side of the covered bridge, north bank.
NM05	Nashua River, Pepperell/Groton, MA	Pepperell Pond at Pepperell/Groton town line- off the bike path.
NM06	Nashua River, Groton, MA	Petapawag- downstream of 119 at boat ramp.
NM08	Nashua River, Shirley/Devens, MA	Upstream of Hospital Road bridge on eastern shore.
NM09	Nashua River, Harvard, MA	Tank bridge at Still River Road
NM10	Nashua River, Lancaster, MA	Downstream of Route 117 bridge, west side.
CT01	Catacunamaug Brook, Shirley, MA	At Lovell Road- mouth of brook on south bank. Enters Mainstem downstream of upstream of site NM08.
SN01	South Nashua River, Lancaster, MA	Upstream of Mill Street bridge, south side. Enters Mainstem upstream of site NM10
<b>Nissitissit River and Gulf Brook</b>		
<b>Site</b>	<b>Water Body, Town</b>	<b>Field Description of Site Location</b>
NT01	Nissitissit River, Pepperell, MA	100 yds upstream from mouth of river. Behind Lomar Industrial Park
NT06	Nissitissit River, Pepperell, MA	Below Rt. 111 bridge
NT02	Nissitissit River, Pepperell, MA	Upstream of Prescott Street bridge
NT04	Nissitissit River, Brookline, NH	200 ft. downstream from Bohannon bridge at “fishing area”
NT05	Nissitissit River, Brookline, NH	100 ft. downstream from Potanipo Lighthouse
GB01	Gulf Brook, Pepperell, MA	Upstream of Chestnut Street. Enters Nissitissit downstream of site NT04.
<b>Squannacook River and Willard Brook</b>		
<b>Site</b>	<b>Water Body, Town</b>	<b>Field Description of Site Location</b>
SQ03	Squannacook River, Groton	Opposite Candice Lane, off Townsend Road.
SQ04	Squannacook River, Townsend	Downstream from Shepard’s Auto Body, below Harbor Pond.
SQ06	Squannacook River, Townsend	At Adams Dam
WB01	Willard Brook, West Townsend	Upstream of West Meadow Road Bridge.
<b>North Nashua River, Phillips Brook, and Flag Brook</b>		
<b>Site</b>	<b>Water Body, Town</b>	<b>Field Description of Site Location</b>
NN01	North Nashua River, Lancaster, MA	Main Street railroad crossing. Access is a dirt road off of Route 70, on left after bridge over N. Nashua.
NN02	North Nashua River, Lancaster, MA	Cook Conservation Area power line crossing. Access is at Conservation Area-through gate.

NN03	North Nashua River, Lancaster	Rte 190. Accessed off Rt. 117 North Main Street.
NN12	North Nashua River, Leominster	Behind Gear Works Cyclery on Hamilton Street
NN09	North Nashua River, Fitchburg	Behind McDonald's parking lot. Access behind large shrub
NN11	North Nashua River, Fitchburg	Along Rt. 12 near the West Fitchburg Restaurant
FB01	Flag Brook, Fitchburg	Opening just before RR overpass on Rt. 31
WE01	Wekepeke Brook, Lancaster, MA	South side of Route 117, d.s. of Bartlett Pond outlet; access through private yard.
PB03	Phillips Brook, Fitchburg, MA	Phillips Brook behind British-American club on Rt. 12 (Junction of Nashua and Phillips Brook)
PB02	Phillips Brook, Ashburnham, MA	Off River Street at former town swimming pond, upstream of dam.

**Appendix B: Map of Watershed**

**Appendix C: Field Data Sheet sample**

**Appendix D: Data by Parameter**

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## Endnotes

- <sup>1</sup> Lowry, M. 2002. *Site selection for the Nashua River Watershed Association volunteer water quality monitoring program*. Masters Thesis. Clark University, MA.
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- <sup>3</sup> MADEP. 2000. 314 CRM: Massachusetts surface water quality standards. <http://www.mass.gov/dep/bwp/iww/files/314004.pdf>. Accessed March 8, 2005.
- <sup>4</sup> MADEP. 105 CMR. 445.000 Minimum standards for bathing beaches: Sanitary state code chapter VII. [http://www.mass.gov/dph/dcs/bb4\\_01.pdf](http://www.mass.gov/dph/dcs/bb4_01.pdf). Accessed March 8, 2005.
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