New Hampshire Volunteer River Assessment Program
2007 Exeter River Watershed Water Quality Report

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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New Hampshire Volunteer River Assessment Program
2007 Exeter River Watershed Water Quality Report

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Cover Photo: Exeter River, 14-EXT, Exeter

TABLE OF CONTENTS

1. INTRODUCTION……6

1.1 Purpose of Report……6
1.2 Report Format……6

2. PROGRAM OVERVIEW……8

2.1 What is VRAP?……8
2.2 Why is VRAP Important?……8
2.3 How Does VRAP Work?……8
2.4 What is VBAP?……9
2.5 Equipment & Sampling Schedule……9
2.6 Training & Technical Support……9
2.7 Data Usage……10
2.8 Quality Assurance & Quality Control……11

3. METHODS……13

4. RESULTS & RECOMMENDATIONS……15

4.1 Dissolved Oxygen……15
4.2 pH……21
4.3 Turbidity……25
4.4 Specific Conductance……27
4.5 Water Temperature……31
4.6 Biological Assessment……34

List of Figures and Tables

Figure 1: Dissolved Oxygen Concentration Statistics................................16
Figure 2: Dissolved Oxygen Concentration Statistics (7/11/07 – 7/16/07)........18
Figure 3: Dissolved Oxygen Saturation Statistics (7/11/07 – 7/16/07).. 18
Figure 4: Dissolved Oxygen Concentration Statistics (7/27/07 – 7/31/07)........19
Figure 5: Dissolved Oxygen Saturation Statistics (7/27/07 – 7/31/07) 19
Figure 6: pH Statistics...22
Figure 7: pH Statistics (7/11/07 – 7/16/07)..23
Figure 8: pH Statistics (7/21/07 – 7/31/07)..23
Figure 9: Turbidity Statistics...26
Figure 10: Specific Conductance Statistics..28
Figure 11: Specific Conductance Statistics (7/11/07 – 7/16/07).........................29
Figure 12: Specific Conductance Statistics (7/27/07 – 7/31/07).........................29
Figure 13: Water Temperature Statistics...32
Figure 14: Water Temperature Statistics (7/11/07 – 7/16/07)...........................33
Figure 15: Water Temperature Statistics (7/27/07 – 9/31/07)...........................33

Table 1: Field Analytical Quality Controls..12
Table 2: Sampling Stations for the Exeter River Watershed, 2007...........14
Table 3: Sampling and Analysis Methods..14
Table 4: Dissolved Oxygen Concentration Data Summary........................15
Table 5: pH Data Summary..21
Table 6: Turbidity Data Summary...25
Table 7: Specific Conductance Data Summary.......................................27
Table 8: Water Temperature Data Summary..31
Table 9: Biological Data Summary...35

List of Appendices

Appendix A: 2007 Exeter River Watershed Water Quality Data
Appendix B: Interpreting VRAP Water Quality Parameters
Appendix C: VRAP Volunteer Monitor Field Sampling Procedures Assessment *(Field Audit)*
Appendix D: 2007 Exeter River Watershed Biological Data
Appendix E: 2007 Exeter River Watershed Habitat Data
Appendix F: 2007 Biological Assessment Methods
Appendix G: The New Hampshire Surface Water Quality Assessment Process
Appendix H: Programs, Publications & Links of Interest

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2007 Exeter River Volunteers

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1.0 INTRODUCTION

1.1. Purpose of Report

Each year the New Hampshire Volunteer River Assessment Program (VRAP) prepares and distributes a water quality report for each volunteer river monitoring group that is based solely on the water quality data collected by that group during a specific year. The reports summarize and interpret the data, particularly as they relate to New Hampshire's surface water quality standards, and serve as a teaching tool and guidance document for future monitoring activities by the individual volunteer groups.

1.2. Report Format

Each report includes the following:

- **Volunteer River Assessment Program (VRAP) Overview**

  This section includes a description of the history of VRAP, the technical support, training and guidance provided by NHDES, and how data is transmitted to the volunteers and used in surface water quality assessments.

- **Monitoring Program Description**

  This section provides a description of the volunteer group's monitoring program including monitoring objectives as well as a table and map showing sample station locations.

- **Results and Recommendations**

  Water quality data collected during the year are summarized on a parameter-by-parameter basis using (1) a data summary table that includes the number of samples collected, data ranges, the number of samples meeting New Hampshire water quality standards, and the number of samples adequate for water quality assessments at each station, (2) a discussion of the data, (3) a river graph showing the range of measured values at each station and (4) a list of applicable recommendations.

  Sample results reported as less than the detection limit were assumed equal to one-half the detection limit on the river graphs. This approach simplifies the understanding of the parameter of interest, and specifically helps one to visualize how the river or watershed is functioning from upstream to downstream. In addition, this format allows the reader to better understand potential pollution areas and target those areas for additional sampling or environmental enhancements. Where applicable, the river graph also shows New Hampshire surface water quality standards or levels of concern for comparison purposes.

- **Appendix A – Water Quality Data**

  This appendix includes a spreadsheet detailing the data results and additional information such data results which do not meet New Hampshire surface water quality standards, and data that are unusable for assessment purposes due to quality control requirements.

- **Appendix B – Interpreting VRAP Water Quality Parameters**

  This appendix provides a brief description of water quality parameters typically sampled by VRAP volunteers and their importance, as well as applicable state water quality criteria or levels of concern.

- **Appendix C – VRAP Volunteer Monitor Field Sampling Procedures Assessment *(Field Audits)***

  This appendix provides an overview of the VRAP Volunteer Monitor Field Sampling Procedures Assessment (field audit) process with respect to programmatic Quality Assurance/Quality Control (QAQC) guidelines.

- **Appendix D – Biological Data**

  This appendix includes a spreadsheet detailing biological data results including Order, common name, number of individuals found, group tolerance value, group biotic score, station biotic score, and narrative category.

- **Appendix E – Habitat Data**

  This appendix includes a spreadsheet detailing habitat data results such as surrounding land use, riparian habitat, in-stream characteristics, and erosion and other streamside impacts.

- **Appendix F – VBAP Sampling Methods**

  This appendix details sampling methods in association with the New Hampshire Volunteer Biological Assessment Program.

- **Appendix G – The New Hampshire Surface Water Quality Assessment Process**

  This appendix provides an overview of how data collected by VRAP volunteers, meeting QAQC criteria, is used in the state assessment process of New Hampshire's rivers and streams.

- **Appendix I - Programs, Publications, & Links of Interest**

  This appendix lists NHDES Watershed Management Bureau programs, publications, and links of interest with respect to water quality, chemistry, biology, and watershed protection.

2.0 PROGRAM OVERVIEW

2.1 What is VRAP?

In 1998, the New Hampshire Volunteer River Assessment Program (VRAP) was established to promote awareness and education of the importance of maintaining water quality in New Hampshire's rivers and streams. VRAP aims to educate people about river and stream water quality and ecology and to improve water quality monitoring coverage for the protection of water resources.

Today, VRAP loans water quality monitoring equipment, provides technical support, and facilitates educational programs to volunteer groups on numerous rivers and watersheds throughout the state. VRAP volunteers conduct water quality monitoring on an ongoing basis and increase the amount of river water quality information available to local, state and federal governments, which allows for better watershed planning.

2.2 Why is VRAP Important?

VRAP establishes a regular volunteer-driven water sampling program to assist NHDES in evaluating water quality throughout the state. VRAP empowers volunteers with information about the health of New Hampshire's rivers and streams. Regular collection of water quality data allows for early detection of water quality changes allowing NHDES to trace potential problems to their source. Data collected by VRAP volunteers are directly contributing to New Hampshire's obligations under the Clean Water Act. Measurements taken by volunteers are used in assessing the water quality of New Hampshire's river and streams, and are included in reporting to the US Environmental Protection Agency (EPA).

2.3 How Does VRAP Work?

VRAP is a cooperative program between NHDES, river groups, local advisory committees, watershed associations, and individuals working to protect New Hampshire's rivers and streams. Volunteers are trained by VRAP staff in the use of water quality monitoring equipment at an annual training workshop. VRAP works with each group to establish monitoring stations and develop a sampling plan.

During the summer months, VRAP receives water quality data from trained volunteers. The data are reviewed for quality assurance, and are entered into the environmental monitoring database (EMD) at NHDES. During the off-season, VRAP interprets the data and compiles the results into an annual report for each river. VRAP volunteers can use the data as a means of understanding the details of water quality, as well as guide future sampling efforts. NHDES can use the data for making surface water quality assessments, provided that the data met certain quality assurance/quality control guidelines.

2.4 What is VBAP?

The Volunteer Biological Assessment Program (VBAP) was established in 2005 to supplement biological data collected by the New Hampshire Department of Environmental Services Biomonitoring Unit. The Biomonitoring program regularly collects detailed biological data in order to complete water quality assessments of wadeable streams. VBAP serves to educate the public about water quality issues as interpreted through biological data, build a constituency of volunteers to practice sound water quality management at a local level, and build public support for water quality protection.

Since the program's establishment in 2005, VBAP has continued to work closely with watershed volunteers throughout New Hampshire providing technical assistance, field supervision, training in biological monitoring protocols, educational outreach, and annual biological data collection reports. In 2007, VBAP collaborated with the Volunteer River Assessment Program building greater strength and capability for the future.

2.5 Equipment and Sampling Schedule

VRAP frequently lends and maintains water quality monitoring equipment kits to VRAP groups throughout the state. The kits contain meters and supplies for routine water quality parameter measurements of turbidity, pH, dissolved oxygen, water temperature and specific conductance (conductivity). Other parameters such as nutrients, metals, and *E. coli* can also be studied, although VRAP does not always provide funds to cover laboratory analysis costs. Thus, VRAP encourages groups to pursue other fundraising activities such as association membership fees, special events, in-kind services (non-monetary contributions from individuals and organizations), and grant writing.

Each year, volunteers design and arrange a sampling schedule in cooperation with VRAP staff. Project designs are created through a review and discussion of existing water quality information, such as known and perceived problem areas or locations of exceptional water quality. The interests, priorities, and resources of the partnership determine monitoring locations, parameters, and frequency. VRAP typically recommends sampling every other week from May through September, and VRAP groups are encouraged to organize a long-term sampling program in order to begin to determine trends in river conditions.

2.6 Training and Technical Support

Each VRAP volunteer attends an annual training workshop to receive a demonstration of monitoring protocols and sampling techniques and the calibration and use of water quality monitoring equipment. During the training, volunteers have an opportunity for hands-on use of the equipment and receive instruction in the collection of samples for laboratory analysis. NHDES also provides equipment, supplies and staff support for VRAP groups participating in biological assessment activities.

VRAP groups conduct sampling according to a prearranged monitoring schedule and VRAP protocols. For groups participating in biological assessment, each station is sampled once annually during the month of September. VRAP staff aim to visit each group annually during a scheduled sampling event to verify that volunteers successfully follow the VRAP protocols (see Appendix C). If necessary, volunteers are re-trained during the visit, and the group's monitoring coordinator is notified of the result of the verification visit. VRAP groups forward water quality results to NHDES for incorporation into an annual report and state water quality assessment activities.

Groups participating in biological assessment activities attend two training sessions prior to sampling. The first training session provides information on the biological monitoring protocol and aquatic invertebrate identification. The second session provides instruction in field methods. An NHDES staff person assists volunteers with all biological assessment activities during the sampling period.

2.7 Data Usage

Annual Water Quality Reports

Water quality measurements repeated over time create a picture of the fluctuating conditions in rivers and streams and help to determine where improvements, restoration or preservation may benefit the river and the communities it supports. All data collected by volunteers are summarized in water quality reports that are prepared and distributed after the conclusion of the sampling period. VRAP groups can use the reports and data as a means of understanding the details of water quality, guiding future sampling efforts, or determining restoration activities.

New Hampshire Surface Water Quality Assessments

Along with data collected from other water quality programs, specifically the State Ambient River Monitoring Program (ARMP), applicable volunteer data are used to support periodic NHDES surface water quality assessments. VRAP data are entered into NHDES's Environmental Monitoring Database (EMD) and are ultimately uploaded to the Environmental Protection Agency's database. Assessment results and the methodology used to assess surface waters are published by NHDES every two years (i.e., Section 305(b) Water Quality Reports) as required by the federal Clean Water Act. The reader is encouraged to log on to the NHDES web page to review the assessment methodology and list of impaired waters www.des.nh.gov/wmb/swqa/.

2.8 Quality Assurance/Quality Control

In order for VRAP data to be used in the assessment of New Hampshire's surface waters, the data must meet quality control guidelines as outlined in the VRAP Quality Assurance Project Plan (QAPP). The VRAP QAPP was approved by NHDES and reviewed by EPA in the summer of 2003. The QAPP is reviewed annually and is officially updated and approved every five years. The VRAP Quality Assurance/Quality Control (QA/QC) measures include a six-step approach to ensuring the accuracy of the equipment and consistency in sampling efforts.

- **Calibration:** Prior to each measurement, the pH and DO meters must be calibrated. Conductivity and turbidity meters are checked against a known standard before the first measurement and after the last one.

- **Replicate Analysis:** A second measurement by each meter is taken from the original sample at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the replicate analysis should be conducted at different stations. Replicates should be measured within 15 minutes of the original measurements.

- **6.0 pH Standard:** A reading of the pH 6.0 buffer is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the 6.0 pH standard check should be conducted at different stations.

- **Zero Oxygen Solution:** A reading of a zero oxygen solution is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the zero oxygen standard check should be conducted at different stations.

- **DI (De-Ionized) Turbidity Blank**: A reading of the DI blank is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the blank check should be conducted at different stations.

- **End of the Day Conductivity and Turbidity Meter Check:** At the conclusion of each sampling day, the conductivity and turbidity meters are re-checked against a known standard.

2.8.1 Measurement Performance Criteria

Precision is calculated for field and laboratory measurements through measurement replicates (instrumental variability) and is calculated for each sampling day. The use of VRAP data for assessment purposes is contingent on compliance with a parameter-specific relative percent difference (RPD) as derived from equation 1, below. Any data exceeding the limits of the individual measures are disqualified from surface water quality assessments. All data that exceeds the limits defined by the VRAP QAPP are acknowledged in the data tables with an explanation of why the data was unusable. Table 1 shows typical parameters studied under VRAP and the associated quality control procedures.

(Equation 1)

$$RPD = \frac{|x_1 - x_2|}{\frac{x_1 + x_2}{2}} \times 100 \ \%$$

where x_1 is the original sample and x_2 is the replicate sample

Table 1. Field Analytical Quality Controls

Water Quality Parameter	QC Check	QC Acceptance Limit	Corrective Action	Person Responsible for Corrective Action	Data Quality Indicator
Temperature	Measurement Replicate	RPD < 10% or Absolute Difference <0.8 C.	Repeat Measurement	Volunteer Monitors	Precision
Dissolved Oxygen	Measurement Replicate	RPD < 10%	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Precision
	Known Buffer (Zero O_2 Sol.)	RPD < 10% or Absolute Difference <0.4 mg/L	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Relative Accuracy
pH	Measurement Replicate	RPD < 10% or Absolute Difference <0.3 pH units	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Precision
	Known Buffer (pH = 6.0)	± 0.1 std units	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Accuracy
Specific Conductance	Measurement Replicate	RPD < 10% or Absolute Difference <5µS/cm	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Precision
	Method Blank (Zero Air Reading)	± 5.0 µS/cm	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Accuracy
Turbidity	Measurement Replicate	RPD < 10% or Absolute Difference <0.5 NTU	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Precision
	Method Blank (DI Water)	± 0.1 NTU	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Accuracy
Laboratory Parameters	Measurement Replicate	RPD < 20% or Absolute Difference less than ½ the mean value of the parameter in NHDES's Environmental Monitoring Database	Repeat Measurement	Volunteer Monitors	Precision

3.0 METHODS

During the summer of 1998, volunteers from the Exeter Conservation Commission began water quality monitoring on the mainstem of the Exeter River. The goal of this effort was to provide water quality data from the Exeter River relative to surface water quality standards and to allow for the assessment of the river for support of aquatic life. The establishment of a long-term monitoring program will allow for an understanding of the river's dynamics, or variations on a station-by-station and year-to-year basis. The data can also serve as a baseline from which to determine any water pollution problems in the river and/or watershed. NHDES provided field training, equipment, financial assistance, and technical assistance.

During the autumn of 2006, volunteers also began conducting biological monitoring in the Exeter River watershed. The goal of this effort was to complete "screening" level investigations of aquatic macroinvertebrate communities inhabiting the Exeter River and surrounding tributaries. Annual biological sampling at designated stations throughout the watershed can provide an indication of biological community condition, general water quality and overall watershed health as well as highlight changes that occur over time. The program serves to provide supplementary biological data to the NHDES Biomonitoring Program, enhancing statewide monitoring efforts and tracking potential problem areas needing further investigation.

During 2007, trained volunteers monitored water quality at 18 stations in the Exeter River watershed (Figure 1, Table 2). In addition, seven stations in the Exeter River watershed were monitored by VRAP staff using submersible dataloggers, and eight stations were monitored for biological assessment purposes. Stations IDs are designated using a number indicating the relative position of the station and a three letter code to identify the waterbody name. The higher the station number the more upstream the station is in the watershed. All stations monitored during 2007 are designated as Class B waters.

Water quality monitoring was conducted monthly from May through September. In-situ measurements of water temperature, air temperature, dissolved oxygen, pH, turbidity and specific conductance were taken using handheld meters. Table 3 summarizes the parameters measured, standard methods, and equipment used.

Biological monitoring was conducted one time at each station in September. Biotic scores with corresponding narrative categories to describe general water quality were formulated based on macroinvertebrates found in the sample collected. Before collecting macroinvetebrates, an assessment of in-stream and riparian habitat was completed at each station and a representative sampling reach was identified and measured. Macroinvertebrates were then collected, identified and counted to compute a biotic score with a corresponding narrative category describing general water quality. Proportion of the sample sorted, estimated abundance, and percentage of EPT (Empheroptera, Plecoptera, Tricoptera) individuals were also calculated. Additional chemical parameters were measured using VRAP Standard Operating Procedures and handheld meters provided by NHDES. Whenever possible, sampling stations were located at least 100 feet upstream of road crossings.

Table 2. Sampling Stations for the Exeter River Watershed, NHDES, 2007

Station ID	Waterbody Name	Location	Town	Elevation* (Ft.)
30-EXT**	**Exeter River**	Wells Road	Sandown	300
02-TWL**	**Towle Brook**	Towle Road	Chester	200
27-EXT**	**Exeter River**	Shepherd Home Road Bridge	Chester	200
03-FDY**	**Fordway Brook**	Lane Road Bridge	Raymond	300
01-FDY**	**Fordway Brook**	Sandown Road	Raymond	200
04-LIT**	**Little River**	Little River Road	Kingston	100
15-EXT	**Exeter River**	Haigh Road	Brentwood	100
14-EXT	**Exeter River**	Cross Road Bridge	Exeter	100
13-EXT**	**Exeter River**	Kingston Road Bridge	Exeter	0
12-EXT	**Exeter River**	Route 108 Bridge	Exeter	0
12A-EXT	**Exeter River**	Linden Street Bridge	Exeter	0
11-EXT	**Exeter River**	Larry Lane	Exeter	0
02-DDY	**Dudley Brook**	Route 111A Bridge	Exeter	0
05-LTE	**Little River**	Garrison Road Bridge	Exeter	0
02-LTE**	**Little River**	Linden Street Bridge	Exeter	0
00-LTE	**Little River**	Gilman Street Bridge	Exeter	0
10-EXT	**Exeter River**	Phillips Exeter Academy Athletic Fields	Exeter	0
09-EXT	**Exeter River**	High Street Bridge	Exeter	0

*Elevations have been rounded off to 100-foot increments for calibration of dissolved oxygen meter
** VRAP/VBAP Stations

Table 3. Sampling and Analysis Methods

Parameter	Sample Type	Standard Method	Equipment Used	Laboratory
Temperature	In-Situ	SM 2550	YSI 95	------
	Datalogger	SM 2550	In Situ Multiparameter Series Troll 9500	------
Dissolved Oxygen	In-Situ	SM 4500 O G	YSI 95	------
	Datalogger	SM 2550	In Situ Multiparameter Series Troll 9500	------
pH	In-Situ	SM 4500 H+	Orion 210A	------
Turbidity	In-Situ	EPA 180.1	LaMotte 2020	
Specific Conductance	In-Situ	SM 2510	YSI 30	------
	Datalogger	SM 2550	In Situ Multiparameter Series Troll 9500	------

RESULTS AND RECOMMENDATIONS

Results and recommendations for each monitored parameter are presented in the following sections. For a description of the importance of each parameter and pertinent water quality criteria for these and other parameters, please see Appendix B, *"Interpreting VRAP Water Quality Parameters".*

4.1 Dissolved Oxygen

Between one and six measurements were taken in the field for dissolved oxygen concentration at 17 stations in the Exeter River watershed from Sandown to Exeter (Table 4). VRAP staff also deployed submersible dataloggers to record dissolved oxygen at seven stations in the Exeter River watershed. Of the 55 measurements taken, 50 met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

The Class B New Hampshire surface water quality standard for dissolved oxygen includes a minimum concentration of 5.0 mg/L **and** a minimum daily average of 75 percent of saturation. In other words, there are criteria for both concentration and saturation that must be met before the river can be assessed as meeting dissolved oxygen standards. Table 4 reports only dissolved oxygen concentration as more detailed analysis is required to determine if instantaneous dissolved oxygen saturation measurements are above or below water quality standards.

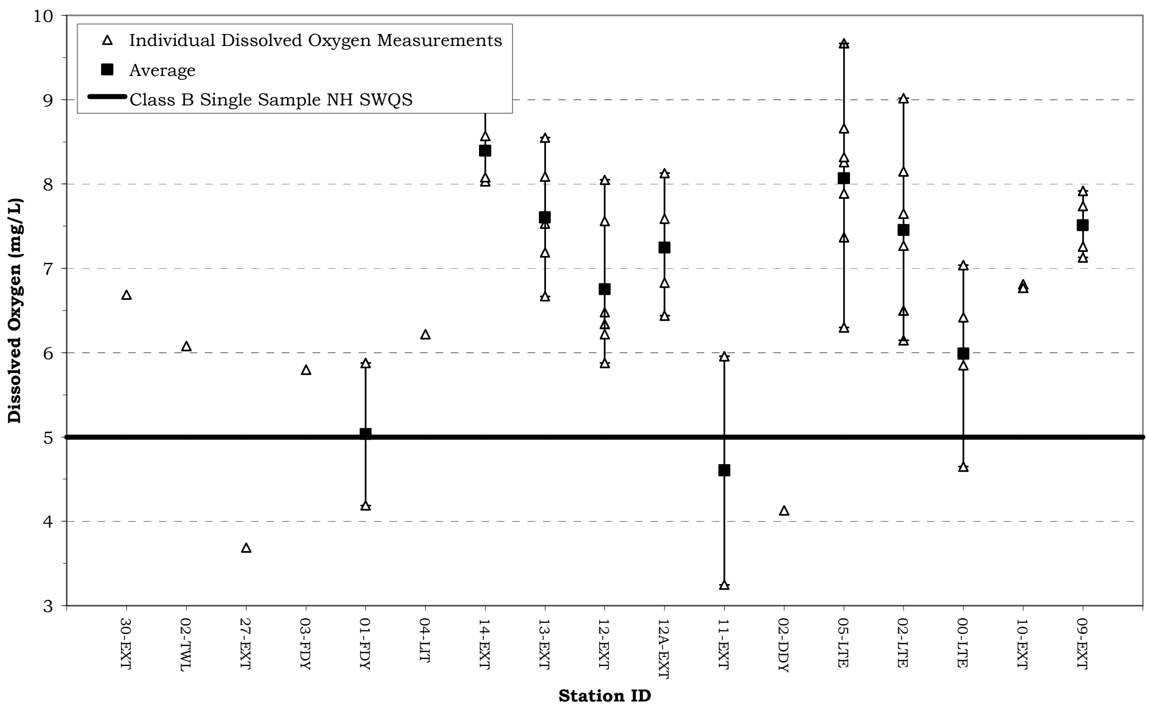
Table 4. Dissolved Oxygen Concentration (mg/L) Summary – Exeter River Watershed, 2007

Station ID	Samples Collected	Data Range (mg/l)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
30-EXT	1	6.69	0	1
02-TWL	1	6.08	0	1
27-EXT	1	3.69	1	1
03-FDY	1	5.80	0	1
01-FDY	3	4.19 - 5.88	1	3
04-LIT	1	6.22 - 6.22	0	1
14-EXT	4	8.03 - 8.90	0	3
13-EXT	5	6.67 - 8.55	0	4
12-EXT	6	5.88 - 8.05	0	5
12A-EXT	4	6.44 - 8.13	0	3
11-EXT	2	3.25 - 5.96	1	2
02-DDY	1	4.13	1	1
05-LTE	7	6.30 - 9.67	0	7
02-LTE	6	6.15 - 9.02	0	6
00-LTE	4	4.65 - 7.04	1	4
10-EXT	4	6.77 - 6.81	0	4
09-EXT	4	7.13 - 7.92	0	3
Total	**55**	_____	**5**	**50**

Dissolved oxygen concentration levels were above the New Hampshire Class B surface water quality standard at 12 of the stations on all occasions. Five stations had a single measurement that was below the standard. The average dissolved oxygen concentration ranged from 5.04 mg/L in Fordway Brook to 8.40 mg/L at station 14-EXT (Figure 1). Levels of dissolved oxygen sustained above the standards are considered adequate for the support of aquatic life and other desirable water quality conditions.

Stations where the instantaneous dissolved oxygen standard was not met could potentially have a dissolved oxygen problem and further investigation is warranted. It should be noted however, that low dissolved oxygen levels may be the result of natural conditions (e.g., the presence of wetlands or stagnant water caused by a beaver dam).

Figure 1. Dissolved Oxygen Concentration Statistics for the Exeter River Watershed May 27 - September 19, 2007, NHDES VRAP



Figures 2 though 5 illustrate the results of dissolved oxygen concentration and saturation levels obtained at seven stations in the Exeter River watershed using submersible multiparameter dataloggers deployed on two separate occasions. On each occasion, the meters were programmed to take dissolved oxygen readings every 15 minutes over a multiple day period. In general the daily minimum is used to determine if the waterbodies are meeting the surface water quality standard for dissolved oxygen concentration (mg/L) and the 24 hour average is analyzed for % saturation of dissovled oxygen.

During the first deployment (July 11 through July 16) four full 24-hour periods were measured at four stations (12-EXT, 11-EXT, 10-EXT, and 02-LTE). Dissolved oxygen concentration levels were above the New Hampshire Class B surface water quality standard of 5.0 mg/L at stations 12-EXT and 10-EXT on all occasions, while concentration levels at station 02-LTE were above the standard on most occasions. Station 11-EXT had multiple dissolved oxygen concentration daily minimum that were below the standard. and concentration 11-EXT hovered above and below the standard (Figure 2). Station 02-LTE also shows the most significant daily changes in dissolved oxygen concentration levels. All four stations had multiple daily averages that were below the standard of 75% (Figure 3).

During the second deployment (July 27 through July 31) three full 24-hour periods were measured at three stations. Dissolved oxygen concentration levels were above the state of New Hampshire Class B surface water quality standard of 5.0 mg/L at station 05-LTE on all occasions. Dissolved oxygen concentration levels were below the standard on all occasions at stations 01-FDY and 02-DDY (Figure 4). Similarly, the daily average of dissolved oxygen % saturation was also above the state of New Hampshire Class B surface water quality standard of 75% at station 05-LTE and below the standard at stations 01-FDY and 02-DDY on all occasions (Figure 5).

Figures 2 through 5 also depict the typical cyclical variations in dissolved oxygen measurements one would expect to see during a 24-hour period in the summer. In general, dissolved oxygen levels are lowest in the early morning when there is low photosynthetic activity and a peak in respiration from organisms throughout the water column. This is the time of least oxygen production and greatest carbon dioxide emission. Peak dissolved oxygen levels occur when photosynthetic activity is at its peak. The greater the amount of photosynthetic activity the greater the production of oxygen as a byproduct of photosynthesis.

From July 12th to 14th day and night levels of dissovled oxygen levels at station 02-LTE varied significantly. The type and amount of plants and algae present in a waterbody can significantly impact dissolved oxygen levels. If due to an excessive amount of plant material, there are high levels of chlorophyll present, the water can become supersaturated with dissolved oxygen during the day as photosynthesis occurs. Dissovled oxygen levels can then decrease dramatically during the night when respiration is at its peak. The large daytime/nighttime swing in dissolved oxygen levels at 02-LTE is indicative of nuicance levels of plant and/or algae.

Figure 2. Dissolved Oxygen Concentration Statistics for the Exeter River Watershed
July 11-16, 2007, NHDES VRAP

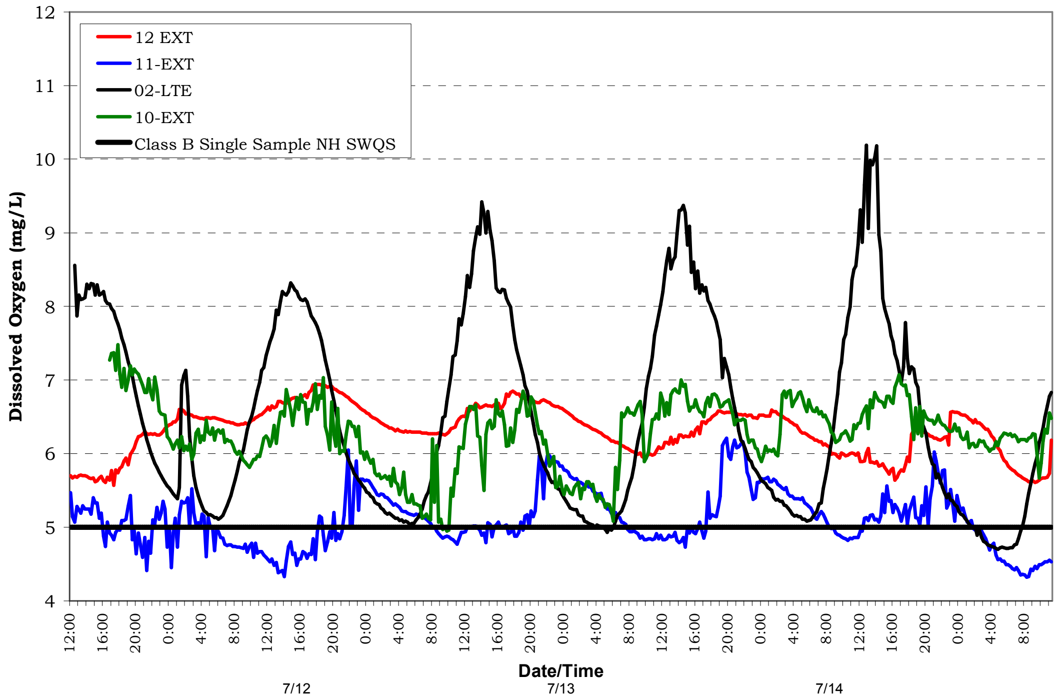


Figure 3. Dissolved Oxygen Saturation Statistics for the Exeter River Watershed
July 11- 16, 2007, NHDES VRAP

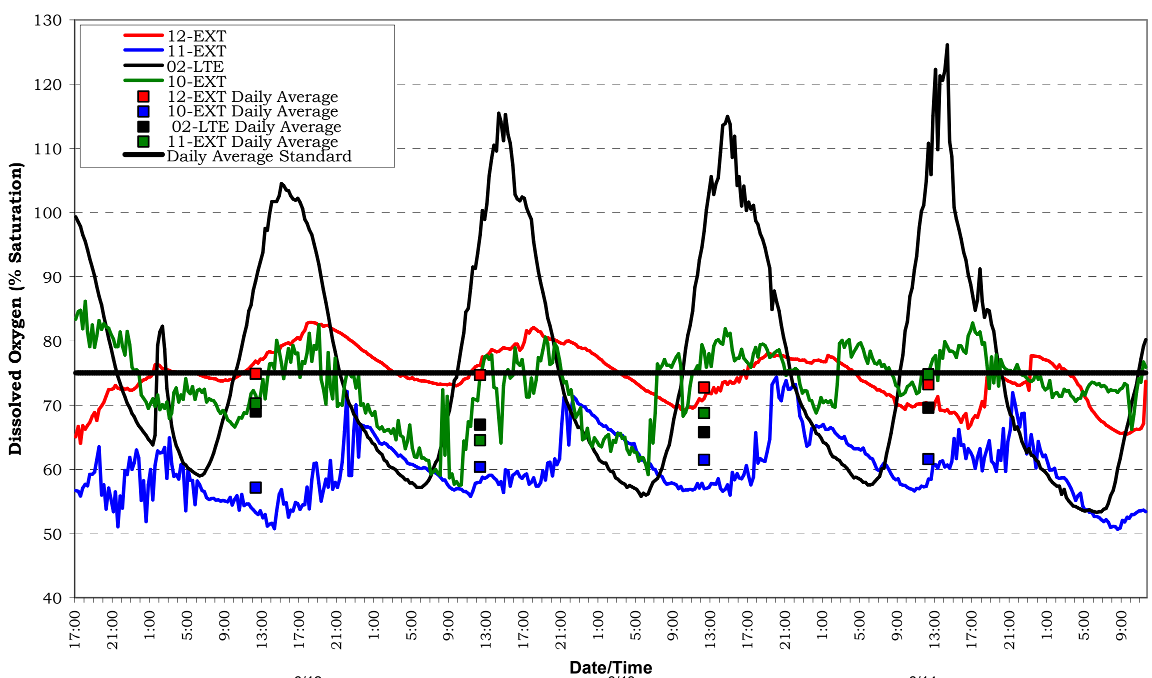


Figure 4. Dissolved Oxygen Concentration Statistics for the Exeter River Watershed
July 27-31, 2007, NHDES VRAP

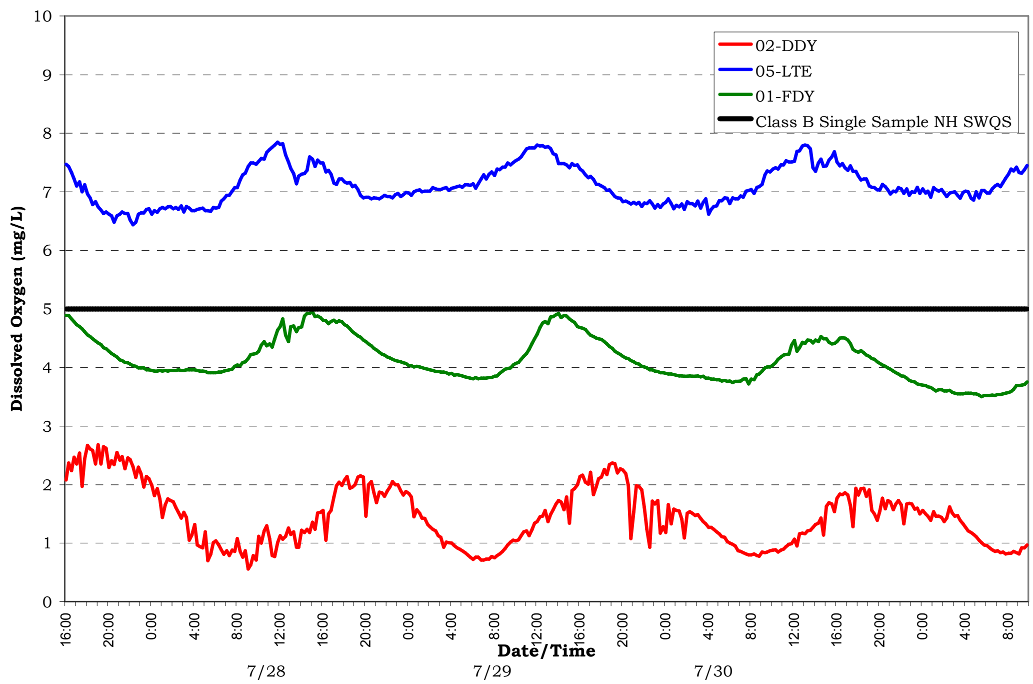
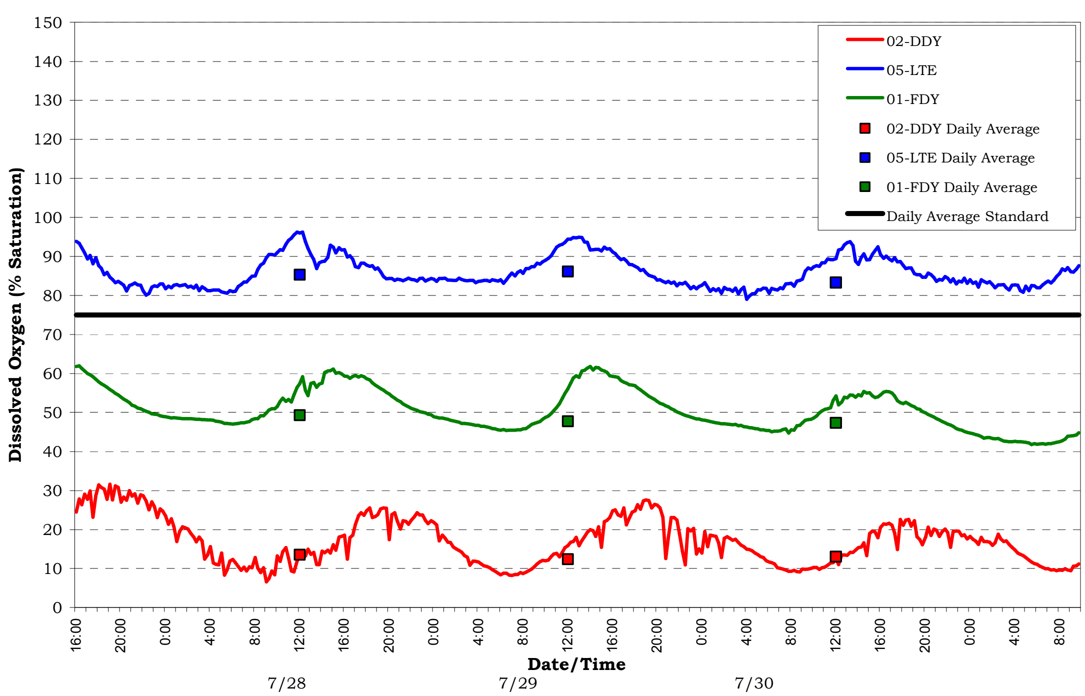


Figure 5. Dissolved Oxygen Saturation Statistics for the Exeter River Watershed
July 27-31, 2007, NHDES VRAP



Recommendations

- Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.

- Further investigation should be conducted at 02-LTE regarding the widely varying dissovled oxygen levels. Phosphorous and chlorophyll-a sampling should be conducted in 2008 in conjunction with another deployment of a datalogger to measure dissolved oxygen.

- If possible, take measurements between 5 a.m. and 10 a.m., which is when dissolved oxygen is usually the lowest, and between 2 p.m. and 7 p.m. when dissolved oxygen is usually the highest. In general, dissolved oxygen levels are lowest in the early morning when there is low photosynthetic activity and a peak in respiration from organisms throughout the water column. This is the time of least oxygen production and greatest carbon dioxide emission. Peak dissolved oxygen levels occur when photosynthetic activity is at its peak. The greater the amount of photosynthetic activity the greater the production of oxygen as a byproduct of photosynthesis.

- Continue incorporating the use of in-situ dataloggers to automatically record dissolved oxygen saturation levels during a period of several days. The use of these instruments is dependent upon availability, and requires coordination with NHDES.

4.2 pH

Between one and seven measurements were taken in the field for pH at 17 stations in the Exeter River watershed from Sandown to Exeter. VRAP staff also deployed submersible dataloggers to record pH at seven stations in the Ashuelot River watershed [Table 5]. Of the 53 measurements taken, 48 met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

The Class B New Hampshire surface water quality standard is 6.5 - 8.0, unless naturally occurring.

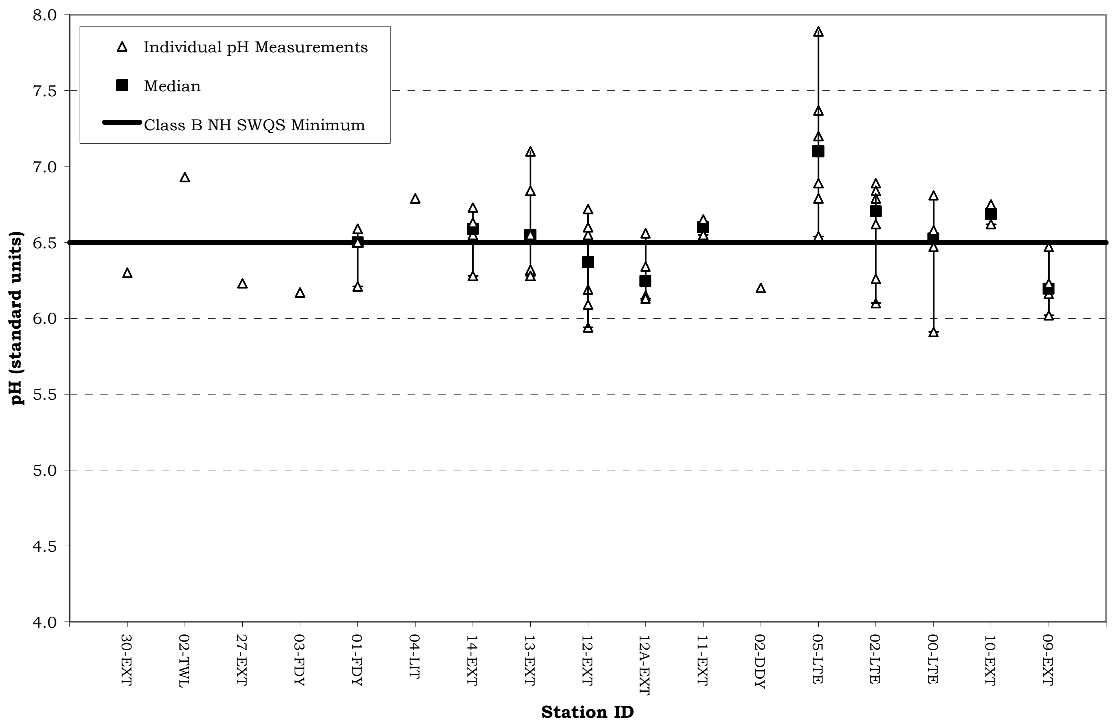
Table 5. pH Data Summary – Exeter River Watershed, 2007

Station ID	Samples Collected	Data Range (standard units)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
30-EXT	1	6.30	1	1
02-TWL	1	6.93	0	1
27-EXT	1	6.23	1	1
03-FDY	1	6.17	1	1
01-FDY	3	6.21 - 6.59	1	3
04-LIT	1	6.79 - 6.79	1	1
14-EXT	4	6.28 - 6.73	1	3
13-EXT	5	6.28 - 7.10	2	4
12-EXT	6	5.94 - 6.72	2	5
12A-EXT	4	6.13 - 6.56	3	3
11-EXT	2	6.55 - 6.65	0	2
02-DDY	1	6.20	0	1
05-LTE	7	6.54 - 7.89	0	7
02-LTE	6	6.10 - 6.89	2	6
00-LTE	4	5.91 - 6.81	2	4
10-EXT	2	6.62 - 6.75	0	2
09-EXT	4	6.02 - 6.47	4	3
Total	**53**	_____	**21**	**48**

A majority of the pH measurements failed to meet the New Hampshire surface water quality standard minimum (Figure 6). However, pH measurements at stations 02-TWL, 04-LIT, 11-EXT, 05-LTE, and 10-EXT met the standard on all occasions.

Lower pH measurements are likely the result of natural conditions such as the soils, geology, or the presence of wetlands in the area. Rain and snow falling in New Hampshire is relatively acidic, which can also affect pH levels; after the spring melt or significant rain events, surface waters will generally have a lower pH.

Figure 6. pH Statistics for the Exeter River Watershed
May 27 - September 19, 2007, NHDES VRAP



Figures 7 and 8 illustrate the results of pH measurements obtained at six stations in the Exeter River watershed using submersible multiparameter dataloggers deployed on two separate occasions. On each occasion, the meters were programmed to take pH readings every 15 minutes over a multiple day period. In general the daily minimum is used to determine if the waterbodies are meeting the surface water quality standard for pH.

During the first deployment (July 11 through July 16) stations 11-EXT and 10-Ext had daily minimum pH levels which met the surface water quality standard. Station 02-LTE had daily minimums on two days that were below the standard (Figure 7).

During the second deployment (July 27 through July 31) pH measurements from stations 05-LTE met the state of New Hampshire surface water quality standard on all occasions while most of the measurements from stations 02-DDY and 01-FDY failed to meet the standard (Figure 8).

Instantaneous measurements and the datalogger measurements show that station 02-LTE had significantly higher pH levels than other stations in the Exeter River watershed. The large variation in dissolved oxgygen levels at this station which was described in the previous section are likely contributing to higher pH levels. During daylight hours when all plants and algae are in an active state of photosynthesis, they absorb carbon dioxide from the water and use the sun's energy to convert it to simple organic compounds. Carbon dioxide in the solution is acidic so as plants remove it the water becomes more alakaline. Thus, a higher density of plants and/or algae and subsequent high levels of chlorophyll can lead to higher pH values.

Figure 7. pH Statistics for the Exeter River Watershed
July 11- 16, 2007, NHDES VRAP

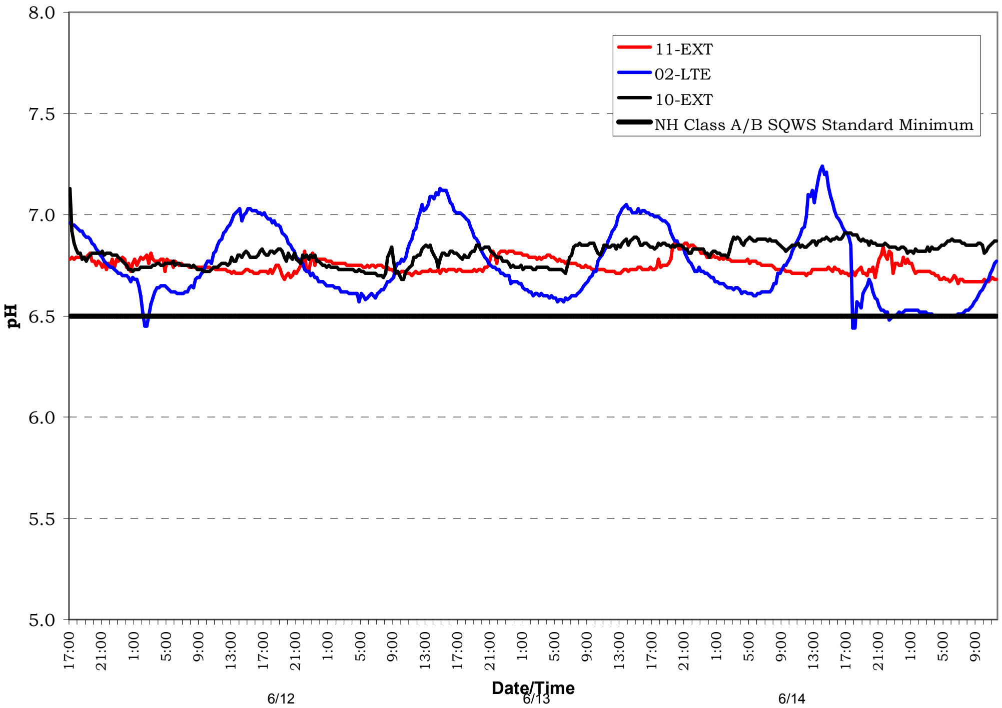
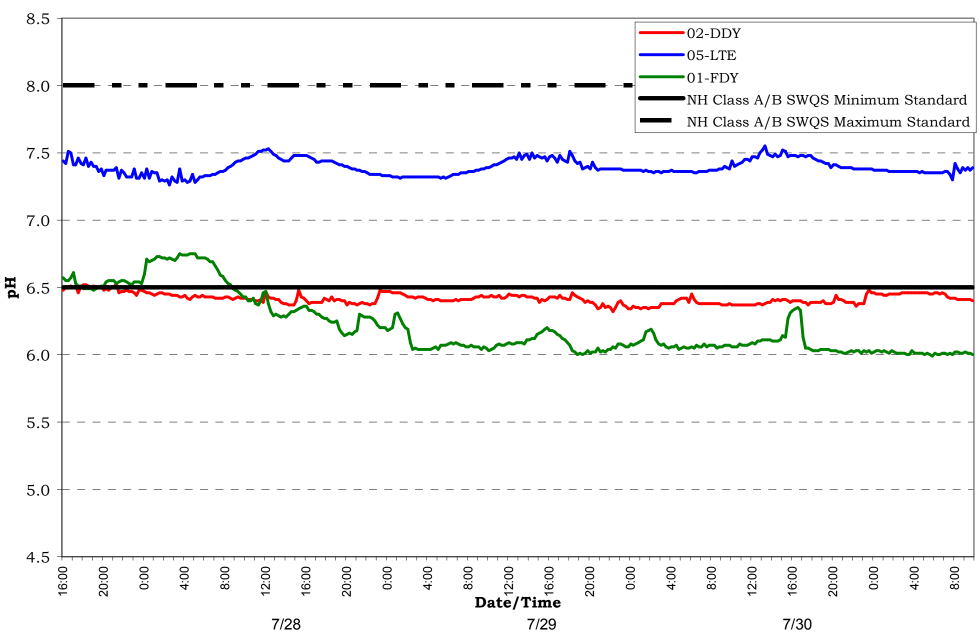


Figure 8. pH Statistics for the Exeter River Watershed
July 27-31, 2007, NHDES VRAP



Recommendations

- Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.

- Consider sampling for pH in some of the tributaries and wetland areas that are influencing the pH of stations with measurements below state standards. Site conditions are considered along with pH measurements because of the narrative portion of the pH standard. RSA 485-A:8 states that pH of Class B waters *shall be between 6.5 and 8.0, except when due to natural causes*. Wetlands can lower the pH of a river naturally by releasing tannic and humic acids from decaying plant material. If the sampling location is influenced by wetlands or other natural conditions, then the low pH measurements are not considered a violation of water quality standards. It is important to note that the New Hampshire water quality standard for pH is fairly conservative, thus pH levels slightly below the standard are not necessarily harmful to aquatic life. In this case, additional information about factors influencing pH levels is needed.

4.3 Turbidity

Between one and five measurements were taken in the field for turbidity at 11 stations in the Exeter River watershed from Sandown to Exeter [Table 6]. Of the 31 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

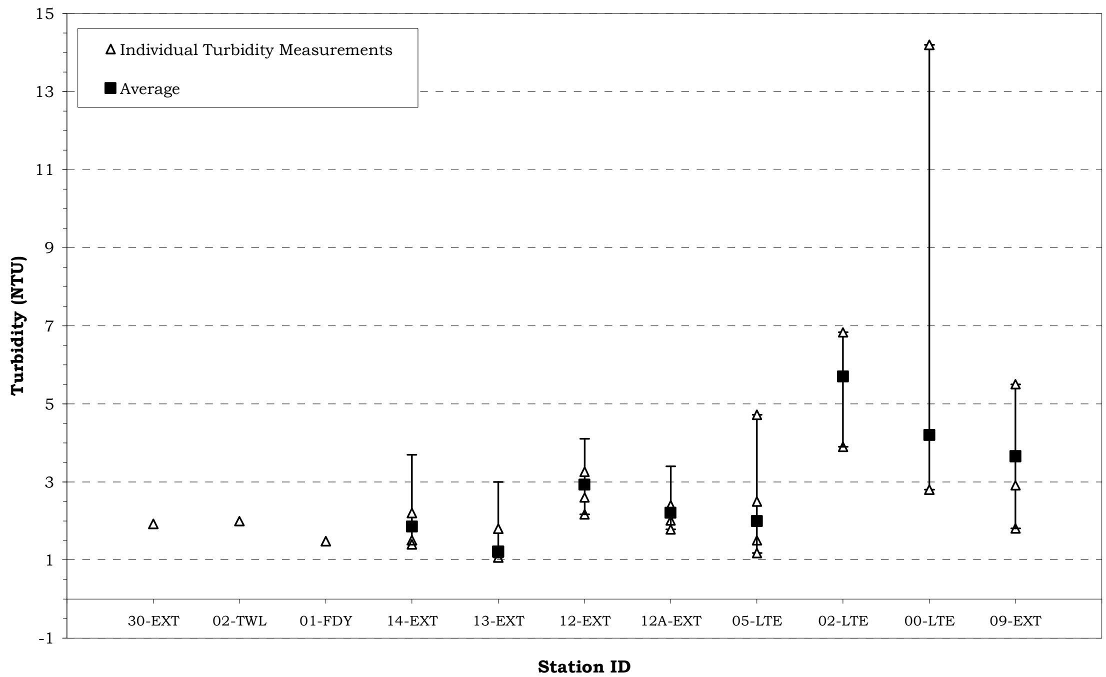
The Class B New Hampshire surface water quality standard for turbidity is less than 10 NTU above natural background.

Table 6. Turbidity Data Summary – Exeter River Watershed, 2007

Station ID	Samples Collected	Data Range (NTU)	Acceptable Samples Potentially Not Meeting NH Class B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
30-EXT	1	1.92	0	1
02-TWL	1	1.99	0	1
01-FDY	1	1.48	0	1
14-EXT	1	1.40 - 3.70	0	1
13-EXT	5	1.06 - 3.00	0	5
12-EXT	4	2.17 - 4.10	0	4
12A-EXT	4	1.78 - 3.40	0	4
05-LTE	4	1.18 - 4.72	0	4
02-LTE	3	3.90 - 6.83	0	3
00-LTE	3	2.80 - 14.2	1	3
09-EXT	4	1.81 - 5.50	0	4
Total	**31**	____	**1**	**31**

Turbidity levels were low with the average ranging from 1.21 NTU to 5.70 NTU (Figure 9). In general, turbidity levels tended to increase throughout the watershed. Station 00-LTE had one elevated measurement of 14.2 NTU on 7/4/2007. Although clean waters are associated with low turbidity there is a high degree of natural variability involved. Precipitation often contributes to increased turbidity by flushing sediment, organic matter and other materials from the surrounding landscape into surface waters. However, human activities such as removal of vegetation near surface waters and disruption of nearby soils can lead to dramatic increases in turbidity levels. In general it is typical to see a rise in turbidity in more developed areas due to increased runoff.

Figure 9. Turbidity Statistics for the Exeter River Watershed
May 27, - September 19, 2007, NHDES VRAP



Recommendations

- Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.

- Collect samples during wet weather. This will help us to understand how the river responds to runoff and sedimentation.

- If a higher than normal turbidity measurement occurs, volunteers can investigate further by moving upstream and taking additional measurements. This will facilitate isolating the location of the cause of the elevated turbidity levels. In addition, take good field notes and photographs. If human activity is suspected or verified as the source of elevated turbidity levels, volunteers should contact NHDES.

4.4 Specific Conductance

Between one and seven measurements were taken in the field for specific conductance at 17 stations in the Exeter River watershed from Sandown to Exeter. VRAP staff also deployed submersible dataloggers to record specific conductance at seven stations in the Exeter River watershed [Table 7]. Of the 53 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

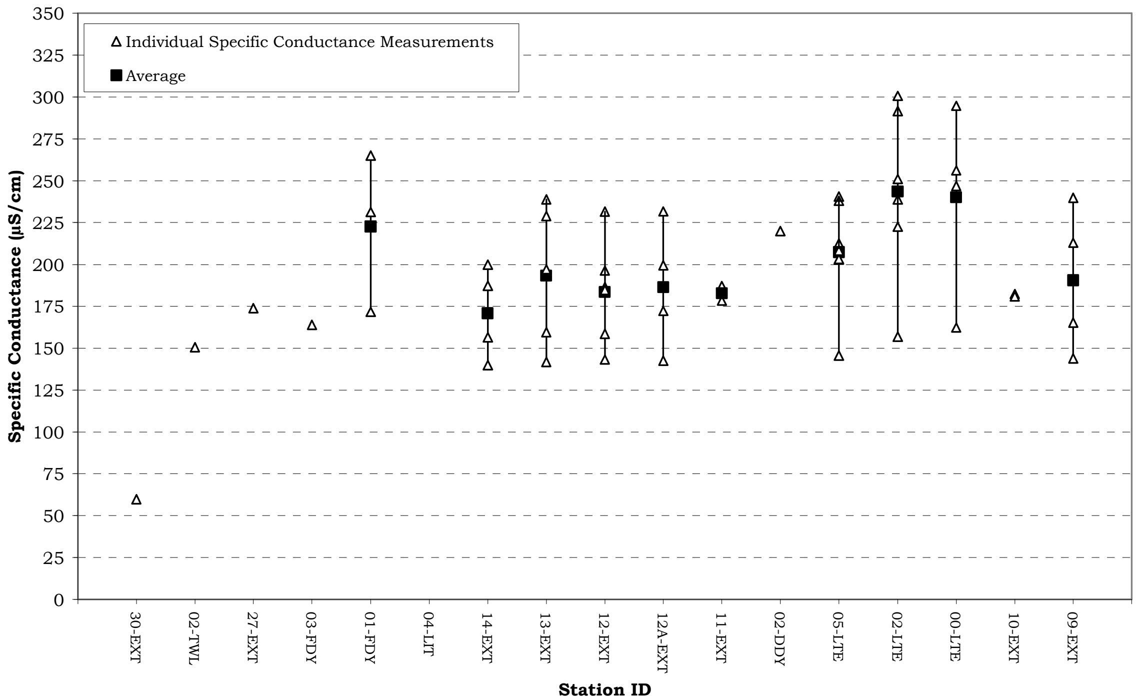
New Hampshire surface water quality standards do not contain numeric limits for specific conductance.

Table 7. Specific Conductance Data Summary – Exeter River Watershed, 2007

Station ID	Samples Collected	Data Range (µS/cm)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
30-EXT	1	59.8	Not Applicable	1
02-TWL	1	150.5	N/A	1
27-EXT	1	173.9	N/A	1
03-FDY	1	164.0	N/A	1
01-FDY	3	171.7 - 265.1	N/A	3
04-LIT	1	312.8 - 312.8	N/A	1
14-EXT	4	139.9 - 199.8	N/A	4
13-EXT	5	141.7 - 238.9	N/A	5
12-EXT	6	143.2 - 231.6	N/A	6
12A-EXT	4	142.5 - 231.7	N/A	4
11-EXT	2	178.4 - 187.2	N/A	2
02-DDY	1	219.9	N/A	1
05-LTE	7	145.6 - 240.6	N/A	7
02-LTE	6	156.9 - 300.7	N/A	6
00-LTE	4	162.3 - 294.8	N/A	4
10-EXT	2	181.0 - 182.4	N/A	2
09-EXT	4	143.9 - 239.9	N/A	4
Total	**53**	_____	**N/A**	**53**

Specific conductance levels were variable with the average ranging from 170.9 µS/cm to 243.6 µS/cm (Figure 10). Specific conductance measurements tended to be higher in the lower portion of the watershed. Higher specific conductance levels (> 200 µS/cm) can be indicative of pollution from sources such as urban/agricultural runoff, road salt, failed septic systems, or groundwater pollution. Thus, the variable specific conductance levels indicate low pollutant levels at some stations and higher levels at others.

Figure 10. Specific Conductance Statistics for the Exeter River Watershed
May 27 - September 19, 2007 NHDES VRAP



Figures 11 and 12 illustrate the results of specific conductance measurements obtained at seven stations in the Exeter River watershed using submersible multiparameter dataloggers deployed on two separate occasions. On each occasion, the meters were programmed to take specific conductance readings every 15 minutes over a multiple day period.

During the first deployment (July 7 through July 16), in general, specific conductance measurements were elevated at all stations. However, measurements were highest at station 02-LTE with a significant drop and rise on the first and last day. Measurements were also higher at station 11-EXT.

During the second deployment (July 27 through July 27) specific conductance measurements were highest at station 02-DDY, followed by 01-FDY and then 05-LTE.

Figure 11. Specific Conductance Statistics for the Exeter River Watershed July 11- 16, 2007, NHDES VRAP

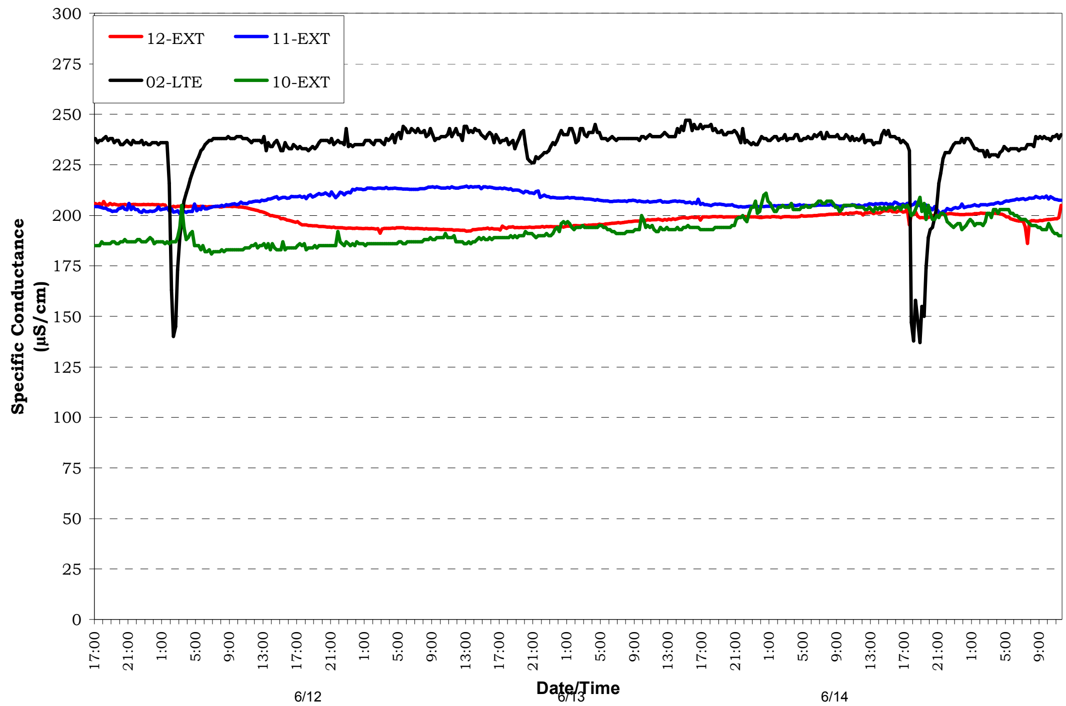
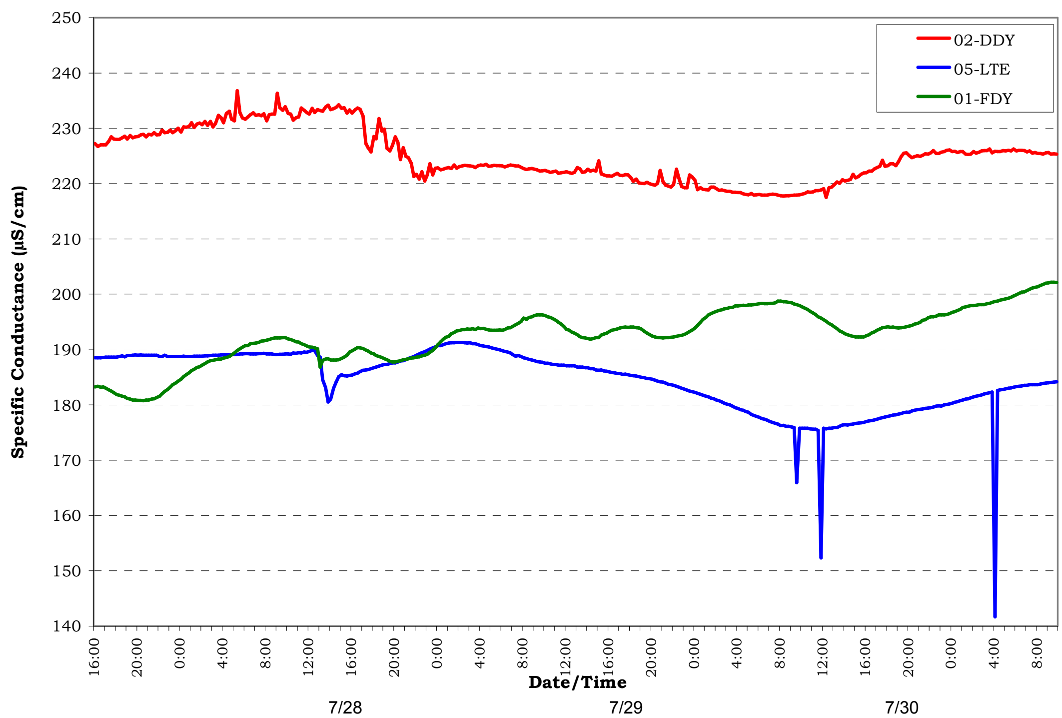


Figure 12. Specific Conductance Statistics for the Exeter River Watershed July 27-31, 2007, NHDES VRAP



Recommendations

- Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.

- Consider collecting chloride samples at the same time that specific conductance is measured. During the late winter/early spring snowmelt, higher specific conductance levels are often seen due to elevated concentrations of chloride in the runoff. Specific conductance levels are very closely correlated to chloride levels. Simultaneously measuring chloride and specific conductance will allow for a better understanding of their relationship.

- Continue incorporating the use of in-situ dataloggers to automatically determine specific conductance levels during rain events, snowmelt, and baseline dry weather conditions. The use of these instruments is dependent upon availability, and requires coordination with NHDES.

4.5 Water Temperature

Between one and seven measurements were taken in the field for water temperature at 17 stations in the Exeter River watershed from Sandown to Exeter. VRAP staff also deployed submersible dataloggers at seven stations in the Exeter River watershed [Table 8]. Of the 53 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

Although there is currently no numerical water quality criteria for water temperature, NHDES is in the process of collecting biological and water temperature data that will contribute to the development of a procedure for assessing rivers and stream based on water temperature and its corresponding impact to the biological integrity of the waterbody.

Table 8. Water Temperature Data Summary – Exeter River Watershed, 2007

Station ID	Samples Collected	Data Range (°C)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
30-EXT	1	17.5	Not Applicable	1
02-TWL	1	16.2	N/A	1
27-EXT	1	21.1	N/A	1
03-FDY	1	12.7	N/A	1
01-FDY	3	20.8 - 23.9	N/A	3
04-LIT	1	23.0	N/A	1
14-EXT	4	19.4 - 25.8	N/A	4
13-EXT	5	18.7 - 25.8	N/A	5
12-EXT	6	19.5 - 25.4	N/A	6
12A-EXT	4	19.4 - 25.2	N/A	4
11-EXT	2	25.2 - 25.4	N/A	2
02-DDY	1	24.8	N/A	1
05-LTE	7	15.4 - 25.8	N/A	7
02-LTE	6	14.5 - 24.9	N/A	6
00-LTE	4	17.6 - 21.9	N/A	4
10-EXT	2	24.2 - 24.5	N/A	2
09-EXT	4	20.6 - 26.2	N/A	4
Total	**53**	_____	**N/A**	**53**

Figure 13 shows the results of instantaneous water temperature measurements taken at 17 stations in the Exeter River watershed. The average water temperature varied from 20.2 °C. to 24.4 °C. Figures 14 and 15 illustrate the results of water temperature measurements obtained at seven stations in the Exeter River watershed using submersible multiparameter dataloggers deployed on two separate occasions. On each occasion, the meters were programmed to take water temperature readings every 15 minutes over a multiple day period.

Water temperature is a critical parameter for aquatic life and has an impact on other water quality parameters such as dissolved oxygen concentrations, and the activity of bacteria in the water. Water temperature controls the metabolic and reproductive processes of aquatic species and can determine which fish and macroinvertabrate species can survive in a given river or stream.

A number of factors can have an impact on water temperature including the quantity and maturity of riparian vegetation along the shoreline, the rate of flow, the percent of impervious surfaces contributing stormwater, thermal discharges, impoundments and the influence of groundwater.

Figure 13. Water Temperature Statistics for the Exeter River Watershed
May 27 - September 19, 2007 NHDES VRAP

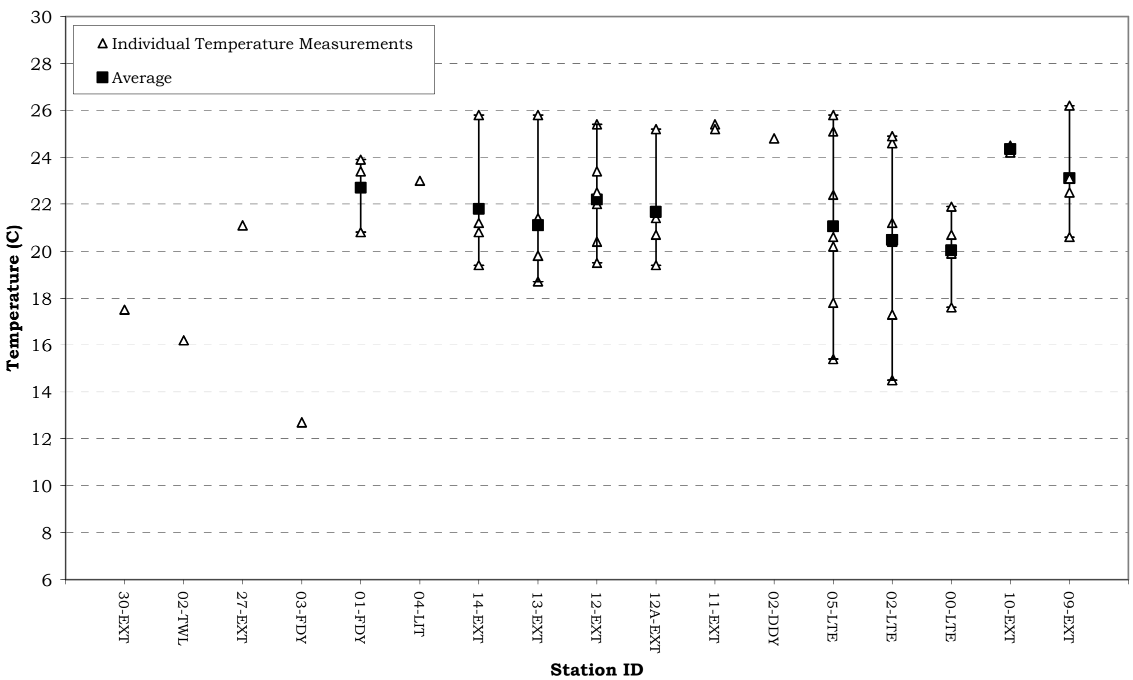


Figure 14. Temperature Statistics for the Exeter River Watershed
July 11- 16, 2007, NHDES VRAP

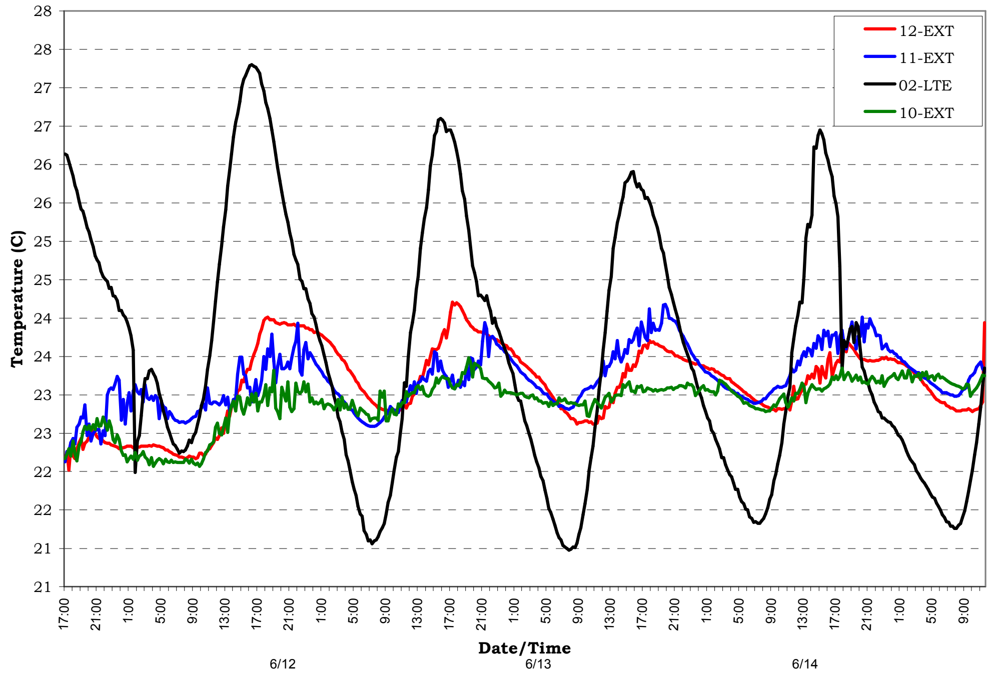
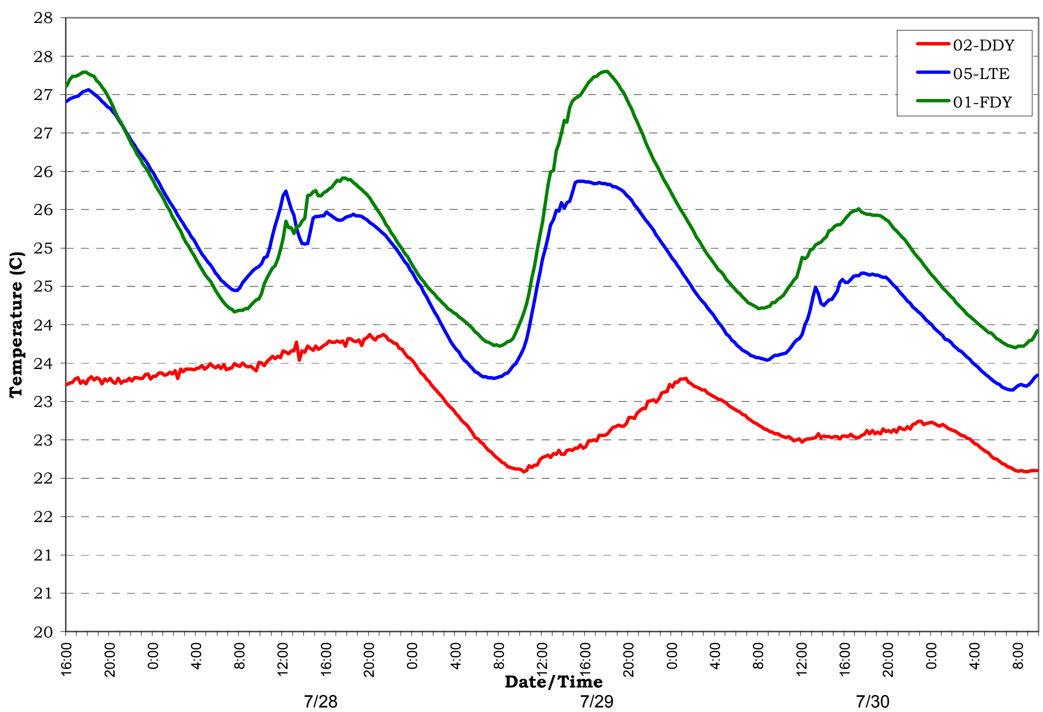


Figure 15. Temperature Statistics for the Exeter River Watershed
July 27-31, 2007, NHDES VRAP



Recommendations

- Continue collecting water temperature data via both instantaneous readings and consider long-term deployment of NHDES water temperature dataloggers.

4.6 Biological Assessment

Habitat Analysis

Surrounding land use, riparian habitat, and in-stream habitat were examined prior to collecting biological samples at each of the nine stations in the Exeter River watershed. Findings were recorded on a standardized Volunteer Habitat Data Sheet included in the Volunteer Biological Assessment Program 2007 Draft Protocol.

Land Use

Of the nine stations assessed, five stations had forested land making up 80% or greater of the station's surrounding land use with residential making up the remainder. The remaining four stations had residential making up 50% or greater of each of the station's surrounding land use with forest and field/pasture making up the remainder.

Riparian Habitat

The riparian habitat at all stations was dominated by trees with a lesser presence of shrubs in the lower canopy structure. Deciduous species made up the majority of trees in the riparian zone at seven of the nine stations. Although present, but less abundant at most stations, conifers were found to be the dominant species at one station and equally abundant at one station. Canopy coverage was greater than 40% at five of the nine stations while the remaining four stations were identified as having less than 10% coverage. The riparian buffer zone ranged from less than 20 feet to over 500 feet from station to station. Overall, greater than 500 feet was most frequently identified followed by 20 to 100 feet and 100 to 500 feet. Only two stations had riparian buffers identified as being less than 20 feet.

In-Stream Habitat

Riffles were the most prevalent habitat type found at all nine stations with cobble and sand as the most commonly found substrate. Substrate ranged from 50-75% embedded at four out of the nine stations followed by 25-50% embedded at three stations. Flow ranged from low to moderate at all nine stations and water color was primarily identified as clear. Aquatic vegetation was present at seven of the nine stations in the form of algae, moss, and/or plants. Stream bank erosion was present at six out of the nine stations varying in degree from slight to moderate.

Biological Community Condition

Upon completing an evaluation of habitat conditions, volunteers from the Exeter River Local Advisory Committee and New Hampshire Coastal Program staff collected, sorted and identified macroinvertebrates at each station. Results from the sample collection were used to compute biotic scores for each station (refer to Appendix F for BI computation). Biotic scores are based on the number, type and tolerance values of macroinvertebrate taxonomic groups collected in the sample. More tolerant groups have higher tolerance values and less tolerant groups have lower values. Final biotic scores correspond to three interim narrative categories that refer to general water quality: excellent (0-3.5), good (>3.5-4.8), or fairly poor (>4.8). Of the nine stations sampled, six had biotic scores that corresponded to the "good" narrative category (>3.5-4.8). The remaining three stations had biotic scores corresponding to the “excellent” narrative category (0-3.5). The average biotic score for the entire watershed was 3.65 corresponding to the “good” narrative category. Final biotic scores in the mainstem Exeter River ranged from 2.79 to 4.03, while biotic scores in the tributaries ranged from 3.30 to 4.51 (Table 9).

Three stations had approximately 75 percent or greater samples comprised of EPT individuals (Table 9). The percentage of EPT individuals refers to the total percentage of Ephemeroptera (mayfly nymphs), Plecoptera (stonefly nymphs), and Trichoptera (caddisfly larvae) individuals in a sample. Generally, the percent of EPT individuals increases with increasing water quality.

The fraction of the sample sorted at each of the nine stations ranged from 0.19 to 0.75. The total number of macroinvertebrates sorted and identified by volunteers ranged from 67 to 278 individuals at each station with an estimated abundance (total number of individuals within a sample) ranging from 134 to 1153 individuals (Appendix D).

Table 9: Biotic Score, Associated Narrative Quality of Streams, and Percentage of EPT Individuals, Exeter River Watershed, 2007

Station ID	Biotic Score	Narrative Category	EPT (%)
30-EXT	2.79	Excellent	30
02-TWL	3.30	Excellent	73
27-EXT	4.03	Good	81
03-FDY	3.38	Excellent	63
01-FDY	4.51	Good	73
04-LIT	3.70	Good	86
15-EXT	3.82	Good	74
13-EXT	3.62	Good	61
05-LTE	3.70	Good	78

Quality Control Test

In order to test the accuracy of volunteer identification skills and validity of data, New Hampshire Coastal Program Staff performed a quality control (QC) test of ten percent of the samples (i.e. one station) collected. The Fordway Brook station, 01-FDY, was selected as the QC sample. The streamside volunteer identification yielded a biotic score of 4.51, corresponding to the “good” narrative category. The QC test of the invertebrates collected at the station yielded a biotic score of 5.28. With a difference of .77, the QC biotic score corresponds to “fairly poor,” resulting in a shift in narrative category. Two hundred and seventy-eight invertebrates were counted and identified in the field versus 267 in the lab. Major differences included 9 more scuds and 7 more caddisflies identified in the field than in the lab, while 7 more aquatic worms were identified in the lab than in the field. While the totals for number of macroinvertebrates counted and identified were not drastically different, the difference in numbers and type of individuals found resulted in a significant difference in biotic score.

Recommendations:

- Consider closely monitoring water quality at station 30-EXT through further physical, chemical, and biological sampling. Determine influence of past activities upstream on habitat conditions and work to create a restoration plan.

- In 2007, volunteers from the Exeter River Local Advisory Committee reported a bloom of cyanobacteria at 01-FDY to NHDES. A considerable amount of trash was noted near the sampling station as well. Work to clean up station and consider closely monitoring water quality through further physical, chemical, and biological sampling.

- Continue annual sampling at all stations in order to develop a long term data set to better understand trends as time goes on.

APPENDIX A

2006 Exeter River Watershed Water Quality Data

2007 EXETER RIVER WATERSHED VRAP DATA

(blue shading)	Measurements not meeting New Hampshire surface water quality standards
(diagonal line)	Measurements not meeting NHDES quality assurance/quality control standards

[A] QA/QC Sample collected during datalogger deployment/retreival

[B] Water quality data collected in association with VBAP sampling

[C] Water quality data collected by Matt LaJoie, separate of VRAP, for Biomonitoring effort

30-EXT, Exeter River, Wells Road, Sandown

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Turbidity (NTUs)	Specific Conductance (µS/cm)	Water Temp. (°C)	Air Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	NA	Narrative	NA
9/12/2007[B]	15:15	6.69	69.7	6.30	1.92	59.8	17.5	18.1

02-TWL, Towle Brook, Towle Road, Chester

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Turbidity (NTUs)	Specific Conductance (µS/cm)	Water Temp. (°C)	Air Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	NA	Narrative	NA
9/12/2007[B]	10:00	6.08	61.5	6.93	1.99	150.5	16.2	20.0

27-EXT, Exeter River, Shepherd Home Road Bridge, Chester

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Specific Conductance (µS/cm)	Water Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	Narrative
8/24/2007[C]	17:30	3.69	41.9	6.23	173.9	21.1

03-FDY, Fordway Brook, Lane Road Bridge, Raymond

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Specific Conductance (µS/cm)	Water Temp. (°C)	Air Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	Narrative	NA
9/19/2007[B]	9:50	5.80	63.5	6.17	164.0	12.7	15.0

01-FDY, Fordway Brook, Sandown Road, Raymond

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Turbidity (NTUs)	Specific Conductance (µS/cm)	Water Temp. (°C)	Air Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	NA	Narrative	NA
8/24/2007[C]	17:00	5.88	66.3	6.50		171.7	23.4	
7/31/2007[A]	10:00	4.19	49.8	6.21		231.3	23.9	
9/14/2007[B]	12:15	5.04	73.2	6.59	1.48	265.1	20.8	22.1

04-LIT, Little River, Little River Road, Kingston

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Specific Conductance (µS/cm)	Water Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	Narrative
8/24/2007[C]	18:15	6.22	70.6	6.79	312.8	23.0

14-EXT, Exeter River, Pickpocket Dam/Cross Road Bridge, Exeter

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Turbidity (NTUs)	Specific Conductance (µS/cm)	Water Temp. (°C)	Air Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	NA	Narrative	NA
05/30/2007	07:55	8.90	97.4	6.63	2.20	139.9	19.4	15.0
06/26/2007	07:40	8.57	97.1	6.73	3.70	156.6	21.2	20.7
08/03/2007	07:45	8.03	99.1	6.55	1.51	187.3	25.8	23.1
08/29/2007	07:35	8.08	90.1	6.28	1.40	199.8	20.8	17.1

13-EXT, Exeter River, Kingston Road (Route 111) Bridge, Exeter

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Turbidity (NTUs)	Specific Conductance (µS/cm)	Water Temp. (°C)	Air Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	NA	Narrative	NA
05/30/2007	08:15	8.55	95.4	6.55	1.80	141.7	19.8	18.3
06/26/2007	08:00	8.09	91.8	6.28	3.00	159.6	21.4	22.5
08/03/2007	08:05	6.67	82.3	6.32	1.21	197.1	25.8	23.9
08/29/2007	07:50	7.19	78.9	6.84	1.20	229.0	19.8	18.1
9/7/2007[B]	09:55	7.53	78.7	7.10	1.06	238.9	18.7	20.3

12-EXT, Exeter River, Court Street/Route 108 Bridge, Exeter

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Turbidity (NTUs)	Specific Conductance (µS/cm)	Water Temp. (°C)	Air Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	NA	Narrative	NA
05/30/2007	09:03	8.05	89.1	6.60	2.60	143.2	19.5	18.3
06/26/2007	08:30	7.56	86.9	6.09	4.10	158.6	22.0	22.9
7/11/2007[A]	10:45	5.88	67.5	6.55		186.6	22.5	23.4
7/16/2007[A]	11:00	6.22	73.0	6.72		184.8	23.4	24.5
08/03/2007	08:50	6.48	79.2	5.94	2.17	196.3	25.4	24.4
08/29/2007	08:45	6.34	70.2	6.19	3.26	231.6	20.4	18.7

12A-EXT, Exeter River, Linden Street Bridge, Exeter

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Turbidity (NTUs)	Specific Conductance (µS/cm)	Water Temp. (°C)	Air Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	NA	Narrative	NA
05/30/2007	08:35	8.13	89.1	6.56	2.40	142.5	19.4	16.2
06/26/2007	08:20	7.59	87.3	6.34	3.40	172.2	21.4	21.3
08/03/2007	08:25	6.83	82.8	6.15	1.78	199.4	25.2	23.7
08/29/2007	08:20	6.44	71.8	6.13	2.01	231.7	20.7	17.7

11-EXT, Exeter River, Larry Lane, Exeter

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Specific Conductance (µS/cm)	Water Temp. (°C)	Air Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	Narrative	NA
7/11/2007[A]	11:50	5.96	69.6	6.55	178.4	25.4	22.9
7/16/2007[A]	11:35	3.25	40.3	6.65	187.2	25.2	23.2

02-DDY, Dudley Brook, Route 111A Bridge, Exeter

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Specific Conductance (µS/cm)	Water Temp. (°C)	Air Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	Narrative	NA
7/31/2007[A]	12:58	4.13	49.8	6.20	219.90	24.8	27.2

05-LTE, Little River, Garrison Road Bridge, Exeter

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Turbidity (NTUs)	Specific Conductance (µS/cm)	Water Temp. (°C)	Air Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	NA	Narrative	NA
05/27/2007	09:50	8.26	91.5	6.79		145.6	20.2	18.3
07/04/2007	07:40	8.66	91.7	6.89	4.72	203.0	17.8	16.8
7/31/2007[A]	12:25	8.32	102.1	7.10		203.2	25.8	26.5
08/10/2007	07:50	7.89	87.8	6.54	2.50	208.3	20.6	18.9
8/24/2007[C]	18:35	7.37	84.8	7.37		212.5	22.4	
09/06/2007	07:50	9.67	97.5	7.20	1.50	240.6	15.4	12.5
9/7/2007[B]	14:30	6.30	79.8	7.89	1.18	238.0	25.1	25.9

02-LTE, Little River, Linden Street Bridge, Exeter

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Turbidity (NTUs)	Specific Conductance (µS/cm)	Water Temp. (°C)	Air Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	NA	Narrative	NA
05/27/2007	10:10	7.65	85.2	6.62		156.9	20.4	19.2
07/04/2007	07:55	7.27	76.7	6.26	6.83	300.7	17.3	17.4
7/11/2007[A]	12:30	9.02	108.5	6.89		222.5	24.6	25.5
7/16/2007[A]	12:10	8.15	98.4	6.84		251.0	24.9	26.5
08/10/2007	08:10	6.15	69.2	6.10	3.90	238.9	21.2	18.9
09/06/2007	08:10	6.50	64.2	6.79	5.70	291.7	14.5	12.4

00-LTE, Little River, Gilman Street Bridge, Exeter

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Turbidity (NTUs)	Specific Conductance (µS/cm)	Water Temp. (°C)	Air Temp. (°C)
Standard	NA	>5.0	>75% Daily Average	6.5-8.0	NA	NA	Narrative	NA
05/27/2007	10:30	5.85	64.4	6.58		162.3	19.9	20.6
07/04/2007	08:20	7.04	79.0	6.47	14.20	256.2	20.7	19.4
08/10/2007	08:25	4.65	53.2	5.91	4.20	246.9	21.9	19.6
09/06/2007	08:30	6.42	67.3	6.81	2.80	294.8	17.6	14.2

10-EXT, Phillip's Exeter Academy Athletic Fields, Exeter

Standard	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Specific Conductance (µS/cm)	Water Temp. (°C)
Standard	**NA**	**>5.0**	**>75% Daily Average**	**6.5-8.0**	**NA**	**Narrative**
7/11/2007[A]	16:45	6.81	80.3	6.62	182.4	24.5
7/16/2007[A]	01:25	6.77	80.2	6.75	181.0	24.2

09-EXT, Exeter River, High Street Bridge, Exeter

Date	Time of Sample	DO (mg/L)	DO (% sat.)	pH	Turbidity (NTUs)	Specific Conductance (µS/cm)	Water Temp. (°C)	Air Temp. (°C)
Standard	**NA**	**>5.0**	**>75% Daily Average**	**6.5-8.0**	**NA**	**NA**	**Narrative**	**NA**
05/30/2007	09:35	7.92	88.6	6.47	5.50	143.9	20.6	22.8
06/26/2007	08:50	7.74	89.6	6.02	4.40	165.4	22.5	22.6
08/03/2007	09:10	7.26	89.7	6.16	2.91	213.0	26.2	25.3
08/29/2007	09:10	7.13	83.2	6.23	1.81	239.9	23.1	19.7

APPENDIX B:
Interpreting VRAP Water Quality Monitoring Parameters

Chemical Parameters

Dissolved Oxygen (DO)

- **Unit of Measurement:** concentration (milligrams per liter) and saturation (percent); (abbreviated as mg/L and %, respectively).
- **Description:** A measure of the amount of oxygen in the water: Concentration is a measure of the amount of oxygen in a volume of water; saturation is a measurement of the amount of oxygen in the water compared to the amount of oxygen the water can actually hold at full saturation. Both of these measurements are necessary to accurately determine whether New Hampshire surface water quality standards are met.
- **Importance**: Oxygen is dissolved into the water from the atmosphere, aided by wind and wave action, or from rocky, steep, or uneven stream beds. The presence of dissolved oxygen is vital to bottom-dwelling organisms as well as fish and amphibians. Aquatic plants and algae produce oxygen in the water during the day, but consume oxygen during the night. Bacteria utilize oxygen (day and night) as they process organic matter deposited in the river into smaller and smaller particles.

Class A NH Surface Water Quality Standard: 6 mg/L at any place or time, or 75% minimum daily average – (unless naturally occurring).

Class B NH Surface Water Quality Standard: 5 mg/L at any place or time or 75% minimum daily average – (unless naturally occurring).

Several measurements of oxygen saturation taken in a 24-hour period must be averaged to compare to the 75 percent daily average saturation standard. The concentration of dissolved oxygen is dependent on many factors including temperature and sunlight, and tends to fluctuate throughout the day. Saturation values are averaged because a reading taken in the morning may be low due to respiration, while a measurement that afternoon may show that the saturation has recovered to acceptable levels. Water can become saturated with more than 100 percent dissolved oxygen.

pH

- **Unit of Measurement:** units (no abbreviation).
- **Description:** A measure of hydrogen ion activity in water, or, in general terms, the acidity of water. pH is measured on a logarithmic scale of 0 to 14 with 7 being neutral. A high pH is indicative of an alkaline or basic environment and a low pH is indicative of an acidic environment. pH is influenced by geology and soils, organic acids (decaying leaves and other matter), and human-induced acids from acid rain (which typically has a pH of 3.5 to 5.5).
- **Importance:** pH affects many chemical and biological processes in the water and this is important to the survival and reproduction of fish and other aquatic life. Different organisms flourish within different ranges of pH. Measurements outside of this preferred range can potentially stress the physiological systems of organisms and can limit their growth and reproduction. Low pH can also affect the toxicity of aquatic compounds such as ammonia and certain metals. Lower pH levels can make these toxic compounds more "available" for uptake by aquatic plants and animals. This can produce conditions that are toxic to aquatic life.

Class A NH Surface Water Quality Standard: Between 6.5 and 8.0 (unless naturally occurring).

Class B NH Surface Water Quality Standard: Between 6.5 and 8.0 (unless naturally occurring).

Sometimes, readings that fall below this range are determined to be naturally occurring, perhaps because of the influence of wetlands near the sample station. This is due to the presence or release of tannic and humic acids by decaying plants, which can create more acidic waters in areas influenced by wetlands.

pH Units	Category
<5.0	High Impact
5.0 – 5.9	Moderate to High Impact
6.0 – 6.4	Normal; Low Impact
6.5 – 8.0	Normal;
6.1 – 8.0	Satisfactory

Specific Conductance or Conductivity

- **Unit of Measurement:** micromhos per centimeter or microsiemens per centimeter (abbreviated as umhos/cm or uS/cm, respectively).
- **Description:** The numerical expression of the ability of water to carry an electrical current at 25^{o} C and is a measurement of free ion (charged particles) content in the water. These ions can come from natural sources such as bedrock, or human sources such as stormwater runoff. Specific conductance can be used to indicate the presence of chlorides, nitrates, sulfates, phosphates, sodium, magnesium, calcium, iron, and aluminum ions. The difference between conductivity and specific conductance is specific conductance accounts for the actual water temperature rather than 25^{o}C. The term "specific conductance" is used in the VRAP because the actual measurement is of the *conductivity* (or electric current) at a *specific* water temperature. In some studies and programs, the term "conductivity" is used. This term should only be used when the measurement *does not* adjust to a specific temperature.
- **Importance:** Discharges to streams can change the conductivity depending on their make-up. Specific conductance readings are useful in locating potential pollution sources because they usually have higher specific conductance than unimpaired surface waters. High specific conductance values may indicate pollution from sources such as road salting, septic systems, wastewater treatment plants, or urban/agricultural runoff. Specific conductance can also be related to geology. In rivers and streams not impacted by pollutants, geology and the associated groundwater are the primary influcences on specific conductance levels.

Class A NH Surface Water Quality Standard: No numeric standard.

Class B NH Surface Water Quality Standard: No numeric standard.

Although there is no formal standard for specific conductance, data collect by VRAP groups and NHDES indicated a very close relationship between specific conductance levels. In some cases NHDES can use specific conductance measurements as a surrogate for chloride levels. The data collected by NHDES indicate that the chronic chloride standard is correlated with a specific conductance level of approximately 850 µS/cm.

Unit	Category
0 – 100	Normal
101 – 200	Low Impact
201 – 500	Moderate Impact
> 501	High Impact
> 850	Likely exceeding chronic chloride standard

Turbidity

- **Unit of Measurement:** Nephelometric Turbidity Units (abbreviated at NTU).
- **Description:** A measurement of the amount of suspended material in the water, such as clay, silt, algae, suspended sediment, and decaying plant material, that cause light to be scattered and absorbed, not transmitted in straight lines through the water.
- **Importance:** Higher turbidity increases water temperatures because suspended particles absorb more heat. This, in turn, reduces the concentration of dissolved oxygen (DO) because warm water holds less DO than cold. Higher turbidity also reduces the amount of light penetrating the water, which reduces photosynthesis and the production of DO. Suspended materials can clog fish gills, reducing resistance to disease in fish, lowering growth rates, and affecting egg and larval development. As the particles settle, they can blanket the stream bottom, especially in slower waters, and smother fish eggs and benthic macroinvertebrates. Clean waters are generally associated with low turbidity, but there is a high degree of natural variability involved. Rain events often contribute turbidity to surface waters by flushing sediment, organic matter and other materials from the surrounding landscape into surface waters. Human activities such as removal of vegetation near surface waters and disruption of nearby soils can lead to dramatic increases in turbidity levels.

Class A NH Surface Water Quality Standard: As naturally occurs.

Class B NH Surface Water Quality Standard: Shall not exceed naturally occurring conditions by more than 10 NTU.

Physical Parameters

Temperature

- **Unit of Measurement:** ^{o} Celsius

Importance: Water temperature is a critical parameter for aquatic life and has an impact on other water quality parameters such as dissolved oxygen concentrations, and the activity of bacteria in the water. Water temperature controls the metabolic and reproductive processes of aquatic species and can determine which fish and macroinvertabrate species can survive in a given river or stream.

A number of factors can have an impact on water temperature including the quantity and maturity of riparian vegetation along the shoreline, the rate of flow, the percent of impervious surfaces contributing stormwater, thermal discharges, impoundments and the influence of groundwater.

Class A NH Surface Water Quality Standard: No numeric standard; as naturally occurs.

Class B NH Surface Water Quality Standard: No numeric standard

Although there is currently no numerical water quality criteria for water temperature, NHDES is in the process of collecting biological and water temperature data that will contribute to the development of a procedure for assessing rivers and stream based on water temperature and its corresponding impact to the biological integrity of the waterbody.

Nutrient Parameters

Chlorophyll-a (Chlor a)

- **Unit of Measurement:** Milligrams per liter (abbreviated as mg/L).
- **Description:** An indicator of the biomass, or abundance, of planktonic algae in the river. The technical term "biomass" is used to represent "amount by weight." Chlorophyll-a can be strongly influenced by phosphorus, which is derived by natural and human activities.
- **Importance:** Because algae is a plant and contains the green pigment chlorophyll-a, the concentration of chlorophyll-a found in the water gives an estimation of the concentration of algae. If the chlorophyll-a concentration increases, this indicates an increase in the algal population.

Class A NH Surface Water Quality Standard: No numeric standard.

Class B NH Surface Water Quality Standard: No numeric standard.

Unit	Category
< 3	Excellent
3 – 7	Good
7 – 15	Less than desirable
> 15	Nuisance

Total Phosphorus (TP)

- **Unit of Measurement:** Milligrams per liter (abbreviated as mg/L).
- **Description:** A measure of all forms of phosphorus in the water, including inorganic and organic forms. There are many sources of phosphorus, both natural and human. These include soil and rocks, sewage, animal manure, fertilizer, erosion, and other types of contamination.
- **Importance:** Phosphorus is a nutrient that is essential to plants and animals, however, in excess amounts can cause rapid increases in the biological activity in water. Phosphorus is usually the "limiting nutrient" in freshwater streams, which means relatively small amounts can increase the amount of algae and chlorophyll-a levels in the river. Algal blooms and/or excessive aquatic plant growth can decrease oxygen levels and the attractiveness of waters for recreational purposes. Phosphorus can indicate the presence of septic systems, sewage, animal waste, lawn fertilizer, road and construction erosion, other types of pollution, or natural wetlands and atmospheric deposition.

Class A NH Surface Water Quality Standard: No numeric standard; as naturally occurs.

Class B NH Surface Water Quality Standard: No numeric standard; as naturally occurring, shall contain no phosphorus in such concentrations that would impair any existing or designated uses.

Unit	Category
< 0.010	Ideal
0.011 – 0.025	Average
0.026 – 0.050	More than desirable
> 0.051	Excessive (potential nuisance concentration)

Total Kjeldahl Nitrogen (TKN)

- **Unit of Measurement:** Milligrams per liter (abbreviated mg/L).
- **Description:** A measure of the amount of ammonia and organic nitrogen in the water.
- **Importance:** High nitrogen can increase the amount of algae and chlorophyll-a levels in the river, but is generally of less concern in fresh water when compared to phosphorus. Nitrogen can indicate the presence of sewage, animal waste, fertilizer, erosion, or other types of pollution.

Class A NH Surface Water Quality Standard: No numeric standard; as naturally occurs.

Class B NH Surface Water Quality Standard: No numeric standard; as naturally occurring, shall contain no nitrogen in such concentrations that would impair any existing or designated uses.

Unit	Category
< 0.25	Ideal
0.26 – 0.40	Average
0.41 – 0.50	More than desirable
> 0.51	Excessive (potential nuisance concentration)

Other Parameters

Chloride

- **Unit of Measurement:** Milligrams per liter (abbreviated as mg/L).
- **Description:** The chloride ion (Cl-) is found naturally in some surface waters and groundwater and in high concentrations in seawater. Higher-than-normal chloride concentrations in freshwater, due to sodium chloride (table salt) that is used on foods and present in body wastes, can indicate sewage pollution. The use of highway deicing salts can also introduce chlorides to surface water or ground water. Elevated groundwater chlorides in drinking water wells near coastlines may indicate saltwater intrusion. In New Hampshire, the application of road salt for winter accident prevention is a large source of chloride to the environment, which is increasing over time due to the expansion of road networks and increased vehicle traffic. Road salt (most often sodium chloride) readily dissolves and enters aquatic environments in ionic forms. Although chloride can originate from natural sources, most of the chloride that enters the environment is associated with the storage and application of road salt. As such, chloride-containing compounds commonly enter surface water, soil, and groundwater during late-spring snowmelt (since the ground is frozen during much of the late winter and early spring). Chloride ions are conservative, which means they are not degraded in the environment and tend to remain in solution, once dissolved. Chloride ions that enter ground water can ultimately be expected to reach surface water and, therefore, influence aquatic environments and humans.
- **Importance:** Research shows that elevated chloride levels can be toxic to freshwater aquatic life. Among the species tested, freshwater aquatic plants and invertebrates tend to be the most sensitive to chloride. In order to protect freshwater aquatic life in New Hampshire, the state has adopted acute and chronic chloride criteria.

Acute Standard: 860 mg/L.

Chronic Standard: 230 mg/L.

Escherichia Coliform Bacteria *(E. coli)*

- **Unit of Measurement:** Counts per 100 milliliter (abbreviated as cts/100 mL).
- **Description:** An indicator of the potential presence of pathogens in fresh water. *E. coli* bacteria is a normal component in the large intestines of humans and other warm-blooded animals, and can be excreted in their fecal material. Organisms causing infections or disease (pathogens) are often excreted in the fecal material of humans and other warm-blooded animals.
- **Importance:** *E.coli* bacteria is a good indicator of fecal pollution and the possible presence of pathogenic organisms. In freshwater, *E. coli* concentrations help determine if the water is safe for recreational uses such as swimming.

  Several factors can contribute to elevated *E. coli* levels, including, but not limited to rain storms, low river flows, the presence of wildlife, and the presence of septic systems along the river.

Class A NH Surface Water Quality Standard: Unless naturally occurring, shall contain not more than either a geometric mean of 47 *E.coli* cts/100 mL based on at least three samples obtained over a sixty-day period, or greater than 153 *E.coli* cts/100 mL in any one sample.

Class B NH Surface Water Quality Standard: Unless naturally occurring, shall contain not more than either a geometric mean of 126 *E.coli* cts/100 mL based on at least three samples obtained over a sixty-day period, or greater than 406 *E.coli* cts/100 mL in any one sample.

Metals

Depending on the metal concentration, its form (dissolved or particulate), and the hardness of the water, trace metals can be toxic to aquatic life. Metals in dissolved form are generally more toxic than metals in the particulate form. The dissolved metal concentration is dependent on the pH of the water, as well as the presence of solids and organic matter that can bind with the metal to render it less toxic.

Hardness is primarily a measure of the calcium and magnesium ion concentrations in water, expressed as calcium carbonate. The hardness concentration affects the toxicity of certain metals. New Hampshire water quality regulations include numeric criteria for a variety of metals. Since dissolved metals are typically found in extremely low concentrations, the potential contamination of samples collected for trace metals analyses has become a primary concern of water quality managers. To prevent such contamination and to ensure reliable results, the use of "clean techniques" is becoming more and more frequent when sampling for dissolved metals. Because of this, sampling for metals may be more costly and require additional effort than in the past.

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2008

APPENDIX C:

2007 VRAP Volunteer Monitor Field Sampling Procedures Assessment *(Field Audit)* for the Exeter River VRAP Group

On May 30, 2007, volunteers from the Exeter River VRAP group were visited by VRAP staff for the purpose of an annual volunteer monitor field sampling procedures assessment. VRAP staff aim to visit each group annually during a scheduled sampling event to verify that volunteers successfully follow the VRAP protocols. If necessary, volunteers are re-trained during the visit, and the group is notified of the result of the verification visit. During the visit, volunteers were assessed in the following five categories:

1) Assessment of ***sampling procedures*** included: Appropriate storage of meters, sample collection, laboratory sample collection and transportation, beginning and end of day meter checks, collecting a field replicate once during the sampling day from the original sample, performing QA/QC meter checks, and ensuring that all calibration and sampling data was properly documented on the 2007 *"VRAP Field Data Sheet"* and the *"NHDES Laboratory Services Login & Custody Sheet"*.

2) Assessment of ***turbidity procedures*** included: Inspection and cleaning of glass turbidity vials prior to measurement of standards and samples, performing the *"Initial Turbidity Meter Check Value"* with a known standard *(1.0 or 10.0 NTU)* and calibrating the meter to a known standard at the beginning of the sampling day, recording the value of the DI Turbidity Blank *(QAQA Meter Check)* once during the sampling day, and performing the *"End of the Day Meter Check*" using a known standard *(1.0 or 10.0 NTU)* at the conclusion of the sampling day.

3) Assessment of ***pH procedures*** included: Inspection of the pH electrode probe prior to sampling, calibration to both pH 7.0 and 4.0 buffers prior to each measurement/at each station, rinsing and wiping the pH electrode probe prior to and after the measurement of standards and samples, allowing the pH measurement to stabilize prior to recording the measurement, and recording the value of the 6.0 buffer *(QAQC Meter Check)* once during the sampling day,

4) Assessment of Water ***Temperature and Dissolved Oxygen procedures*** included: Ensuring the calibration chamber sponge was sufficiently moist/dampened, ensuring the meter was turned on at least 15 minutes prior to the first calibration, ensuring the meter was kept on until the end of the day, calibration of the meter to % saturation relative to station elevation prior to each measurement/at each station, rinsing and wiping the probe prior to and after the measurement of standards and samples, slight agitation of the probe in the sample, allowing the water temperature to stabilize, allowing dissolved oxygen *(% saturation)* to stabilize during agitation, immediately taking dissolved oxygen concentration *(mg/L)* after % saturation has stabilized, properly obtaining ambient air temperature, replacing the sensor probe in the calibration chamber for a post-sample check (*Dissolved Oxygen % Saturation in Chamber),* and recording the value of the Zero Dissolved Oxygen Standard *(QAQC Meter Check)* once during the sampling day.

5) Assessment of ***Specific Conductance procedures*** included: Performing the *"Initial Conductivity Check Value"* meter check using a known standard at the beginning of the sampling day, rinsing and wiping the probe prior to and after the measurement of standards and samples, ensuring the probe was entirely submerged in the sample, slight agitation of the probe in the sample, allowing the measurement to stabilize, and performing the *"End of the Day Meter Check*" using a known standard at the conclusion of the sampling day.

During the field sampling procedures assessment, VRAP staff offered important reminders and suggestions to ensure proper sampling techniques and re-trained volunteers in the areas needing improvement. Afterwards, the volunteers were sent a follow-up e-mail providing written reminders and suggestions of the methods that need improvement. Overall, the Exeter River VRAP group did an excellent job. It is important to ensure that all volunteers attend an annual VRAP training workshop prior to the sampling season and to familiarize themselves with proper sampling techniques, written protocols, and the use of water quality meters. Please remember to schedule an annual volunteer field sampling procedures assessment in 2008 by contacting the VRAP Coordinator at (603) 271-0699.

APPENDIX D:
2007 Exeter River Watershed Biological Data

30-EXT, Exeter River, Wells Road, Sandown 9/12/07

Order	Common Name	Number of Individuals Found	Group Tolerance Value	Group Biotic Score	Station Biotic Score	Narrative Category
Ephemeroptera	Mayfly Nymph	1	3	3		
Plecoptera	Stonefly Nymph	9	1	9		
Trichoptera	Caddisfly Larvae	10	4	40		
Odonata	Dragonfly Nymph	3	3	9		
Diptera	Midge Larvae	3	6	18		
	Most True Flies	9	4	36		
Megaloptera	Fishfly or Helgrammite	20	0	0		
Coleoptera	Riffle Beetle	6	4	24		
Others	Aquatic Worms	6	8	48		
Totals		**67**		**187**	**2.79**	**Excellent**

Fraction of Sample Sorted: 0.50; Estimated Abundance: 134

02-TWL, Towle Brook, Towle Road, Chester 9/12/07

Order	Common Name	Number of Individuals Found	Group Tolerance Value	Group Biotic Score	Station Biotic Score	Narrative Category
Ephemeroptera	Mayfly Nymph	6	3	18		
Plecoptera	Stonefly Nymph	34	1	34		
Trichoptera	Caddisfly Larvae	58	4	232		
Odonata	Dragonfly Nymph	1	3	3		
Diptera	Midge Larvae	5	6	30		
	Most True Flies	6	4	24		
Megaloptera	Fishfly or Helgrammite	11	0	0		
Coleoptera	Water Penny	2	4	8		
Others	Aquatic Worms	10	8	80		
	Scuds	2	8	16		
Totals		**135**		**445**	**3.30**	**Excellent**

Fraction of Sample Sorted: 0.25; Estimated Abundance: 540

27-EXT, Exeter River, Shepherd Home Road, Chester, 9/14/07

Order	Common Name	Number of Individuals Found	Group Tolerance Value	Group Biotic Score	Station Biotic Score	Narrative Category
Plecoptera	Stonefly Nymph	7	1	7		
Trichoptera	Caddisfly Larvae	170	4	680		
Odonata	Damselfly Nymph	2	7	14		
Diptera	Black Fly Larvae	1	7	7		
	Midge Larvae	8	6	48		
	Most True Flies	8	4	32		
Megaloptera	Fishfly or Helgrammite	9	0	0		
Coleoptera	Riffle Beetle	4	4	16		
Others	Aquatic Worms	1	8	8		
	Scuds	8	8	64		
	Clams And Mussels	1	7	7		
Totals		**219**		**883**	**4.03**	**Good**

Fraction of Sample Sorted: 0.19; Estimated Abundance: 1,153

03-FDY, Fordway Brook, Lane Road, Raymond 9/19/07

Order	Common Name	Number of Individuals Found	Group Tolerance Value	Group Biotic Score	Station Biotic Score	Narrative Category
Ephemeroptera	Mayfly Nymph	30	3	90		
Plecoptera	Stonefly Nymph	25	1	25		
Trichoptera	Caddisfly Larvae	115	4	460		
Odonata	Dragonfly Nymph	2	3	6		
Diptera	Black Fly Larvae	1	7	7		
	Midge Larvae	20	6	120		
Megaloptera	Fishfly or Helgrammite	48	0	0		
Coleoptera	Riffle Beetle	4	4	16		
Others	Cray Fish	1	6	6		
	Aquatic Worms	21	8	168		
	Scuds	1	8	8		
Totals		**268**		**906**	**3.38**	**Excellent**

Fraction of Sample Sorted: 0.75; Estimated Abundance: 357

01-FDY, Fordway Brook, Sandown Road, Raymond 9/14/07

Order	Common Name	Number of Individuals Found	Group Tolerance Value	Group Biotic Score	Station Biotic Score	Narrative Category
Ephemeroptera	Mayfly Nymph	38	3	114		
Plecoptera	Stonefly Nymph	8	1	8		
Trichoptera	Caddisfly Larvae	157	4	628		
Odonata	Dragonfly Nymph	4	3	12		
	Damselfly Nymph	4	7	28		
Diptera	Midge Larvae	2	6	12		
	Most True Flies	6	4	24		
Megaloptera	Fishfly or Helgrammite	5	0	0		
Coleoptera	Beetle & Beetle-Like	2	7	14		
Others	Crayfish	1	6	6		
	Aquatic Worms	21	8	168		
	Scuds	30	8	240		
Totals		**278**		**1254**	**4.51**	**Good**

Fraction of Sample Sorted: 0.25; Estimated Abundance: 1,112

04-LIT, Little River, Little River Road, Kingston, 9/5/07

Order	Common Name	Number of Individuals Found	Group Tolerance Value	Group Biotic Score	Station Biotic Score	Narrative Category
Ephemeroptera	Mayfly Nymph	46	3	138		
Plecoptera	Stonefly Nymph	3	1	3		
Trichoptera	Caddisfly Larvae	150	4	600		
Odonata	Dragonfly Nymph	1	3	3		
	Damselfly Nymph	1	7	7		
Diptera	Black Fly Larvae	5	7	35		
	Midge Larvae	2	6	12		
Megaloptera	Fishfly or Helgrammite	16	0	0		
Coleoptera	Riffle Beetle	3	4	12		
Others	Scuds	5	8	40		
Totals		**232**		**850**	**3.70**	**Good**

Fraction of Sample Sorted: 0.25; Estimated Abundance: 928

15-EXT, Exeter River, Brentwood 8/16/07

Order	Common Name	Number of Individuals Found	Group Tolerance Value	Group Biotic Score	Station Biotic Score	Narrative Category
Ephemeroptera	Mayfly Nymph	45	3	135		
Plecoptera	Stonefly Nymph	21	1	21		
Trichoptera	Caddisfly Larvae	110	4	440		
Odonata	Dragonfly Nymph	3	3	9		
Diptera	Black Fly Larvae	4	7	28		
	Midge Larvae	1	6	6		
	Most True Flies	2	4	8		
Megaloptera	Helgrammite	11	0	0		
Coleoptera	Riffle Beetle	14	4	56		
	Beetle & Beetle Like	11	7	77		
Others	Aquatic Worms	14	8	112		
	Scuds	2	8	16		
Totals		**238**		**908**	**3.82**	**Good**

Fraction of Sample Sorted: 0.25; Estimated Abundance: 952

13-EXT, Exeter River, Haige Road Exeter 9/7/07

Order	Common Name	Number of Individuals Found	Group Tolerance Value	Group Biotic Score	Station Biotic Score	Narrative Category
Ephemeroptera	Mayfly Nymph	19	3	57		
Plecoptera	Stonefly Nymph	15	1	15		
Trichoptera	Caddisfly Larvae	58	4	232		
Odonata	Dragonfly Nymph	3	3	9		
Diptera	Black Fly Larvae	2	7	14		
Megaloptera	Fishfly or Helgrammite	14	0	0		
Coleoptera	Riffle Beetle	23	4	92		
	Water Penny	1	4	4		
Others	Scuds	15	8	120		
Totals		**150**		**543**	**3.62**	**Good**

Fraction of Sampled Sorted: 0.25; Estimated Abundance: 600

05-LTE, Little River, Garrison Road, Exeter 9/7/07

Order	Common Name	Number of Individuals Found	Group Tolerance Value	Group Biotic Score	Site Biotic Score	Vbap Narrative Category
Ephemeroptera	Mayfly Nymph	34	3	102		
Plecoptera	Stonefly Nymph	33	1	33		
Trichoptera	Caddisfly Larvae	101	4	404		
Odonata	Dragonfly Nymph	2	3	6		
	Damselfly Nymph	1	7	7		
Diptera	Black Fly Larvae	6	7	42		
	Midge Larvae	3	6	18		
	Most True Flies	15	4	60		
Megaloptera	Fishfly or Helgrammite	1	0	0		
Coleoptera	Riffle Beetle	5	4	20		
	Water Penny	3	4	12		
Others	Aquatic Worms	1	8	8		
	Scuds	9	8	72		
Totals		**214**		**784**	**3.70**	**Good**

Fraction of Sample Sorted: 0.19; Estimated Abundance: 1,126

APPENDIX E:
2007 Exeter River Watershed Habitat Data

Station ID	Surrounding Land Use	RIPARIAN HABITAT			IN-STREAM CHARACTERISTICS				Erosion & Other Streamside Impacts
		Dominant Vegetative Type	Width of Riparian Zone (ft)	% Canopy Cover/ % tree type	Most Prevalent Habitat Type	Water Color/ Stream Flow	Substrate/ % Embeddness	Aquatic Vegetation	
30-EXT	Forest (100%)	Trees	R ~ >500 L ~ >500	>75%/ 70% D, 30% C	Riffles & Runs	Clear / Low	Sand, Cobble & Boulder 0-25%	Moss	Slight erosion on both banks Salvage yard located upstream Riverbed completely filled in by unnatural cobble (rip-rap) and asphalt Culvert upstream was replaced last spring
02-TWL	Residential (60%) / Forest (40%)	Trees	R ~ 100-500 L ~ 100-500	>75%/ 90% D, 10% C	Riffles	Clear / Moderate	Sand & Cobble 0-25%	None	Right Bank = Slight Left Bank = Moderate
27-EXT	Forest (80%) / Residential (20%)	Trees & Shrubs	R ~ >500 L ~ >500	<10% / 80% D, 20% C	Riffles & Runs	Clear / Low	Silt, Sand, Cobble & Boulder 50-75%	Moss & Plants	No erosion noticeable on banks
03-FDY	Forest (90%) / Residential (10%)	Trees	R ~ 100-500 L ~ >500	>75%/ 50 % D, 50 % C	Riffles	Clear / Low	Cobble 25-50%	None	Slight erosion on both banks Sediment from road runoff visible in downstream reach
01-FDY	Forest (85%) / Residential (15%)	Trees & Shrubs	R ~ 100-500 L ~ 0-20	40-75% / 70% D, 30% C	Riffles & Pools	Cloudy / Moderate	Silt, Sand, Gravel & Cobble 50-75%	Algae & Moss	Slight erosion on both banks Invasive riparian plants present Lots of garbage and debris Residential lawn leads directly up to left bank w/ no buffer Abundant algal growth in pools
04-LIT	Residential (90%) / Field-Pasture (10%)	Trees	R ~ 20-100 L ~ 20-100	>75% / 90% D, 10% C	Riffles	Cloudy / Low	Silt, Sand, Gravel, & Cobble 50-75%	Moss	No erosion noticeable on banks Water was very cloudy with thin layer of silt/sediment covering stream bed
15-EXT	Residential (50%) / Forest (20%) / Field-Pasture-Agricultural (30%)	Trees	R ~ 20-100 L ~ 20-100	<10% / 25% D, 75% C	Run/ Glides	Clear / Low	Sand, Cobble & Boulder 50-75%	Algae	Right Bank = Slight Left Bank = Moderate Black PVC pipe leads up to house on right bank Invasive riparian plants abundant upstream of bridge crossing
13-EXT	Residential (80%) / Forest (20%)	Trees & Shrubs	R ~ 100-500 L ~ 0-20	<10% / 100% D	Riffles	Clear / Low	Silt, Sand, & Boulder 25-50%	Moss	Right Bank = Slight Left Bank = Moderate Residential lawn leads directly up to left bank w/ no buffer
05-LTE	Forest (80%) / Residential (20%)	Trees & Shrubs	R ~ >500 L ~ 20-100	<10% / 90% D, 10% C	Riffles	Clear / Low	Sand, Cobble, & Boulder 25-50%	Algae, Moss, & Plants	No erosion noticeable on banks

Note: Data is derived from a standardized Field Volunteer Biomonitoring Habitat Data Sheet included in the Volunteer Biological Assessment Program 2007 Draft Protocol instructions. R = Right bank, L = Left bank, D = Deciduous, C = Coniferous

APPENDIX F:
2007 Biological Sampling Methods

Background

The Volunteer Biological Assessment Program protocol focuses on the collection and identification of aquatic macroinvertebrates as an indicator of aquatic community condition. Macroinvertebrates are organisms capable of being seen by the naked eye such as immature and adult insects, mollusks, worms, leeches, and crayfish. These organisms have different abilities to tolerate pollution, demonstrate variable feeding strategies, and vary in their habitat preferences. As a result the macroinvertebrate community collected at any particular site represents a unique picture that reflects the shared effects of multiple pollutants and environmental conditions integrated over time. The common term for the use organisms, such a macroinvertebrates, as indicators of aquatic community condition is "biomonitoring."

Volunteer Training

Prior to sampling, two training sessions (lab and field) were held and consisted of three major components: (1) macroinvertebrate sampling techniques (2) macroinvertebrate identification, and (3) biotic index computation. Volunteers were also trained to collect and record supplementary data, which consisted of basic physical and chemical parameters.

Sampling Station Identification

All stations were accessible, wadeable, approximately 50-200 feet in length, and contained appropriate sampling habitat (at least one riffle with mixed cobble substrate). Where possible, stations were located upstream of major human influences (i.e. bridges and schools). The number of volunteers participating was recorded at each station.

Macroinvertebrate Sampling/Data Collection

Before collecting macroinvetebrates, general station information was recorded and a representative sample reach was identified (50-200 feet in length) and sketched on the Volunteer Biomonitoring Habitat Data Sheet. Additionally, in-stream and riparian habitat found at the sample reach was assessed and subsequent data was recorded on the same data sheet. During this time, volunteers were careful not to walk in the stream to avoid disrupting biological communities. After station information was recorded and five sampling locations were identified within the representative reach, macroinvertebrates were collected by placing a 500 micron mesh kicknet immediately downstream of area to be sampled, perpendicular to stream flow and firmly against the streambed with the opening of the net faced upstream to promote macroinvertebrate collection. Another person stood upstream of the net and disturbed the sample area in one-fifth square meter for a total of 60 seconds (30 second hand scrub followed by a 30-second foot disruption). Subsequently, the kicknet was carefully lifted out of the water and the same process was repeated four additional times with each sample collected further upstream. Collectively, total active sampling time approximated five minutes within one square meter area at each sampling station, i.e., stream. Once the collection process was complete, the contents of the net were transferred into a plastic dish pan fitted with 500 micron wire mesh and all organisms remaining in the net were carefully removed and added to the sample. The sample was mixed for approximately 15 seconds and divided into four approximately equal portions. One portion of the sample was randomly selected for sorting and transferred to a separate tray(s). The remaining sample was kept in the wire mesh dish pan and submersed in a plastic basin with water to prevent the sample from drying.

Macroinvertebrate Sorting and Identification

Volunteers removed macroinvertebrates from the selected portion of the sample with spoons, forceps, or pipettes for one hour and placed them into separate containers. If the first portion of the sample was completely sorted before one hour of sorting time had elapsed, an additional portion was selected. After sorting, specimens were identified to various coarse taxonomic groups (Table 1). The number of people sorting, cumulative sorting effort (1 hour x # people sorting), and approximate fraction of the total sample sorted was recorded.

The number of macroinvertebrates within each taxonomic group and the total number of individuals sorted was calculated and recorded on the Volunteer Biomonitoring Macroinvertebrate Data Sheet.

Table 1: Order, Common Name, and Tolerance Value of Aquatic Macroinvertebrates Identified

Order	Common Name	Tolerance Value
Ephemerotera	Mayfly nymph	3
Plecoptera	Stonefly nymph	1
Trichoptera	Caddisfly larvae	4
Odonata	Dragonfly nymph	3
	Damselfly nymph	7
Diptera	Black fly larvae	7
	Midge larvae	6
	Most true flies	4
Megaloptera	Alderfly	4
	Fishfly or helgrammite	0
Coleoptera	Riffle beetle	4
	Water penny	4
	Beetle and beetle-like	7
Others	Crayfish	6
	Snails	7
	Aquatic worms	8
	Scuds	8
	Sowbugs	7
	Clams and mussels	8

Quality Control Test

Quality control (QC) samples were taken at 10 percent of the stations to evaluate the ability of volunteers to identify and enumerate macroinvertebrates. All of the sorted organisms included in the QC sample were preserved and later identified by a trained biologist.

Biotic Index and Accessory Metric Computation

Biotic scores were computed using the Biotic Index Calculation Worksheet found in the Volunteer Biological Assessment Program Protocol. Biotic scores are based on tolerance values assigned to individual taxonomic groups, which range from zero to ten (Table 1). More tolerant groups have higher tolerance values and less tolerant groups have lower values. Taxonomic-specific biotic scores were computed by multiplying the number of individuals by their respective tolerance value. The final biotic score was calculated by summing the taxonomic-specific biotic scores and dividing the sum by the total number of individuals identified. Final biotic scores correspond to three interim categories: excellent (0-3.5), good (3.5-4.8), or fairly poor (>4.8).

Additionally, abundance, which estimates the total number of organisms within the sample, was calculated by dividing 1.00 by the fraction of sampled sorted and multiplying the result by the number of individuals found.

Water Quality Data

In addition to biological sampling, basic water quality data including turbidity, pH, dissolved oxygen, specific conductance, and water temperature were collected at each station using VRAP Standard Operating Procedures (SOPs) and handheld meters provided by NHDES. Water quality data was recorded on NH VRAP Field Data sheets.

APPENDIX G:
New Hampshire Surface Water Quality Standards and the Surface Water Quality Assessment Reporting Process

Every two years, the federal Clean Water Act (CWA) requires states to submit two surface water quality documents to the U.S. Environmental Protection Agency. Section 305(b) of the CWA requires submittal of a report, commonly called the "305(b) Report", that describes the quality of the surface waters and an analysis of the extent to which all such waters provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water. The second document is typically called the "303(d) List" because it is a required by Section 303(d) of the CWA. The 303(d) list includes all surface waters that

- Are impaired or threatened by a pollutant or pollutant(s);
- Are not expected to meet water quality standards even after application of best technology standards for point sources or best management practices for nonpoint sources and;
- Require development of comprehensive water quality studies called Total Maximum Daily Load (TMDL) studies.

Water Quality Standards

It is important to obtain a basic understanding of water quality standards since they are the basis of all water quality assessments. In general, water quality standards provide the baseline quality that all surface waters of the state must meet in order to protect their intended uses. They are the "yardstick" for identifying where water quality violations exist and for determining the effectiveness of regulatory pollution control and prevention programs.

Env-WS 1700 includes the state's surface water quality regulations. A copy can be obtained by visiting www.des.nh.gov/wmb/wmbrules.htm. The standards are composed of three parts: designated uses, water quality criteria, and antidegradation.

Designated Uses

All surface waters of the state are either classified as Class A or Class B, with the majority of waters being Class B. NHDES maintains a list that includes a narrative description of all the legislative classified waters. Designated uses represent the uses that a waterbody should support. As indicated below, state statute RSA 485-A:8 is quite general with regards to designated uses for New Hampshire surface waters.

- **Class A:** These are generally of the highest quality and are considered potentially usable for water supply after adequate treatment. Discharge of sewage or wastes is prohibited to waters of this classification.

- **Class B:** Of the second highest quality, these waters are considered acceptable for fishing, swimming, and other recreational purposes, and, after adequate treatment, for use as water supplies.

Further review and interpretation of the regulations (Env-Ws 1700), however, reveals that the general uses can be expanded and refined to include the seven specific designated uses. Each of the designated uses, with the exception of wildlife, is assessed during the reporting period. An assessment methodology for wildlife has not yet been developed but will be included in future assessments.

Designated Use	Definition	Applicable Surface Waters
Aquatic Life	Waters that provide suitable chemical and physical conditions for supporting a balanced, integrated and adaptive community of aquatic organisms.	All surface waters
Fish Consumption	Waters that support fish free from contamination at levels that poses a human health risk to consumers.	All surface waters
Shellfish Consumption	Waters that support a population of shellfish free from toxicants and pathogens that could pose a human health risk to consumers.	All tidal surface waters
Drinking Water Supply After Adequate Treatment	Waters that with adequate treatment will be suitable for human intake and meet state/federal drinking water regulations.	All surface waters
Primary Contact Recreation *(i.e swimming)*	Waters that are suitable for recreational uses that require or are likely to result in full body contact and/or incidental ingestion of water.	All surface waters
Secondary Contact Recreation *(i.e boating)*	Waters that support recreational uses that involve incidental contact with the water.	All surface waters
Wildlife	Waters that provide suitable physical and chemical conditions in the water and the riparian corridor to support wildlife as well as aquatic life.	All surface waters

Water Quality Criteria

The second major component of the water quality standards is the “criteria”. Criteria are designed to protect the designated uses of all surface waters and may be expressed in either numeric or narrative form. A waterbody that meets the criteria for its assigned classification is considered to meet its intended use. Water quality criteria for each classification may be found in RSA 485-A:8, I-V and in the state’s surface water quality regulations.

Antidegradation

The third component of water quality standards is antidegradation which are provisions designed to preserve and protect the existing beneficial uses and to minimize degradation of the state’s surface waters. Antidegradation regulations are included in Part Env-Ws 1708 of the state’s surface water quality regulations. According to Env-Ws 1708.03, and antidegradation applies to the following:

- Any proposed new or increased activity, including point and nonpoint source discharges or pollutants that would lower water quality or affect the existing or designated uses;
- A proposed increase in loadings to a waterbody when the proposal is associated with existing activities;
- An increase in flow alteration over an existing alteration; and
- All hydrologic modifications, such as dam construction and water withdrawals.

Assessment and Listing Methodology: Waterbody Coverage, Waterbody Types, and Assessment Units

Waterbody Coverage

Assessment units are the basic unit of record for conducting and reporting water quality assessments. In 2002, all surface waters in New Hampshire were subdivided into approximately 5,100 assessment units. The system is based on 1:100,000 scale hydrography that is linked to the National Hydrography Dataset (NHD), the national coverage used by EPA. By 2010, NHDES will attempt to move to higher resolution (1:24,000 scale) hydrography, which will result in even more accurate assessments.

Waterbody Types & Sizes

Based on the NHD coverage and to facilitate reporting, surface waters are separated into five waterbody types; Rivers and Streams, Impoundments, Lakes and Ponds, Estuaries, and the Ocean.

Assessment Units

Each waterbody is divided into smaller segments called Assessment Units (AUs). In general, AUs are the basic unit of record for conducting and reporting the results of all water quality assessments. AUs are intended to be representative of homogenous segments: consequently, sampling stations within an AU can be assumed to be representative of the segment. In general, the size of AUs are not so small that they result in an unmanageable number of AUs for reporting. On the other hand, AUs are not so large that they result in grossly inaccurate assessments. Many factors can influence the homogeneity of a segment. Factors used to establish homogenous AUs for assessments include: waterbody type, HUC-12 boundaries, water quality standards, pollutant sources, Maximum AU size for rivers and streams, major changes in land use, stream order/location of major tributaries, public water supplies, outstanding resource waters, shellfish program categories, designated beaches, and cold water fish spawning areas.

How Are Water Quality Assessments Conducted?

How do we determine if a waterbody is healthy (i.e. fully supporting), impaired (i.e. not supporting), threatened, or if there is insufficient information to make an assessment? Answers to these questions and many more can be found in the Consolidated Assessment and Listing Methodology, (CALM), which is available at http://www.des.nh.gov/WMB/swqa/. In general the CALM is the translator for how the water quality data will be used to make surface water quality attainment decisions by designated use (aquatic life, swimming, …) consistent with state surface water quality standards, RSA 485-A:8, and Env-Ws 1700 which can be viewed by visiting www.des.nh.gov/wmb/wmbrules.htm

What is the CALM?

The Consolidated Assessment and Listing Methodology (or CALM) describes, in detail, the process used to make surface water quality attainment decisions for 305(b) reporting and 303(d) listing purposes. The term "listing" refers to the process of placing (or listing) a water on the Section 303(d) List of impaired waters. The CALM also includes descriptions and definitions of the many terms used in the presentation of assessment results; consequently all are encouraged to review the CALM prior to reviewing the assessments as it will help one to better understand and interpret assessment results.

It is important to understand that assessment methodologies are dynamic and likely to change as new information and assessment techniques become available. Such changes can also impact monitoring strategies designed to determine if waterbodies are attaining water quality standards.

Periodic updates of the methodology will hopefully result in even more accurate and reliable assessments and, therefore, better management of water resources in the future.

Is Volunteer Data Used?

As long as the quality assurance/quality control measures result in data of adequate quality, we can and do use it in the assessments. The 2006 assessments of riverine assessment units included over 53,000 water quality standard comparisons of which nearly 60 percent came from volunteer sampling efforts. This volunteer data contributed to the assessment of 1,820 miles of rivers and streams on 489 riverine assessment units.

Factors to Consider When Assessing Waterbodies

Physical, chemical, toxicological, biological and/or habitat indicators can be used to assess the aquatic life use. If data for more than one indicator is available for assessments this can sometimes lead to conflicting assessment results. That is, one indicator might suggest that the designated use is not supporting (NS) while others may indicate a fully supporting (FS) use attainment status.

To resolve cases with conflicting data, NHDES uses an approach to make final assessment decisions. In general, this approach involves "weighing" the factors shown in the following table for each of the indicators. The assessment is then based on the indicator(s) with the highest weight (i.e., score).

Factor	Comments
Data Quality *(Sampling and Analysis Protocols)*	Data of high quality is given more weight than data of low quality.
Sample Time	Usually more weight is given to data which is the most recent, but one must also consider if samples were taken at times when exceedances are most likely to occur (i.e., the critical period). For example, when sampling for dissolved oxygen in rivers, water quality exceedances are most likely to occur during the summer months in the early morning when river flows are low and temperatures are high. If data for Indicator A indicated FS and was more recent but was not collected during the critical period, and data for Indicator B was older but indicated NS, more weight would be given to Indicator B as Indicator A data was not collected during the critical period.
Sample Location	Although AUs are theoretically homogenous, in reality, water quality differences can and do occur within an AU. In general, more weight is given to data that is collected the furthest downstream in an AU as it is more representative of all conditions affecting the AU. However if a particular location within an AU is suspected or known to have a greater likelihood of criteria exceedence, samples from that site would likely be given weight over a downstream site where water quality may have recovered.
Quantity of Samples	In general, more weight is given to the indicator which has the most data as it is more likely to be representative of the population being sampled, provided that a sufficient number of samples were collected during the critical period when violations are most apt to occur. In other words, quantity of data is not permitted to override critical condition data.
Type of Data *(i.e., physical, chemical, toxicological, habitat and/or biological)*	It is generally believed that for making aquatic life use assessments, biological data should be weighted more heavily than physical, chemical, habitat or toxicological data. This is because high quality biological data provide a direct measure of aquatic life and can detect the cumulative impact of multiple stressors on the aquatic community including new or previously undetected stressors over time. Physical/chemical data, on the other hand, provides a snapshot of river conditions when the samples were taken and do not account for the long term effects of stressors or the presence of other pollutants which may be impairing the biota.

Use Support Attainments

Each designated use for each assessment unit (AU), and each assessed parameter is assigned one of the following four base use support attainment options.

- **Fully Supporting:** A use is fully supporting if there is sufficient data or evidence for the core indicators to determine that the use is fully supporting and there is no other data or evidence indicating an impaired or threatened status.

- **Not Supporting:** A use is not supporting (i.e., impaired) if there is sufficient data or evidence to indicate impairment.

- **Insufficient Information:** This option is assigned to any use associated with any AU which has some, but not enough useable data or information to make a final assessment decision.

- **Not Assessed:** This option is assigned to any use associated with any AU, which does not have any useable data or information to make an assessment decision.

The CALM further describes how the four base use support attainment options have been subdivided to describe degrees of support, non-support, and insufficient information. For example, fully supporting is broken down to illustrate cases where a parameter just meets standards (i.e. marginal) or is well above standards (i.e. good).

How Many Measurements Must VRAP Groups Take for Assessment Purposes?

Statistically, for most parameters measured, less data is required to determine that a waterbody is impaired than is necessary to say that a parameter fully meets water quality criteria. The number of samples below presumes that the parameter in question will meet water quality standards.

- **Turbidity:** Routine turbidity measurements are not currently used in surface water quality assessments. However, turbidity easements related to specific projects with ongoing management issues are compared with water quality standards.

- **pH:** 10 measurements within five years.

- **Water Temperature:** Water temperature is currently only used to assess lake and impoundment profiles. Although there is currently no numerical water quality criteria for water temperature, NHDES is in the process of collecting biological and water temperature data that will contribute to the development of a procedure for assessing rivers and stream based on water temperature and its corresponding impact to the biological integrity of the waterbody. In that case, critical times and periods will be more important.

- **Dissolved Oxygen:** 10 measurements within five years. Samples must be taken during critical times and seasons depending on the water type and use:

  - If the surface water is not a cold water natural reproducing fishery, at least 50% of the minimum number of independent samples needed for Fully Supporting shall be taken between June 1 and September 30. This is when dissolved oxygen is most apt to be lowest due to high temperatures and low flows.

  - If the surface water is a cold water natural reproducing fishery, 100% of the minimum number of independent samples needed for Fully Supporting determination shall be taken between October 1 and May 14. Additionally, at least 50% of the minimum number of independent samples needed for Fully Supporting shall be taken between June 1 and September 30.

- **Chloride/Specific Conductance:** 10 measurements within five years. Chloride and specific conductance are very closely related to one another and the protocols NHDES uses to assess waterbodies allows specific conductance to be used as a formal surrogate for chloride. Monitoring for specific conductance and chloride in the winter and early spring months will help determine what the immediate runoff impact of road salt application is in the watershed. Sampling in late summer under low flow conditions will help determine the degree of chloride saturation in baseflow. At least 50% of the minimum number of independent samples needed for Fully Supporting need to come from each of these key periods and combined these samples will indicated what time of year chloride levels tend to be highest.

- ***Escherichia coli*/Bacteria *(E.coli)*:** 10 samples within five years. To be Fully Supporting, there must be sufficient data to make an assessment during the peak contact recreation season (May 24 to September 15). In order to fully determine whether a waterbody is meeting surface water standards for *E.coli* a geometric mean should be calculated. A geometric mean is calculated using three independent samples collected within a 60-day period provided that at least two of the samples are separated by a period of at least 1 day.

- **Total Phosphorus (TP):** Total Phosphorus is not currently used directly in surface water quality assessments.

- **Total Kjeldahl Nitrogen (TKN) and Nitrate/Nitrite:** Neither Total Kjeldahl Nitrogen, nor nitrate/nitrite are currently used directly in surface water quality assessments.

- **Chlorophyll-a:** 10 measurements within five years. To be Fully Supporting, there must be sufficient data to make an assessment during the peak contact recreation season (May 24 to September 15).

- **Metals:** 10 samples within five years. For seven metals; cadmium, copper, chromium+3, lead, nickel, silver, and zinc the exact water quality criteria is dependent upon the hardness of the water at the time of sampling. Consequentially, hardness samples need to be collected when one or more of those seven metals is to be analyzed. Additionally, it is important to ensure that the laboratory that will analyze the samples has detection limits that are below the water quality criteria to be compared.

How Can VRAP Groups Determine Which Portions of Their River have been Assessed?

There are an assortment of text documents available at the surface water quality assessment web-site. For those with GIS capabilities the AU shapefiles are available. As a fallback you can contact NHDES. All VRAP data marked as valid is used on the portion of river it is sampled in.

Where Can You Find the Report?

You can access the report by visiting http://des.nh.gov/wmb/swqa/.

For More Information

Contact Ken Edwardson, NHDES Water Quality Planning Section, at (603) 271-8864 or kedwardson@des.state.nh.us

APPENDIX H:

Programs, Publications & Links of Interest

Biomonitoring Program
http://www.des.nh.gov/WMB/biomonitoring/

Clean Lakes Program
http://www.des.nh.gov/wmb/CleanLakes/

Coastal Program
http://www.des.nh.gov/Coastal/

Exotic Species Program
http://www.des.nh.gov/WMB/exoticspecies/

- **Exotic Plant Distribution Map**
  http://www.des.nh.gov/WMB/ExoticSpecies/milfoil_list.htm
- **Unwanted: The Frightful Fourteen**
  http://www.des.nh.gov/WMB/ExoticSpecies/documents/Fourteen.pdf
- **Exotic Species Fact Sheets**
  http://www.des.nh.gov/WMB/ExoticSpecies/facts.htm
- **2004-2005 Exotic Species Program Report**
  http://www.des.nh.gov/WMB/ExoticSpecies/documents/2004-2005_Report.pdf
- **Weed Watchin': Annual Weed Watcher Newsletter**
  http://www.des.nh.gov/WMB/ExoticSpecies/documents/2005_Weed_Watchin.pdf

Fact Sheets of Interest
http://www.des.nh.gov/openme.htm

- **Lake Biology:** http://www.des.nh.gov/bb.htm
- **Shoreland Protection Program:** http://www.des.nh.gov/sp.htm
- **Water Supply:** http://www.des.nh.gov/sp.htm
- **Watershed Management:** http://www.des.nh.gov/sp.htm
- **Wetlands Bureau:** http://www.des.nh.gov/wet.htm

Lakes Management & Protection Program
http://www.des.nh.gov/wmb/lakes/

Rivers Management & Protection Program
http://www.des.nh.gov/rivers/

- **Publications & Fact Sheets**
  http://www.des.nh.gov/Rivers/link-2.htm
- **Meanderings: Newsletter of the Rivers Management & Protection Program**
  Spring 2007: http://www.des.nh.gov/news/meanderings/MeanderSpring07.pdf

Shoreland Protection Program http://www.des.nh.gov/cspa/

Surface Water Quality Assessments http://www.des.nh.gov/WMB/swqa/

Volunteer Lake Assessment Program http://www.des.nh.gov/WMB/vlap/

- **VLAP Field Manual**

  http://www.des.nh.gov/wmb/VLAP/documents/fieldmanual.pdf

- **The Sampler: Annual VLAP Newsletter**

  Spring 2007: http://www.des.nh.gov/wmb/VLAP/documents/Samplr07.pdf

- **Annual Reports**

  http://www.des.nh.gov/wmb/VLAP/2006/

Volunteer River Assessment Program http://www.des.nh.gov/WMB/vrap

- **Water Quality Monitoring Field Sampling Protocols for Volunteer Monitors**

  http://www.des.nh.gov/wmb/vrap/documents/Protocols.pdf

- **Interpreting VRAP Water Quality Parameters**

  http://www.des.nh.gov/wmb/vrap/documents/WQParams.pdf

- **VRAP Water Quality Standards**

  http://www.des.nh.gov/wmb/vrap/documents/WQ_Standards.pdf

- **Native Shoreland & Riparian Buffer Plantings for New Hampshire**

  http://www.des.nh.gov/wmb/vrap/documents/NativeShorelandRiparianBufferPlantingsNH.pdf

- **Glossary of River Ecology Terms**

  http://www.des.nh.gov/wmb/vrap/documents/Glossary_of_Riverine_Ecology_Terms.pdf

- **A Field Guide to Common Riparian Plants of New Hampshire**

  http://www.des.nh.gov/wmb/vrap/documents/FieldGuideToCommonRiparianPlantsOfNH.pdf

- **Streamlines: Annual VRAP Newsletter**

  June 2007: http://www.des.nh.gov/wmb/vrap/documents/Streamlines/June2007.pdf

- **Annual Reports, Data, & Maps**

  http://www.des.nh.gov/wmb/vrap/data.html

Watershed Assistance http://www.des.nh.gov/WMB/was/

- **Nonpoint Source Newsletter**

  http://www.des.nh.gov/WMB/Was/documents/NPS_news_2004.pdf

- **Greenworks: Ideas for a Cleaner Environment**

  http://www.des.nh.gov/gw-list.htm

Wetlands Bureau http://www.des.nh.gov/Wetlands/