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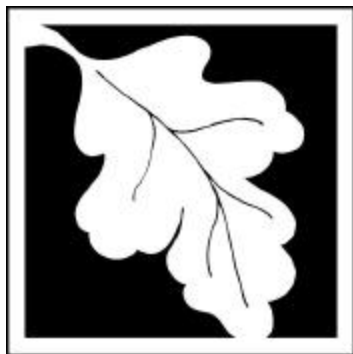
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APPENDIX A



Massachusetts
Department
of
ENVIRONMENTAL
PROTECTION

Technical Memorandum TM-35-7

MA DEP WATER QUALITY MONITORING DATA
MILLERS RIVER WATERSHED 1995 - 2000

DWM Control Number: CN129.0

COMMONWEALTH OF MASSACHUSETTS
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INTRODUCTION

The purpose of this technical memorandum is to publish quality assured water quality monitoring data for rivers in the Millers River Watershed collected by MA DEP staff between 1995 and 2000. These data were collected by Division of Watershed Management (DWM) and/or the Central Regional Office (CERO), Strategic Monitoring and Assessment for Riverbasin Teams (SMART) program staff. Data were collected as part of several projects/surveys including: 1995/1996 and 2000 water quality surveys (including benthic macroinvertebrate sampling); 1996, 1998 and 2000 Numeric Biocriteria Development Project surveys (habitat quality, benthic macroinvertebrate community and fish population); 1995, 1996 and 2000 fish contaminant monitoring surveys; and the 1998/1999 Connecticut River Nutrient Loading Project survey.

Most recently the MA DEP sampled in the Millers River Watershed from March through November 2000. The 2000 MA DEP sampling matrix is summarized in Table 1. Five river stations were established and sampled by the MA DEP SMART monitoring program staff. Five additional river stations were monitored as part of the Year 2 Watershed Monitoring Program by DWM staff. River station sampling included *in-situ* Hydrolab® Multiprobe Series 3 analyzer meter (hereafter referred to as Hydrolab®) measurements (depth, pH, dissolved oxygen and percent saturation, conductivity, temperature, total dissolved solids), chemical (alkalinity, hardness, chloride, suspended solids, turbidity), nutrient (total phosphorus, ammonia, nitrate-nitrogen, total Kjeldahl nitrogen), and/or toxicity (chronic microtox) samples. [Chronic Microtox™ test results and laboratory quality assurance/quality control data are available as open files at DWM and CERO. The chronic Microtox™ test data are not currently maintained in a database nor have these data been subject to any data validation procedures by DWM staff.] Fish contaminant monitoring was performed as part of the ongoing fish contaminant monitoring program, providing information to assess the concentrations of toxic contaminants in freshwater fish. The Massachusetts Department of Public Health (MDPH) uses the data for public health risk assessment relative to fish consumption; subsequently issuing fish consumption advisories, if warranted. These data also supported the ongoing assessment activities relative to PCB contamination in the Millers River Watershed. Macroinvertebrate sampling was also conducted at sixteen sites in the Millers River Watershed by DWM in 2000 as part of the water quality survey. Data from eleven of the sixteen 2000 sampling sites (along with data from the eleven 1995 sampling sites) are reported on in the technical memorandum TM35-5 *Millers River Watershed Results of the 1995 and 2000 Biomonitoring Surveys* (Nuzzo 2003). The remaining five sites sampled in 2000 are Numeric Biocriteria Development Project sites and analysis of those samples are on hold until funding is available.

Table 1. 2000 MA DEP Millers River Watershed sampling matrix.

WATERBODY, SEGMENT DESCRIPTION (SEGMENT #)	SAMPLING STATION	March	May	July	August	September	November
Millers River, Winchendon WWTP, Winchendon to confluence with Otter River, Winchendon (MA35-02)	MI14	X	X	X	X		X
Boyce Brook, NH State Line, Royalston to confluence with East Branch Tully River, Royalston (MA35-17)	WM17BOY*					P*	
Whetstone Brook, Headwaters northeast of Orcutt Hill near New Salem Rd, Wendell to confluence with Millers River, Wendell (MA35-18)	WM04WHE*					P*	
Millers River, South Royalston USGS Gage, Royalston to Erving Paper Company, Erving (MA35-04)	MI10A	X	X	X	X		X
	F0110				T		
	MI08			X	X		
	MI07			X	X		
	F0111				T		
	MI05A			X	X		

Table 1 (continued). 2000 MA DEP Millers River Watershed sampling matrix.

WATERBODY, SEGMENT DESCRIPTION (SEGMENT #)	SAMPLING STATION	March	May	July	August	September	November
Keyup Brook, Headwaters Great Swamp Northfield State Forest, Northfield, to confluence with Millers River, Erving (MA35-16)	WM13KEY*					P*	
Mormon Hollow Brook, Headwaters just north of Montague Rd, Wendell to confluence with Millers River, Wendell (MA35-15)	WM09MOR*					P*	
Lyons Brook, upstream from confluence with Millers River Segment MA35-05 in Montague/Wendell (MA35-19)	LB01					P	
Millers River, Erving Paper Company, Erving to confluence with Connecticut River, Erving (MA35-05)	F0112				T		
	MI03	X	X	X	X		X
Priest Brook, headwaters at the confluence of Towne and Scott Brooks, Royalston to the confluence with the Millers River, Winchendon (MA35-10)	PR01	X	X	X	X		X
Otter River, Gardner WWTP, Gardner to Seaman Paper Dam, Templeton (MA35-07)	F0109				T		
	OT05	X	X	X	X		X
Otter River, Seaman Paper Dam, Templeton to confluence with Millers River, Winchendon (MA35-08)	OT03			X	X		
Beaver Brook, Templeton Developmental Center (formerly Fernald School) discharge, Templeton to confluence with Millers River, Royalston (MA35-09)	BB01			X	X		

X – Monitoring: Hydrolab® multiprobe meter (depth, pH, dissolved oxygen, conductivity, temperature, total dissolved solids, turbidity), chemistry (alkalinity, hardness, chloride, total suspended solids, turbidity), nutrients (total phosphorus, ammonia, nitrate-nitrogen, total Kjeldahl nitrogen), and/or toxicity (chronic microtox).

T – Contaminants in fish tissue (CD, Pb, Hg, As, Se, % lipids, PCBs, organochlorine pesticides). **Note:** Fish contaminant monitoring was also conducted in the Millers River Watershed by MA DEP Office of Water Management in 1995 (Lake Rohunta, Athol/Orange/New Salem and Lake Dennison, Winchendon) and in 1996 (Lake Dennison, Winchendon). While not included in the above matrix, locations are depicted in Figure 3 and data are presented in Table 14.

P – Fish population.

* - Numeric Biocriteria Project stations. **Note:** Data were also collected as part of project 97-09/104 *Numeric Biocriteria* authorized under the 104(b)(3) Wetlands and Water Quality Grant Program.

Several sites in the Millers River Watershed were sampled in 1996, 1998 and/or 2000 as part of the 104b(3) Numeric Biocriteria Development Project, which started in 1996. This sampling schedule is summarized in Table 2. Survey components included water quality, fish population, and/or benthic macroinvertebrate sampling. Water quality sampling was restricted to *in-situ* Hydrolab® measurements of depth, pH, dissolved oxygen, conductivity, temperature, total dissolved solids, turbidity, and dissolved oxygen.

Water quality monitoring was also conducted by DWM staff at one location on the Millers River as part of the 1998/1999 Connecticut River Nutrient Loading Project (MA DEP 2000b). Samples were collected from the river upstream of the Route 63 bridge in Erving/Montague on a monthly basis from June 1998 through May 1999 and were analyzed for chloride, total suspended solids, total Kjeldahl nitrogen, ammonia-nitrogen, nitrate-nitrogen and total phosphorus.

Water quality sampling in the Millers River Watershed was also conducted by DWM staff in June, July, and August of 1995 and concluded with a bacteria sampling survey in May 1996. The 1995/1996 water quality sampling matrix is summarized in Table 3. River station sampling included *in-situ* Hydrolab® measurements, chemical (alkalinity, hardness, chloride, suspended solids, total solids, turbidity), nutrient (total phosphorus, ammonia, nitrate-nitrogen, total Kjeldahl nitrogen) and bacteria (fecal coliform) samples. Fish contaminant monitoring was performed in July and August 1995 and June 1996 as part of the ongoing fish contaminant monitoring program, providing information to assess the concentrations of toxic contaminants in freshwater fish.

Table 2. Millers River Watershed 1996, 1998, and 2000 Numeric Biocriteria Pilot Study sampling matrix.

Stream	Station Identifier	Benthic Macroinvertebrate	Fish Population Survey (station locations illustrated in Figure 2)	<i>In-situ</i> Hydrolab® Measurements (station locations illustrated in Figure 1)
Whetstone Brook	WM04WHE	9 September 1996 11 September 2000	27 September 1996 21 September 1998 21 September 2000	27 September 1996 21 September 1998
Otter River	WM05OTT	9 September 1996	18 October 1996	18 October 1996
Mormon Hollow Brook	WM09MOR	11 September 1996* 17 September 1998 11 September 2000	27 September 1996 21 September 1998 21 September 2000	27 September 1996 21 September 1998
Keyup Brook	WM11KEY	11 September 1996*	26 September 1996	26 September 1996
Keyup Brook	WM13KEY	11 September 1996* 11 September 2000	26 September 1996	26/27 September 1996
Keyup Brook	WM13KEYa	not done	19 September 2000	not done
West Branch Tully River	WM15WBT	12 September 1996 13 September 2000	2 October 1996	2 October 1996
East Branch Tully River	WM16EBT	12 September 1996	18 October 1996	18 October 1996
Boyce Brook	WM17BOY	12 September 1996 12 September 2000	2 October 1996** 21 September 2000	2 October 1996
Lawrence Brook	WM19LAW	13 September 1996	18 October 1996	18 October 1996
Lawrence Brook	B0449***	13 September 2000	not done	not done
Lyons Brook	LB01***	11 September 2000	19 September 2000	not done

* indicates a duplicate benthic macroinvertebrate sample also collected

** indicates a replicate fish population station was also conducted

*** station sampled for the 2000 Millers River Watershed Survey (not specifically for Biocriteria Development Project).

Table 3. 1995/1996 MA DEP DWM Millers River Watershed sampling survey matrix.

Stream	Station	1995 June	1995 July	1995 August	1996 May
Millers River	M104	not done	not done	not done	B
Otter River	M01	H, N, W	H, N, W	H, N, W, M	B
Otter River	M02	H, N, W	H, N, W	H, N, W, M	B
Otter River	M03	H, N, W	H, N, W	H, N, W, M	B
Otter River	M04	H, N, W	H, N, W	H, N, W, M	B
Otter River	M05	H, N, W	H, N, W	H, N, W, M	B
Otter River	M06	H, N, W	H, N, W	H, N, W, M	B
Otter River	M07	H, N, W	H, N, W	H, N, W, M	B
Priest Brook	M105	not done	not done	not done	B

B = Fecal coliform bacteria

H = Hydrolab® meter (pH, temperature, dissolved oxygen, specific conductance)

M = Macroinvertebrate sampling and habitat analysis

N = Nutrients (total phosphorus, ammonia nitrogen, nitrate nitrogen, total Kjeldahl nitrogen)

W = Water quality (alkalinity, hardness, chloride, total suspended solids, turbidity)

Water quality monitoring at river station locations for the surveys conducted in the Millers River Watershed by DWM and CERO SMART staff between 1995 and 2000 are illustrated in Figure 1.

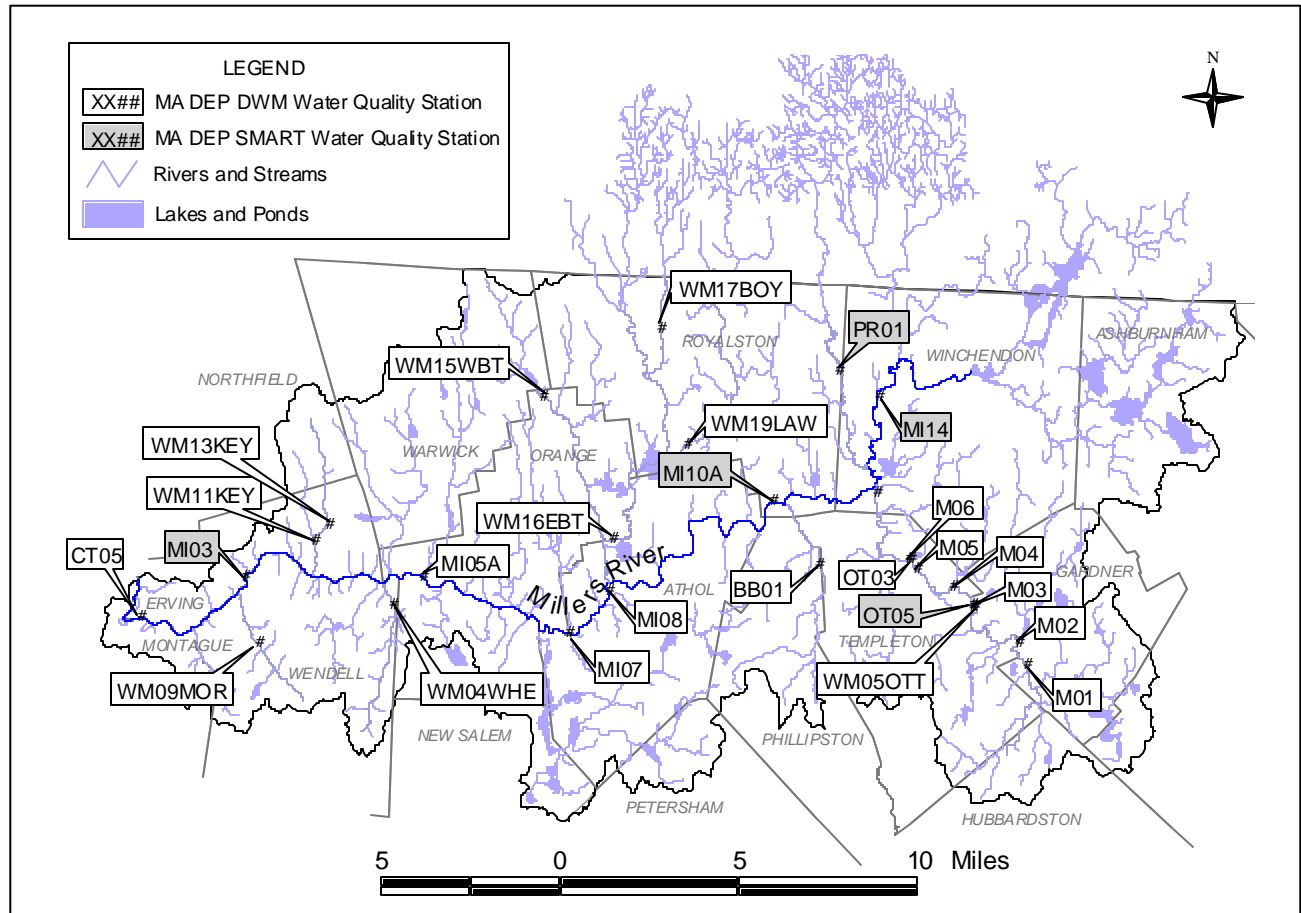


Figure 1. Location of MA DEP water quality sampling stations in the Millers River Watershed - 1995 to 2000.

Fish Population Surveys in the Millers River Watershed were conducted at nine stations in 1996 as part of Division of Watershed Management (DWM) Numeric Biocriteria Development Project. Two of these stations were sampled in 1998 in an effort to document temporal variation. In 2000, in conjunction with the DWM Year 2 monitoring efforts and/or the ongoing DWM Numeric Biocriteria Development Project, fish population sampling was conducted at five stations (one stream, Lyons Brook, was sampled as part of the Millers River Watershed survey not the biocriteria development project). Sampling station locations are depicted in Figure 2.

METHODS

Water Quality Sampling

Procedures used for water sampling and sample handling are described in the *Grab Collection Techniques for DWM Water Quality Sampling, Standard Operating Procedure* (MA DEP 1999b) and *Hydrolab® Series 3 Multiprobe, Standard Operating Procedure* (MA DEP 1999c). SMART monitoring personnel followed procedures outlined in the draft *SMART Water Quality Monitoring Quality Assurance Project Plan* (MA DEP 2000a). Procedures followed in 1995 are detailed in *Basins Program Standard Operating Procedures River and Stream Monitoring* (MA DEP 1990). The Wall Experiment Station (WES), the Department's analytical laboratory, supplied all sample bottles and field preservatives, which were prepared according to the *WES Laboratory Quality Assurance Plan and Standard Operating Procedures* (MA DEP 1995a). Samples were preserved in the field as necessary, transported on ice to WES, and analyzed according to WES standard operating procedures.

Quality Assurance Quality Control and Data Validation for Water Quality Sampling and Data

Monitoring surveys in the Millers River Watershed from 1995 to 2000 were performed with attention to maintaining quality assurance and control of field samples and field-generated data. For the majority of water quality surveys, quality control samples (field blanks and sample splits or field replicates) were taken at a minimum of one each per crew per survey. Typically, field monitoring activities followed accepted DWM standard operating procedures. Where strict procedures were not in place or necessary, it is assumed that DWM field staff exercised best professional judgment.

All Hydrolab® multi-probe data were validated using a multi-staff review procedure. Data symbols (e.g., ** for censored/missing data) were applied to Hydrolab® data as necessary. Other water quality sample data were validated by reviewing QC sample results, analytical holding time compliance, QC sample frequency and related ancillary data/documentation (at a minimum). Formal data qualifiers (not just symbols) were used to censor or qualify data where necessary starting in 1999. Appendix 1 of this technical memorandum contains relevant quality control data and information for Millers River Watershed water quality samples collected from 1995-2000, as well as data censoring/qualification decisions for 2000 Millers data. Appendix 2 of this technical memorandum contains definitions for data qualifiers.

The *2000 Data Validation Report* contains additional detail on validation of the 2000 data set while the *Memorandum for 1994, 95 & 96 QA/QC Assessment Report* provides that detail for the 1995/1996 survey (MA DEP 2003 and MA DEP 1999a). The salient considerations with regard to Millers River Watershed data validity summarized here are excerpted from these reports.

Because most ambient river samples taken by DWM and SMART were via the wade-in technique as described in *Grab Collection Techniques for DWM Water Quality Sampling, Standard Operating Procedure* (MA DEP 1999b), the majority of river samples taken in 2000 were assumed to be representative of *in-situ* water quality. Since no field audits were performed in 2000, samples were assumed to have been taken consistent with DWM SOPs (in lieu of information to the contrary). An external lab audit of WES by DWM in 2000 using a Total Phosphorus quality control sample showed very good analytical capability by the WES laboratory. The laboratory also performed periodic internal QC sample analyses as well as on-going data validation procedures. Water samples taken between 1995 and 2000 from elevated crossings (such as at bridges, trestles and roads), however, were usually taken with plastic buckets attached to ropes (e.g., Millers River, station CT05 in 1998-99). The use of plastic buckets as collection devices may potentially contaminate all samples, regardless of analytes, through station-to-station cross-contamination of the bucket and rope (even with rinsing), sampling location disturbance (in shallow conditions), and weather effects (precipitation entering bucket upon retrieval). Sample integrity may be especially compromised when sampling for bacteria, nutrients and solids. Therefore, data users should use such data with caution. (*Information related to bucket use locations in the Millers River Watershed is incomplete; therefore, no such data has been censored or qualified for this reason solely.*)

Fish Population Surveys

Fish population surveys were conducted using techniques similar to Rapid Bioassessment Protocols V (fish) as described by Plafkin, et al. (1989) and outlined in the draft Fish Population Monitoring SOP (MA DEP 2001). Surveys also included a habitat assessment component modified from that described in the aforementioned document.

Fish were sampled by backpack electroshocking using a Coffelt BP6 (occasionally in tandem with a Smith Root Model 12) in 1996, and a Smith Root Model 12 in 1998 and 2000. A reach of between 80m and 100m was sampled by passing a pole mounted anode ring, side to side through stream channel and in and around likely fish holding cover. All fish shocked were netted and held in buckets. Sampling proceeded from an obstruction or constriction, upstream, to an endpoint at another obstruction or constriction such as a waterfall or shallow riffle. Following completion of a sampling run, fish were identified to species, counted, a sub-sample of up to 25 fish per species were measured, weighed, and then released (MA DEP 1996a, 1998, 2000c). Sampling station locations are depicted in Figure 2.

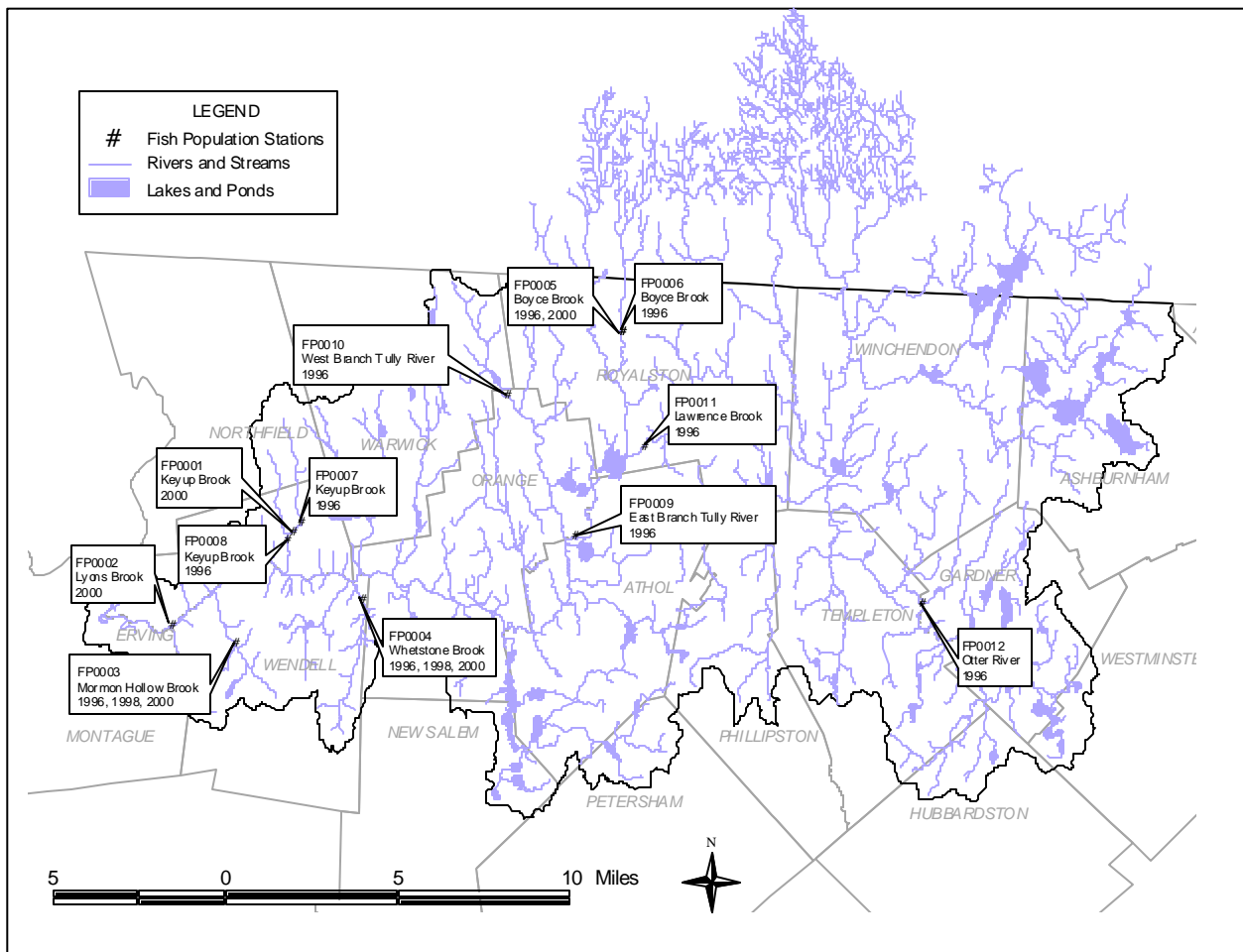


Figure 2. Location of MA DEP fish population stations in the Millers River Watershed - 1995 to 2000.

Quality Assurance Quality Control and Data Validation for Fish Population Data

Fish community data generated by DWM are not externally censored or qualified. The basis for validity of these data generally lies with the best professional judgment of the DWM biologist(s) performing the surveys and any quality control steps taken per the SOP (MA DEP 2001). If their notes or other communication points to potential problems with the survey data (e.g., inconsistency with SOP), this is documented for the data user to consider.

Fish Contaminant Monitoring

Fish contaminant monitoring is a cooperative effort between three MA DEP Offices/Divisions, (Watershed Management, Research and Standards, and Environmental Analysis), the Department of Fisheries and Wildlife Environmental Law Enforcement, and the Department of Public Health (MA DPH). Fish contaminant monitoring is typically conducted to assess the concentrations of toxic contaminants in freshwater fish, identify waterbodies where those concentrations may pose a risk to human health, and identify waters where toxic contaminants may impact fish and other wildlife. Fish contaminant monitoring was designed to screen the edible fillets of several species of fish desired by the angling public for consumption, as well as species representing different feeding guilds (i.e., bottom dwelling omnivores, top-level predators, etc.) for the presence of heavy metals (Pb, Cd, Se, Hg, As), PCBs, and organochlorine pesticides (MA DEP 1999d). These data are used by the Massachusetts Department of Public Health in assessing human health risks associated with the consumption of freshwater fishes.

Details related to the collection, handling, and processing of samples are presented in the report entitled *2000 Fish Toxics Monitoring Public Request and Year 2 Watershed Surveys* (Maietta and Colonna-Romano 2000). According to standard practice, all laboratory analytical results were forwarded to the Massachusetts Department of Public Health.

Millers River Watershed fish contaminant monitoring was conducted by MA DEP OWM (now DWM) personnel in July and August of 1995 at Lake Rohunta, Athol/Orange/New Salem (station F0003) using boat mounted electrofishing gear. Lake Dennison, Winchendon (station F0002) was sampled for fish contaminants in August 1995 and again in June 1996. Boat mounted electrofishing gear was used for the 1 August 1995 and 11 June 1996 sampling events while the 22 August 1995 sample was collected with rod and reel. Fish selected for analysis were placed in an ice filled cooler and brought back to the OWM laboratory for processing and subsequent delivery to Wall Experiment Station. Lake Denison was resampled in June of 1996. In August of 2000 additional fish contaminant monitoring was conducted by MA DEP DWM personnel at three stations on the Millers River (in Athol, Orange, and Erving) and one station on the Otter River (in Winchendon). Sampling events are described below and stations are depicted in Figure 3.

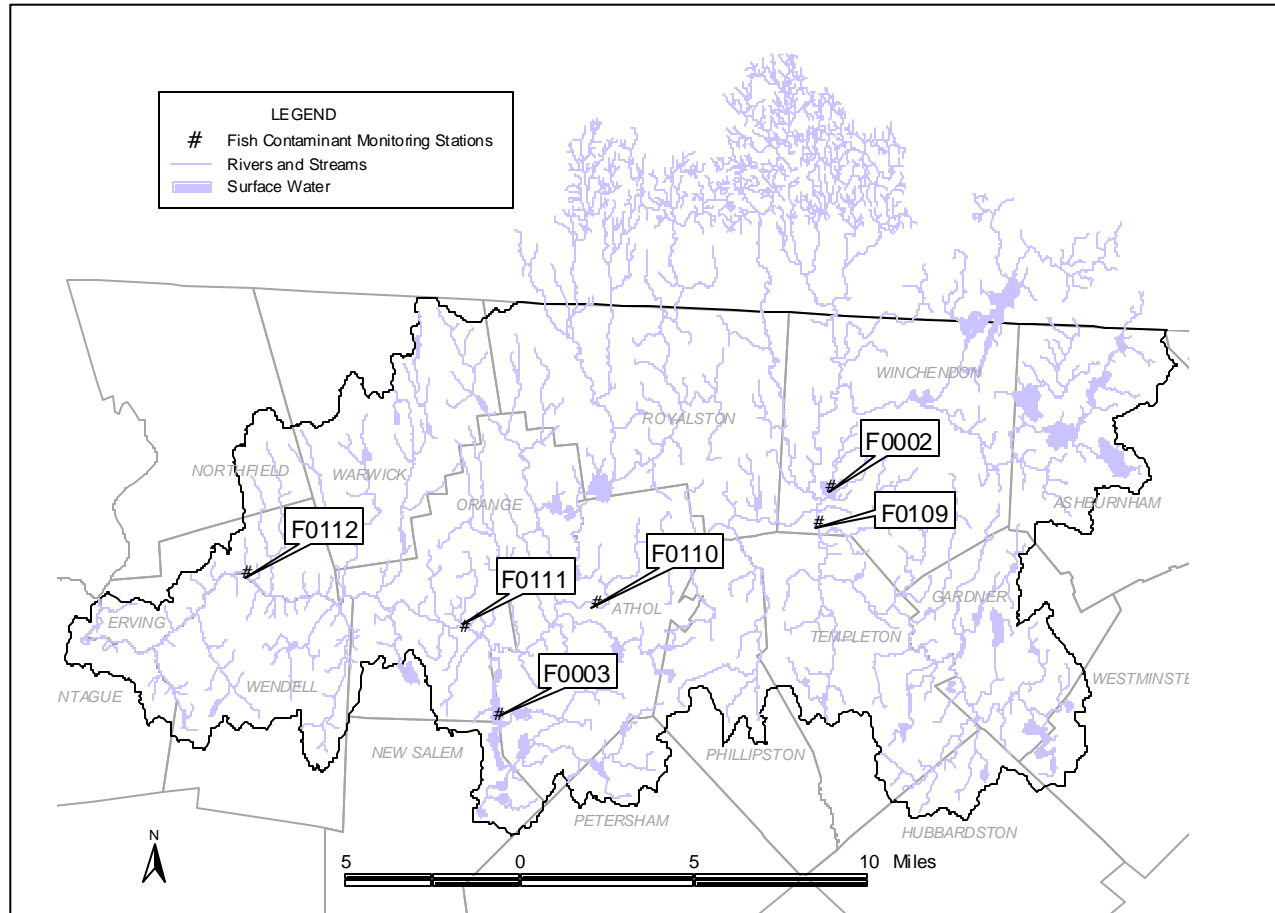


Figure 3. Location of MA DEP fish contaminant monitoring stations in the Millers River Watershed - 1995 to 2000.

Quality Assurance Quality Control and Data Validation for Fish Contaminant Monitoring Data

Due to the need to disseminate information quickly, DWM/WES generated/lab-validated fish contaminant data are typically used directly (upon receipt from the lab) by several groups (including DWM) without extensive external data validation. DWM does not (*ex post facto*) censor or qualify fish contaminant data once it has been used. Rather, specific comments are provided where poor field and/ or analytical accuracy/precision may have occurred. Additional discussion and QC sample data for fish contaminants from 1995-2000 can be found in the Data Validation Report for Year 2000 Project Data (MA DEP 2003). Methods used at the Department’s analytical laboratory, Wall Experimental Station (WES) for metal and organic analysis are provided in Appendix C of this technical memorandum (Table C1 and Table C2) and additional information is available from the WES laboratory (MA DEP 1995a).

RESULTS

When analyzing water quality data, it is important to understand the hydrologic conditions during which the samples were collected and to determine the streamflow condition in relation to the 7-day, 10-year (7Q10) low flow. Precipitation and streamflow data were used to characterize conditions during the 2000 water quality surveys in the Millers River Watershed. Data collected from three DEM Office of Water Resources precipitation stations (Gardner station GAR406, Templeton station TEM405, Otter River station TEM403), one National Weather Service precipitation station (Orange station ORE), and four continuous USGS stream gages (Millers River near Winchendon #01162000, Priest Brook near Winchendon #01162500, Otter River at Otter #01163200, Millers River at Erving #01166500) were analyzed to estimate hydrological conditions for the water quality sampling events conducted during the 2000 sampling season. The periods of record (POR) for the USGS stream gages are: 1916 to present for Millers River near Winchendon #01162000 and Priest Brook near Winchendon #01162500, 1964 to present for Otter River at Otter #01163200, and 1915 to present for Millers River at Erving #01166500 (Socolow *et al.*, 2001 and 2002). It should also be noted that flows in the Millers River can be affected by power plants, flood control projects, dams (including beaver), treatment plant discharges, and reservoirs, therefore data should be interpreted with caution. Data for the five days prior to and on the sampling dates were reviewed. Streamflow conditions in relation to the 7-day, 10-year (7Q10) low flow estimates were also determined.

22 March 2000: This survey was conducted during and following dry weather with the exception of the fourth and fifth days prior to the sample collection date. On the fourth day prior, minor precipitation (0.17 inches) was recorded at only one of the four precipitation monitoring stations (TEM403). However, on the fifth day prior to the survey a storm event occurred with 1.02, 0.43, 0.33, and 0.30 inches of precipitation being recorded at gages ORE, TEM403, TEM405, and GAR406, respectively (Table 4). Streamflows (Table 5) recorded for the sampling event were near the monthly averages for March and slightly above the monthly POR means for each USGS streamflow gage. Discharges on this day at the two USGS gages on the Millers River were approximately 33 and 59 times higher than the 7-day, 10-year (7Q10) low flow estimates with monthly average discharges approximately 32 and 62 times higher than the 7Q10 low flow estimates (Table 5). Flow in Otter River peaked about two days following the storm event and continued to decline until it was slightly less than the monthly mean on the survey day. However, the sampling date discharges were approximately 25 times higher than the 7Q10 low flow estimates with monthly average discharges approximately 30 times higher than the 7Q10 low flow estimates. Priest Brook responded with flows peaking within one day of the rain event and subsequently declined to slightly below the monthly mean by the sampling date but here too sampling day discharges were approximately 187 times higher than the 7Q10 low flow estimates with monthly average discharges approximately 222 times higher than the 7Q10 low flow estimates. Data collected during this survey are interpreted as being representative of dry weather conditions.

10 May 2000: A storm event was recorded at the Gardner, Templeton and Orange precipitation gage stations on this sampling date with 0.90, 0.96, and 1.22 inches of rain reported, respectively. Two days prior, on the 8th of May, a rain event resulted in 0.42, 0.46, and 0.66 inches of precipitation also being recorded at these gaging stations (Table 4). Streamflows (Table 5) recorded for the sampling event were approximately $\frac{1}{2}$ to $\frac{3}{4}$ of both the monthly averages and the monthly POR means for May for each USGS streamflow gage. Discharges on this day at the two USGS gages on the Millers River were approximately 13 and 23 times higher than the 7-day, 10-year (7Q10) low flow estimates with monthly average discharges approximately 17 and 30 times higher than the 7Q10 low flow estimates (Table 5). Flow in Otter River, which peaked about two days following the sampling day storm event, was approximately 15 times higher than the 7Q10 low flow estimates with monthly average discharges approximately 19 times higher than the 7Q10 low flow estimates. Priest Brook flow, which also peaked about two days following the sampling date, was approximately 42 times higher than the 7Q10 low flow estimates with monthly average discharges approximately 85 times higher than the 7Q10 low flow estimates. Data collected during this survey are interpreted as being representative of wet weather conditions.

Table 4. MA DEM and National Weather Service precipitation data summaries for the 2000 Millers River Watershed survey dates and five antecedent days.

Precipitation Data Summary (reported in inches of rain)						
Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Sample Date
Gardner GAR406 (MA DEM 2000)						
3/22/2000	0.3	0.0	0.0	0.0	0.0	0.0
5/10/2000	0.0	0.0	0.0	0.42	0.0	0.90
7/5/2000	0.0	0.0	0.0	0.16	0.0	0.0
8/23/2000	0.11	0.0	0.0	0.0	0.0	0.18
11/8/2000	0.0	0.0	*	0.0	0.0	0.0
Templeton TEM405 (MA DEM 2000)						
3/22/2000	0.33	0.0	0.0	0.0	0.0	0.0
5/10/2000	0.04	0.0	0.0	0.46	0.0	0.96
7/5/2000	0.0	0.0	0.0	0.25	0.0	0.0
8/23/2000	0.20	0.0	0.0	0.0	0.0	0.25
11/8/2000	**	**	**	**	**	**
Otter River TEM403 (MA DEM 2000)						
3/22/2000	1.02	0.17	0.0	0.0	0.0	0.0
5/10/2000	**	**	**	**	**	**
7/5/2000	**	**	**	**	**	**
8/23/2000	**	**	**	**	**	**
11/8/2000	0.0	0.0	0.0	0.05	0.0	0.0
Orange ORE (NWS 2003)						
3/22/2000	0.43	0.0	0.0	0.0	0.0	0.0
5/10/2000	0.04	0.01	0.0	0.66	*	1.22
7/5/2000	0.01	0.0	0.01	0.53	0.01	0.0
8/23/2000	0.07	0.0	0.01	0.0	0.01	0.25
11/8/2000	0.01	0.0	0.01	0.0	0.0	0.0

* trace amount of precipitation noted ** data unavailable

5 July 2000: This survey was conducted during and following relatively dry weather with the exception of a storm recorded on July 3rd, two days prior to the sample collection date. Measurements of 0.16, 0.25, and 0.53 inches of rain were recorded at precipitation stations GAR406, TEM405, and ORE, respectively (Table 4). Streamflows (Table 5) recorded for the sampling event were ½ to slightly less than the July monthly means and the monthly period of record means for all USGS flow gages. Sampling day discharges and the monthly average discharges at the two USGS gages on the Millers River were approximately 6 to 7 times higher than the 7-day, 10-year (7Q10) low flow estimates (Table 5). Flow in Otter River peaked the day before the sampling event (the day following the storm event) and continued to decline until it was slightly less than the monthly mean on the survey day. However, the sampling date discharges were approximately 5 times higher than the 7Q10 low flow estimates with monthly average discharges approximately 6 times higher than the 7Q10 low flow estimates. Priest Brook responded with flows peaking within one day of the rain event (the day before sampling) and subsequently declined to approximately ½ the monthly mean by the sampling date. But, here too, sampling day discharges were approximately 13 times higher than the 7Q10 low flow estimates with monthly average discharges approximately 23 times higher than the 7Q10 low flow estimates. Data collected during this survey are interpreted as being representative of dry weather conditions.

23 August 2000: A small precipitation event was recorded at the Gardner, Templeton and Orange precipitation gage stations on this sampling date with 0.18, 0.25, and 0.25 inches of rain reported, respectively (Table 4). Streamflows (Table 5) recorded for the sampling event were approximately ½ the monthly averages and approximately the same as the monthly POR averages for August for each USGS streamflow gage. Discharges on this day at the two USGS gages on the Millers River were approximately 6 and 7 times higher than the 7-day, 10-year (7Q10) low flow estimates with monthly average discharges approximately 13 and 16 times higher than the 7Q10 low flow estimates (Table 5). Flow in Otter River was declining steadily and apparently showed no response to the precipitation event with the sampling day flow being less than ½ the monthly mean. Otter River flows were approximately five times greater than the 7Q10 low flow estimates with monthly average discharges approximately 10 times higher than

the 7Q10 low flow estimates. Flows on Priest Brook (apparently unaffected by the precipitation event) were also on the decline being just above a third of the monthly average by the sampling date. Priest Brook flows were approximately 27 times greater than the 7Q10 low flow estimates with monthly average discharges approximately 76 times higher than the 7Q10 low flow estimates. Data collected during this survey are interpreted as being representative of dry weather conditions.

8 November 2000: This survey was conducted during and following essentially dry weather (Table 4). Streamflows recorded for the sampling event (Table 5) were approximately ½ the monthly averages for November and ½ or less than the monthly period of record averages for each USGS streamflow gage. Discharges on this day at the two USGS gages on the Millers River were approximately 5 and 10 times higher than the 7-day, 10-year (7Q10) low flow estimates with monthly average discharges approximately 9 and 15 times higher than the 7Q10 low flow estimates (Table 5). The Otter River and Priest Brook flows were approximately 5 and 24 times greater than the 7Q10 low flow estimates and the monthly means were approximately 9 and 52 times greater than the 7Q10 low flow estimates. The data collected during this survey, however, are interpreted as being representative of dry weather conditions.

Table 5. USGS gage data summaries for the 2000 Millers River Watershed survey dates and five antecedent days. (Data includes monthly means, period of record means, and seven-day, ten-year low flow (7Q10) estimates.) (Socolow *et al.* 2001 and 2002).

USGS Flow Data Summary (reported in cfs)								
Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Sample Date	Monthly Mean	POR* Monthly Mean
Millers River near Winchendon, MA Gage #01162000** (7Q10 = 6.9 cfs USGS 13 March 2003)								
3/22/2000	564	603	550	491	436	410	429	263
5/10/2000	197	e175	e160	e140	e120	161	208	181
7/5/2000	e60	e55	e50	e45	e50	e45	46.3	61.3
8/23/2000	98	82	70	58	53	51	110	52.1
11/8/2000	e62	e60	e62	e64	e70	e70	106	119
Priest Brook near Winchendon, MA Gage #01162500 (7Q10 = 0.45 cfs USGS 13 March 2003)								
3/22/2000	169	175	145	115	96	84	100	64.3
5/10/2000	30	23	20	18	17	19	38.4	42.7
7/5/2000	10	8.6	6.8	5.9	6.9	5.7	10.5	12.4
8/23/2000	38	30	24	18	14	12	34.1	10.1
11/8/2000	12	12	12	11	11	11	23.3	29.1
Otter River at Otter River, MA Gage #01163200 (7Q10 = 4.6 cfs USGS 13 March 2003)								
3/22/2000	197	232	188	149	129	118	139	112
5/10/2000	76	71	67	64	72	71	88.8	74.8
7/5/2000	31	28	25	24	26	22	27.2	26.7
8/23/2000	47	41	35	29	24	23	47.3	25.8
11/8/2000	22	21	21	22	24	22	40.0	58.0
Millers River at Erving, MA Gage #01166500*** (7Q10 = 46.8 cfs USGS 13 March 2003)								
3/22/2000	1880	2050	1890	1750	1690	1550	1501	1175
5/10/2000	713	672	645	611	632	610	830	836
7/5/2000	386	332	308	292	298	265	305	290
8/23/2000	716	603	453	370	309	289	611	233
11/8/2000	244	251	239	240	232	230	409	529

* Period of Record

e – Reported by USGS as estimated

** USGS notes that records less than 200 cfs and those for estimated daily discharge are poor at this gage. Flow affected for most of year by backwater from beaver dams located approximately 0.5 miles downstream from gage. Flow regulated by powerplant and by Lake Monomonac and other reservoirs upstream, by wastewater treatment plant 500 feet upstream, and infrequent backwater from U. S. Army Corps of Engineers Flood-Control Project at Birch Hill Dam.

*** USGS notes that at this gage flow regulated by power plants and by Lake Monomonac and other reservoirs; high flow regulated by Birch Hill Reservoir 22 miles upstream since 1941 and Tully Lake since 1948.

Water Quality Sampling

The *in-situ* Hydrolab® results for the 2000 water quality survey are provided in Table 6. Discrete physico/chemical water quality sampling data collected in the Millers River Watershed in 2000 are

provided in Table 7. *In-situ* Hydrolab® data collected during the Numeric Biocriteria Pilot Study surveys and the 1995 Millers River Watershed Survey are provided in Tables 8 and 9, respectively. Table 10 contains the results of the 1995 Millers River Watershed instream physico/chemical data. Bacteria sample results from the surveys conducted in the Millers River Watershed in 1996 can be found in Table 11. Results of samples collected from the Millers River at the Route 63 bridge, Erving/Montague as part of the 1998/1999 Connecticut River Nutrient Loading Project can be found in Table 12.

Table 6. 2000 MA DEP Millers River Watershed *in-situ* Hydrolab® data.

MILLERS RIVER (SARIS: 3522150) Station: MI14, Mile Point: 35.1 Unique ID¹: W0694									
Description: just upstream/north of old bridge abutments on eastern shore of closed dirt road (Sibley Road on 1998 Winchendon USGS quad), Winchendon.									
Date	OWMID ²	Time	Depth	Temp	pH	Conductivity at 25°C	TDS	DO	Saturation
		(24hr)	(m)	(C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
3/22/2000	SM-0020	12:34	1.4	4.4	5.8	70.3	45.0	12.5	94
5/10/2000	SM-0053	12:58	0.3	16.1	5.9	81.4	52.1	8.8	88
7/5/2000	SM-0086	13:42	** i	22.8	6.0	89.0	57.0	6.8	77
8/23/2000	SM-0133	12:40	0.1i	17.1	5.9	82.8	53.0	8.1	82
11/8/2000	SM-0180	12:53	0.4	6.8	6.0	81.1	51.9	11.0	88
MILLERS RIVER (SARIS: 3522150) Station: MI10A, Mile Point: 27.6 Unique ID: W0692									
Description: Blossom Street, approximately 150 meters downstream/west of King Street at USGS flow gauging station, Royalston.									
Date	OWMID	Time	Depth	Temp	pH	Conductivity at 25°C	TDS	DO	Saturation
		(24hr)	(m)	(C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
3/22/2000	SM-0018	11:33	0.6	4.1	5.6	110	70.6	12.5	92
5/10/2000	SM-0051	11:55	0.4	17.7	6.1	137	87.9	8.4	86
7/5/2000	SM-0084	12:35	** i	23.8	6.3	139	89.0	7.3	85
8/23/2000	SM-0131	11:44	0.2	18.2	6.2	137	87.9	8.4	87
11/8/2000	SM-0178	11:54	0.2	7.1	6.3	166	106	11.3	92
MILLERS RIVER (SARIS: 3522150) Station: MI08, Mile Point: 19.3 Unique ID: W0684									
Description: approximately 30 feet upstream/north of Route 2A bridge, Athol.									
Date	OWMID	Time	Depth	Temp	pH	Conductivity at 25°C	TDS	DO	Saturation
		(24hr)	(m)	(C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
7/5/2000	SM-0090	11:45	** i	21.6	6.5	108	69.3	8.4	94
8/23/2000	SM-0137	11:09	0.2	17.0	6.2	103	65.9	9.4	96
MILLERS RIVER (SARIS: 3522150) Station: MI07, Mile Point: 17.4 Unique ID: W0683									
Description: from upstream/eastern side of Daniel Shays Highway bridge, Athol. (near the Athol/Orange border)									
Date	OWMID	Time	Depth	Temp	pH	Conductivity at 25°C	TDS	DO	Saturation
		(24hr)	(m)	(C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
7/5/2000	SM-0089	11:19	** i	21.8	6.5	141	90.2	8.0	90
8/23/2000	SM-0136	10:44	1.5	17.7	6.2	122	77.8	8.7	90
MILLERS RIVER (SARIS: 3522150) Station: MI05A, Mile Point: 11.9 Unique ID: W0682									
Description: from upstream/eastern side of Holtshire Road bridge, Orange.									
Date	OWMID	Time	Depth	Temp	pH	Conductivity at 25°C	TDS	DO	Saturation
		(24hr)	(m)	(C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
7/5/2000	SM-0088	10:28	** i	22.9	6.4	128	81.7	7.5	86
8/23/2000	SM-0135	10:08	0.3	18.2	6.1	117	74.7	8.5	89
MILLERS RIVER (SARIS: 3522150) Station: MI03, Mile Point: 5.8 Unique ID: W0690									
Description: downstream/south of Bridge Street, Erving/Wendell.									
Date	OWMID	Time	Depth	Temp	pH	Conductivity at 25°C	TDS	DO	Saturation
		(24hr)	(m)	(C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
3/22/2000	SM-0015	09:59	1.1	4.6	6.1	89.1	57.0	13.1	98
5/10/2000	SM-0048	10:05	0.9	17.7	6.7	117	74.8	9.2	95
7/5/2000	SM-0081	10:57	0.1i	22.4	7.3c	121	77.7	8.6	98
8/23/2000	SM-0128	10:14	0.5	17.7	7.2c	129	82.6	9.9	102
11/8/2000	SM-0175	10:00	0.3u	7.2	6.9	142u	91.0u	12.2	99

Table 6 (Continued). 2000 MA DEP Millers River Watershed *in-situ* Hydrolab® data.

PRIEST BROOK (SARIS: 3524150) Station: PR01, Mile Point: 4.2 Unique ID: W0693									
Description: approximately 10 meters downstream/south of River Street at USGS flow gauging station, Royalston.									
Date	OWMID	Time	Depth	Temp	pH	Conductivity at 25°C	TDS	DO	Saturation
		(24hr)	(m)	(C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
3/22/2000	SM-0019	12:02	0.6	4.0	4.9	42.7	27.3	11.4	84
5/10/2000	SM-0052	12:27	0.2	16.5	5.1	46.2	29.6	5.5	56
7/5/2000	SM-0085	13:06	** i	22.2	5.3	47.1	30.2	5.3	60
8/23/2000	SM-0132	12:12	0.2	16.6	5.1	41.0	26.2	5.4	54
11/8/2000	SM-0179	12:22	0.3	6.1	5.1	45.6	29.2	8.7	69
OTTER RIVER (SARIS: 3523800) Station: OT05, Mile Point: 6.5 Unique ID: W0691									
Description: approximately 35 meters upstream/southeast of Turner Street, Templeton (approximately 30 feet upstream of USGS flow gauging station)									
Date	OWMID	Time	Depth	Temp	pH	Conductivity at 25°C	TDS	DO	Saturation
		(24hr)	(m)	(C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
3/22/2000	SM-0016	11:02	0.3	4.1	5.8	246	158	12.0	89
5/10/2000	SM-0049	11:13	0.2	17.6	6.1	226	145	7.8	80
7/5/2000	SM-0082	11:57	** i	22.1	6.1	312	200	7.2	81
8/23/2000	SM-0129	11:11	0.1i	17.6	6.1	273	175	8.2	84
11/8/2000	SM-0176	11:17	** i	7.4	6.0	262	168	10.7	87
OTTER RIVER (SARIS: 3523800) Station: OT03, Mile Point: 3.6 Unique ID: W0686									
Description: upstream/east of Route 202 bridge, Templeton. (locality of Baldwinville, sampled from cement embankment at bridge)									
Date	OWMID	Time	Depth	Temp	pH	Conductivity at 25°C	TDS	DO	Saturation
		(24hr)	(m)	(C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
7/5/2000	SM-0092	13:02	** i	23.4	6.8	297	190	8.1	94
8/23/2000	SM-0139	12:27	0.4	18.0	6.6	347	222	9.1	94
BEAVER BROOK (SARIS: 3523600) Station: BB01, Mile Point: 2.5 Unique ID: W0685									
Description: from upstream/south side of Main Road bridge (south of Route 68), Phillipston.									
Date	OWMID	Time	Depth	Temp	pH	Conductivity at 25°C	TDS	DO	Saturation
		(24hr)	(m)	(C)	(SU)	(uS/cm)	(mg/L)	(mg/L)	(%)
7/5/2000	SM-0091	12:28	** i	20.5	5.7	150	96.0	3.8	42
8/23/2000	SM-0138	11:55	0.1i	16.1	5.3	139	88.7	6.6	66

¹Unique ID = unique station identification number.

²OWMID = sample tracking number.

“ ** ” = Censored or missing data

“ i ” = inaccurate readings from Hydrolab multiprobe likely; may be due to significant pre-survey calibration problems, post-survey calibration readings outside typical acceptance range for the low ionic check and for the deionized blank water check, lack of calibration of the depth sensor prior to use, or to checks against laboratory analyses.

“ u ” = unstable readings, due to lack of sufficient equilibration time prior to final readings, non-representative location, highly-variable water quality conditions, etc.

“ c ” = greater than calibration standard used for pre-calibration, or outside the acceptable range about the calibration standard. Typically used for conductivity (>718, 1,413, 2,760, 6,668 or 12,900 uS/cm) or turbidity (>10, 20 or 40 NTU). It can also be used for TDS and Salinity calculations based on qualified (“c”) conductivity data, or that the calculation was not possible due to censored conductivity data (TDS and Salinity are calculated values and entirely based on conductivity reading).

Table 7. 2000 MA DEP Millers River Watershed instream physico/chemical data (TSS = total suspended solids, TKN = total Kjeldahl nitrogen, NH3-N = ammonia-nitrogen, NO3-NO2-N = nitrate-nitrogen, and TP = total phosphorus).

MILLERS RIVER (SARIS: 3522150)												
Station: MI14, Mile Point: 35.1 Unique ID: W0694												
Description: just upstream/north of old bridge abutments on eastern shore of closed dirt road (Sibley Road on 1998 Winchendon USGS quad), Winchendon.												
Date	OWMID ²	QAQC	Time (24hr)	Alkalinity (mg/L)	Hardness (mg/L)	Chloride (mg/L)	TSS (mg/L)	Turbidity (NTU)	TKN (mg/L)	NH3-N (mg/L)	NO3-NO2-N (mg/L)	TP (mg/L)
3/22/2000	SM-0020	Not applicable	**	<2	7.5	14	1.2	0.70	0.22	<0.02	0.06	0.016
5/10/2000	SM-0053		12:58	3	8.5	16	4.0	2.0	0.41	0.05	0.04	0.035
7/5/2000	SM-0086		13:42	4	11	19	2.8	2.2	0.49	0.12	0.11	0.058
8/23/2000	SM-0133		13:00	3	9.3	17	4.3	2.4	0.49	** d	0.09d	0.053
11/8/2000	SM-0180		12:53	3	8.9	16	2.1	1.7	0.38	0.10	0.06	0.052
MILLERS RIVER (SARIS: 3522150)												
Station: MI10A, Mile Point: 27.6 Unique ID: W0692												
Description: Blossom Street, approximately 150 meters downstream/west of King Street at USGS flow gauging station, Royalston.												
Date	OWMID	QAQC	Time (24hr)	Alkalinity (mg/L)	Hardness (mg/L)	Chloride (mg/L)	TSS (mg/L)	Turbidity (NTU)	TKN (mg/L)	NH3-N (mg/L)	NO3-NO2-N (mg/L)	TP (mg/L)
3/22/2000	SM-0018	Not applicable	11:33	3	10	25	<1.0	0.90	0.19	<0.02	0.11	0.018
5/10/2000	SM-0051		11:55	5	14	29	5.4	3.0	0.52	<0.02	0.17	0.060
7/5/2000	SM-0084		12:35	5	18	29	2.5	4.7	0.42	<0.02	0.58	0.097
8/23/2000	SM-0131		11:45	5	17	26	1.8	3.6	0.54	** d	0.37d	0.060
11/8/2000	SM-0178		11:54	5	23	31	1.1	3.2	0.42	0.08	0.74	0.079
MILLERS RIVER (SARIS: 3522150)												
Station: MI08, Mile Point: 19.3 Unique ID: W0684												
Description: approximately 30 feet upstream/north of Route 2A bridge, Athol. (wade in approximately 10 feet from western shore)												
Date	OWMID	QAQC	Time (24hr)	Alkalinity (mg/L)	Hardness (mg/L)	Chloride (mg/L)	TSS (mg/L)	Turbidity (NTU)	TKN (mg/L)	NH3-N (mg/L)	NO3-NO2-N (mg/L)	TP (mg/L)
7/5/2000	SM-0090	Not applicable	11:45	6	17	22	2.0	3.1	0.36	<0.02	0.44	0.065
8/23/2000	SM-0137		11:09	6	15	21	1.8	2.4	0.39e	** de	0.58	0.040
MILLERS RIVER (SARIS: 3522150)												
Station: MI07, Mile Point: 17.4 Unique ID: W0683												
Description: from upstream/eastern side of Daniel Shays Highway bridge, Athol. (near the Athol/Orange border)												
Date	OWMID	QAQC	Time (24hr)	Alkalinity (mg/L)	Hardness (mg/L)	Chloride (mg/L)	TSS (mg/L)	Turbidity (NTU)	TKN (mg/L)	NH3-N (mg/L)	NO3-NO2-N (mg/L)	TP (mg/L)
7/5/2000	SM-0089	Not applicable	11:19	6	20	30	2.0	3.5	0.36	<0.02	0.50	0.087
8/23/2000	SM-0136		10:44	6	16	22	1.9	2.8	0.50	** d	0.40	0.057
MILLERS RIVER (SARIS: 3522150)												
Station: MI05A, Mile Point: 11.9 Unique ID: W0682												
Description: from upstream/eastern side of Holtshire Road bridge, Orange.												
Date	OWMID	QAQC	Time (24hr)	Alkalinity (mg/L)	Hardness (mg/L)	Chloride (mg/L)	TSS (mg/L)	Turbidity (NTU)	TKN (mg/L)	NH3-N (mg/L)	NO3-NO2-N (mg/L)	TP (mg/L)
7/5/2000	SM-0088	Not applicable	10:28	6	19	35	2.2	3.0	0.35	<0.02	0.42	0.067
8/23/2000	SM-0135		10:08	6	15	23	1.4	2.4	0.42	** d	0.34	0.050

Table 7 (continued). 2000 MA DEP Millers River Watershed instream physico/chemical data.

MILLERS RIVER (SARIS: 3522150)												
Station: MI03, Mile Point: 5.8 Unique ID: W0690												
Description: downstream/south of Bridge Street, Erving/Wendell.												
Date	OWMID	QAQC	Time	Alkalinity	Hardness	Chloride	TSS	Turbidity	TKN	NH3-N	NO3-NO2-N	TP
			(24hr)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
3/22/2000	SM-0015	Not applicable	09:59	3	11	18	1.4	1.0	0.18	<0.02	0.08	0.015
5/10/2000	SM-0048		10:05	5	16	17	2.7	1.8	0.37	<0.02	0.13	0.042
7/5/2000	SM-0081		10:57	6	18	24	1.7	2.8	0.28	<0.02	0.35	0.062
8/23/2000	SM-0128		10:30	9	21	24	1.1	2.0	0.44	** d	0.32d	0.043
11/8/2000	SM-0175		10:00	9	25	25	1.2	2.1	0.36	<0.02	0.48	0.062
PRIEST BROOK (SARIS: 3524150)												
Station: PR01, Mile Point: 4.2 Unique ID: W0693												
Description: approximately 10 meters downstream/south of River Street at USGS flow gauging station, Royalston												
Date	OWMID	QAQC	Time	Alkalinity	Hardness	Chloride	TSS	Turbidity	TKN	NH3-N	NO3-NO2-N	TP
			(24hr)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
3/22/2000	SM-0019	Not applicable	12:02	<2	5.3	7.0	<1.0	0.30	0.10	<0.02	<0.02	<0.005
5/10/2000	SM-0052		12:27	4	6.0	7.0	1.8	1.5	0.34	<0.02	<0.02	0.032
7/5/2000	SM-0085		13:06	4	6.6	10	2.4	1.4	0.41	<0.02	0.02	0.045
8/23/2000	SM-0132		12:15	<2	5.0	6.0	<1.0	0.80	0.49e	** de	<0.02d	0.025
11/8/2000	SM-0179		12:22	2	6.2	7.0	<1.0	0.63	0.30	<0.02	<0.02	0.018
OTTER RIVER (SARIS: 3523800)												
Station: OT05, Mile Point: 6.5 Unique ID: W0691												
Description: approximately 35 meters upstream/southeast of Turner Street, Templeton (approximately 30 feet upstream of USGS flow gauging station)												
Date	OWMID	QAQC	Time	Alkalinity	Hardness	Chloride	TSS	Turbidity	TKN	NH3-N	NO3-NO2-N	TP
			(24hr)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
3/22/2000	SM-0016	SM-0017	11:02	2	22	59	1.4	1.3	0.21	<0.02	0.44	0.062
3/22/2000	SM-0017	SM-0016	11:07	2	22	58	1.3	1.3	0.21	<0.02	0.46	0.061
5/10/2000	SM-0049	SM-0050	11:13	6	23	50	7.6	4.4	0.94	0.19	0.50	0.11
5/10/2000	SM-0050	SM-0049	11:18	7	22	53	6.5	4.1	0.85	0.21	0.53	0.11
7/5/2000	SM-0082	SM-0083	11:57	7	38	68	8.6	12	0.73	0.03d	3.1	0.17
7/5/2000	SM-0083	SM-0082	11:57	7	39	68	7.0	12	0.73	<0.02d	3.2	0.17
8/23/2000	SM-0129	SM-0130	11:10	7	33	57	6.0	8.6	0.70	** d	1.8 d	0.11
8/23/2000	SM-0130	SM-0129	11:10	8	33	56	5.7	8.5	0.69	** d	3.1 d	0.11
11/8/2000	SM-0176	SM-0177	11:17	5	32	54	2.4	5.1	0.71	<0.02	3.8	0.39
11/8/2000	SM-0177	SM-0176	11:22	6	32	53	2.9	5.1	0.65	<0.02	3.8	0.39
OTTER RIVER (SARIS: 3523800)												
Station: OT03, Mile Point: 3.6 Unique ID: W0686												
Description: upstream/east of Route 202 bridge, Templeton. (locality of Baldwinville, sampled from cement embankment at bridge)												
Date	OWMID	QAQC	Time	Alkalinity	Hardness	Chloride	TSS	Turbidity	TKN	NH3-N	NO3-NO2-N	TP
			(24hr)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
7/5/2000	SM-0092	SM-0093	13:02	10	39	64	8.0	10	0.67	<0.02	1.8	0.16
7/5/2000	SM-0093	SM-0092	13:07	10	39	64	7.5	9.9	0.81	<0.02	1.8	0.17
8/23/2000	SM-0139	SM-0140	12:27	13	51	64	12	7.3	0.64	** d	2.2	0.13
8/23/2000	SM-0140	SM-0139	12:32	13	51	64	11	7.4	0.64	** d	2.2	0.13

Table 7 (continued). 2000 MA DEP Millers River Watershed instream physico/chemical data.

BEAVER BROOK (SARIS: 3523600)												
Station: BB01, Mile Point: 2.5 Unique ID: W0685												
Description: from upstream/south side of Main Road bridge (south of Route 68), Phillipston.												
Date	OWMID	QAQC	Time (24hr)	Alkalinity (mg/L)	Hardness (mg/L)	Chloride (mg/L)	TSS (mg/L)	Turbidity (NTU)	TKN (mg/L)	NH3-N (mg/L)	NO3-NO2-N (mg/L)	TP (mg/L)
7/5/2000	SM-0091	Not applicable	12:28	6	15	40	2.7	3.3	0.68	<0.02	0.08	0.17
8/23/2000	SM-0138		11:55	3	12	31	1.6	2.0	0.61	** d	0.08	0.091

¹Unique ID = unique station identification number.

²OWMID= sample tracking number.

"**" = Censored or missing data.

"d" = precision of field duplicates (as RPD) did not meet project data quality objectives identified for program or in QAPP. Batched samples may also be affected.

"e" = not theoretically possible. Specifically, used for bacteria data where colonies per unit volume for e-coli bacteria > fecal coliform bacteria, for lake secchi and station depth data where a specific secchi depth is greater than the reported station depth, and for other incongruous or conflicting results.

Additional Note: Information related to bucket use locations in the Millers River Watershed is incomplete; therefore, no such data has been censored or qualified solely for this reason.

Table 8. 1996 and 1998 MA DEP Numeric Biocriteria Development Project: *in-situ* Hydrolab® data from the Worcester Monadnock Plateau sub-ecoregion. (Temp = temperature, Cond = conductivity, TDS = total dissolved solids, DO = dissolved oxygen, SAT = saturation, and Turb = turbidity).

OWMID ¹	Date	Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Cond (uS/cm)	TDS (mg/L)	DO (mg/L)	SAT (%)	Turb (NTU)
MORMON HOLLOW BROOK Station: WM09MOR, Mile Point: 1.7										
Description: Wendell, off the south side of Farley Road approximately 300 meters north (downstream) of the confluence of Baker Brook.										
BC-0019	09/27/96	10:24	**j	9.4	5.7	29	18.6	11.0	94	5i
BC-0072	09/21/98	13:19	**j	16.7	6.7	42	26.5	8.3	83	**U
KEYUP BROOK Station: WM13KEY, Mile Point: 1.8										
Description: Erving, just south (downstream) of Laurel Lake Road near the intersection of Swamp Road (Great Swamp Road).										
BC-0015	09/26/96	15:08	**j	10.3	4.6	23	14.9	10.4	93	6i
BC-0017	09/27/96	07:58	**j	8.8	4.9	23	14.5	11.3	95	7i
KEYUP BROOK Station: WM11KEY, Mile Point: 1										
Description: Erving, just south (downstream) of Swamp Road (Laurel Lake Road) near intersection of North Street.										
BC-0016	09/26/96	17:10	**j	12.4	6.0	33	21.2	9.7	91	6i
WHETSTONE BROOK Station: WM04WHE, Mile Point: 0.7										
Description: Wendell, approximately 50 meters north (downstream) of Kentfield Road (Kempfield Road) crossing.										
BC-0018	09/27/96	08:58	**j	9.3	5.8	18	11.3	11.3	97	7i
BC-0073	09/21/98	15:02	**j	17.1	6.7	18	11.8	9.5	97	7i
WEST BRANCH TULLY RIVER Station: WM15WBT, Mile Point: 6.2										
Description: Orange, approximately 150 meters west (upstream) of Flagg Road.										
BC-0023	10/02/96	09:08	**j	11.9	6.5	36	23.0	9.9	90	6i
EAST BRANCH TULLY RIVER Station: WM16EBT, Mile Point: 0.3										
Description: Orange/Athol border approximately 100 meters east (upstream) of Tully Road/Pinedale Avenue.										
BC-0042	10/18/96	12:11	**j	10.7	5.9	44	28.0	8.6	77	4i
LAWRENCE BROOK Station: WM19LAW, Mile Point: 0.7										
Description: Royalston, approximately 400 meters northeast (upstream) of the intersection of Doane Hill Road, Chestnut Avenue and Athol Road.										
BC-0041	10/18/96	10:03	**j	9.5	5.1	50	31.9	8.4	73	5i
BOYCE BROOK Station: WM17BOY, Mile Point: 1.7										
Description: Royalston, approximately 300 meters north (upstream) of Falls Road.										
BC-0024	10/02/96	11:18	**j	11.9	5.8	34	21.8	10.1	91	7i
OTTER RIVER Station: WM05OTT, Mile Point: 6.6										
Description: Templeton/Gardner border approximately 100 meters southeast (upstream) of Turner Street/Bridge Street.										
BC-0043	10/18/96	14:45	**j	10.8	6.0	152	97.0	9.4	85	14i

¹OWMID= field sample tracking number, ** = censored data, i = inaccurate readings from Hydrolab multiprobe likely, U = Unstable

Table 9. 1995 MA DEP Millers River Watershed *in-situ* Hydrolab® data. (Temp = temperature, TDS = total dissolved solids, DO = dissolved oxygen).

OWMID ¹	Date	Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Conductivity (uS/cm)	TDS (mg/L)	DO (mg/L)	Saturation (%)	Turbidity (NTU)
OTTER RIVER (SARIS: 3523800) Station: M01, Mile Point: 10.3 Unique ID: W0051										
Description: Route 2A bridge, Gardner										
35-0001	6/27/1995	3:01	**j	21.5	6.0	199	128	3.3	37	--
35-0011	6/27/1995	10:26	0.1i	21.0	6.1	227	145	3.1	35	--
35-0201	6/27/1995	21:55	0.1i	22.8	6.1	208	133	4.6	52	--
35-1011	6/28/1995	2:46	**j	20.6	6.1	192	123	4.3	47	9i
35-0111	6/28/1995	10:00	0.1i	19.2	6.1	235	151	4.1	43	--
35-0211	6/28/1995	20:51	0.1i	23.1	6.1	199	127	4.4	51	--
35-0021	6/29/1995	2:52	0.1i	20.8	6.1	188	121	4.0	44	13i
35-0121	6/29/1995	10:18	**j	19.5	6.0	212	136	4.0	43	--
35-0221	6/29/1995	20:38	**j	23.0	6.1	200	128	4.8	55	--
35-0300	7/25/1995	3:06	**j	25.0	6.0	185	119	3.5	42	8i
35-0310	7/25/1995	14:23	0.3	24.5	6.1	219	140	2.9	34	--
35-0320	7/25/1995	21:13	0.2	25.4	6.0	174	111	3.4	41	--
35-0330	7/26/1995	5:25	0.1i	24.7	6.1	177	114	3.0	36	12i
35-0340	7/26/1995	13:13	0.1i	26.0	6.0	171	109	3.1	38	--
35-0350	7/26/1995	20:41	0.1i	26.5	6.0	148	95.0	3.0	37	--
35-0360	7/27/1995	5:25	0.1i	25.0	6.0	184	118	2.5	30	9i
35-0367	7/27/1995	5:31	0.2	24.9	6.1	184	118	2.5	30	8i
35-0370	7/27/1995	13:33	0.3	26.7	6.0	200	128	2.9	36	--
35-0380	7/27/1995	19:30	0.3	27.3	6.0	193	123	2.6	33	--
35-0401	8/22/1995	5:02	**j	20.3	6.1	174	112	3.6	40	11i
35-0410	8/22/1995	13:01	**j	21.4	6.0	188	121	4.4	50	--
35-0420	8/22/1995	20:43	**j	21.9	6.1	193	124	4.8	55	--
35-0430	8/23/1995	4:50	0.1i	19.0	6.0	190	122	3.9	42	17i
35-0440	8/23/1995	13:08	0.1i	20.5	6.0	201	129	4.9	54	--
35-0450	8/23/1995	20:23	0.1i	21.1	6.0	217	139	4.7	53	--
35-0460	8/24/1995	4:45	**j	18.9	6.1	216	138	4.0	43	16i
35-0470	8/24/1995	12:57	**j	20.3	6.1	202	129	4.5	50	--
35-0480	8/24/1995	19:56	**j	21.3	6.1	196	125	4.9	55	--
OTTER RIVER (SARIS: 3523800) Station: M02, Mile Point: 9.4 Unique ID: W0050										
Description: Route 101 bridge, Gardner/Templeton border										
35-0002	6/27/1995	3:34	**j	20.3	6.1	351	224	4.3	47	--
35-0012	6/27/1995	10:51	0.1i	21.7	6.2	339	217	5.9	66	--
35-0203	6/27/1995	21:17	0.1i	21.2	6.3	386	247	5.4	59	--
35-0202	6/27/1995	21:20	0.1i	21.1	6.3	385	246	5.3	59	--
35-1012	6/28/1995	3:09	**j	18.7	6.3	360	231	5.0	53	14i
35-0112	6/28/1995	10:33	0.1i	20.2	6.2	347	222	6.1	66	--
35-0213	6/28/1995	20:26	**j	21.6	6.3	385	246	5.7	64	--
35-0212	6/28/1995	20:31	0.1i	21.7	6.3	388	248	5.5	62	--
35-0022	6/29/1995	3:14	**j	18.5	6.3	369	236	5.0	52	62i
35-0122	6/29/1995	10:37	**j	20.8	6.2	357	229	6.2	69	--
35-0223	6/29/1995	20:14	**j	22.1	6.3	390	249	6.0	68	--
35-0222	6/29/1995	20:18	**j	22.0	6.3	390	249	6.1	69	--
35-0301	7/25/1995	3:30	**j	23.9	6.3	339	217	4.6	54	13i
35-0311	7/25/1995	14:01	0.2	24.5	6.2	344	220	5.0	60	--
35-0321	7/25/1995	20:48	0.1i	24.8	6.2	359	230	4.6	55	--
35-0331	7/26/1995	5:08	**j	23.7	6.2	269	172	4.0	47	11i
35-0341	7/26/1995	12:57	0.1i	26.0	6.1	344	220	5.8	71	--
35-0351	7/26/1995	20:19	**j	25.3	6.3	315	201	4.7	57	--
35-0361	7/27/1995	5:05	**j	24.0	6.2	254	162	3.7	44	14i
35-0371	7/27/1995	13:15	0.2	27.2	6.4	369	236	5.6	71	--
35-0381	7/27/1995	19:15	0.2	26.9	6.2	358	229	4.9	62	--
35-0402	8/22/1995	4:43	**j	20.3	6.3	432	276	5.7	63	17i
35-0411	8/22/1995	12:45	**j	23.4	6.3	447	286	7.4	87	--
35-0421	8/22/1995	20:21	**j	22.2	6.5	462	296	6.5	75	--
35-0431	8/23/1995	4:30	**j	19.2	6.6	442	283	6.0	64	9i
35-0441	8/23/1995	12:51	0.1i	22.8	6.3	455	291	7.8	89	--
35-0451	8/23/1995	19:58	0.1i	21.8	6.4	477	305	6.8	77	--
35-0461	8/24/1995	4:27	**j	19.7	6.4	449	287	6.0	65	18i
35-0471	8/24/1995	12:39	**j	22.1	6.4	466	298	7.3	84	--
35-0481	8/24/1995	19:40	**j	21.4	6.4	482	309	6.9	78	--

Table 9 (continued). 1995 MA DEP Millers River Watershed *in-situ* Hydrolab® data.

OWMID ¹	Date	Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Conductivity (uS/cm)	TDS (mg/L)	DO (mg/L)	Saturation (%)	Turbidity (NTU)
OTTER RIVER (SARIS: 3523800) Station: M03, Mile Point: 6.4 Unique ID: W0048										
Description: Turner Street bridge, Templeton										
35-0003	6/27/1995	4:09	**j	20.7	6.5	300	192	7.2	80	--
35-0013	6/27/1995	11:18	0.1i	21.4	6.5	279	179	7.4	83	--
35-0204	6/27/1995	20:43	0.1i	21.1	6.5	327	209	7.5	83	--
35-1013	6/28/1995	3:34	**j	19.7	6.6	312	200	7.6	82	84i
35-0113	6/28/1995	10:59	0.1i	20.1	6.5	280	179	7.7	83	--
35-0214	6/28/1995	19:56	0.2	21.2	6.5	318	203	7.6	85	--
35-0023	6/29/1995	3:39	0.1i	19.1	6.6	316	203	7.9	84	14i
35-0123	6/29/1995	10:59	**j	20.0	6.5	292	187	7.9	86	--
35-0224	6/29/1995	19:50	**j	21.7	6.5	322	206	7.4	83	--
35-0302	7/25/1995	3:52	0.4	24.2	6.6	299	191	7.4	87	9i
35-0312	7/25/1995	13:33	0.5	24.4	6.6	294	188	7.2	86	--
35-0322	7/25/1995	20:22	0.5	24.6	6.5	317	203	6.7	80	--
35-0332	7/26/1995	4:45	0.4	23.7	6.5	297	190	7.4	87	9i
35-0342	7/26/1995	12:30	0.2	25.9	6.6	271	174	7.1	87	--
35-0352	7/26/1995	20:02	0.4	24.8	6.5	296	189	6.8	82	--
35-0362	7/27/1995	4:45	0.4	24.3	6.6	288	184	7.2	86	9i
35-0372	7/27/1995	12:39	0.6	26.3	6.6	258	165	6.2	77	--
35-0382	7/27/1995	18:58	0.4	26.5	6.6	294	188	6.1	75	--
35-0403	8/22/1995	4:20	0.3	19.2	6.6	332	213	8.1	88	17i
35-0412	8/22/1995	12:26	0.3	21.9	6.9	368	235	8.9	102	--
35-0422	8/22/1995	19:57	0.3	23.5	7.2	367	235	8.4	98	--
35-0432	8/23/1995	4:06	0.3	18.5	6.6	335	214	8.2	87	10i
35-0442	8/23/1995	12:32	0.4	20.9	6.8	370	237	8.9	99	--
35-0452	8/23/1995	19:33	0.4	22.9	7.1	375	240	8.7	100	--
35-0462	8/24/1995	4:06	0.2	18.4	6.7	345	221	8.1	86	14i
35-0472	8/24/1995	12:18	0.2	20.8	6.8	374	239	8.7	97	--
35-0482	8/24/1995	19:24	0.3	22.5	7.0	381	244	8.4	97	--
OTTER RIVER (SARIS: 3523800) Station: M04, Mile Point: 5.5 Unique ID: W0049										
Description: below dam at Seaman Paper Company, Templeton										
35-0004	6/27/1995	4:33	**j	19.5	6.8	259	166	7.7	83	--
35-0014	6/27/1995	11:48	0.1i	21.1	6.8	259	166	8.3	92	--
35-0205	6/27/1995	20:23	0.1i	22.0	6.8	249	159	7.9	89	--
35-1014	6/28/1995	3:57	**j	18.7	6.8	253	162	8.3	88	20i
35-0114	6/28/1995	11:16	0.1i	19.9	6.9	298	191	8.3	89	--
35-0215	6/28/1995	19:36	**j	21.9	6.9	265	170	7.6	86	--
35-0024	6/29/1995	4:00	0.1i	18.2	6.9	278	178	8.3	87	12i
35-0124	6/29/1995	11:17	**j	18.0	6.8	284	182	8.6	90	--
35-0225	6/29/1995	19:31	0.1i	23.6	7.0	284	182	7.9	92	--
35-0303	7/25/1995	4:09	0.1i	24.3	7.0	270	173	7.6	91	7i
35-0313	7/25/1995	13:06	0.1i	24.0	7.0	283	181	7.8	92	--
35-0323	7/25/1995	20:06	0.2	25.4	7.0	284	182	7.5	91	--
35-0333	7/26/1995	4:32	0.1i	23.4	6.9	273	175	7.8	91	15i
35-0343	7/26/1995	12:12	**j	25.3	6.9	287	184	7.7	94	--
35-0353	7/26/1995	19:47	0.1i	25.8	7.0	264	169	7.7	94	--
35-0363	7/27/1995	4:31	0.1i	23.5	6.9	264	169	7.7	90	14i
35-0373	7/27/1995	12:19	0.4	24.7	7.0	277	178	7.5	91	--
35-0383	7/27/1995	18:47	0.4	27.5	7.0	259	166	7.1	89	--
35-0404	8/22/1995	4:07	**j	20.6	7.0	319	204	8.0	90	6i
35-0413	8/22/1995	12:12	0.1i	20.7	7.0	326	209	8.7	97	--
35-0423	8/22/1995	19:42	0.1i	21.7	7.2	334	214	8.3	94	--
35-0433	8/23/1995	3:54	0.1i	19.3	7.0	314	201	8.3	90	15i
35-0443	8/23/1995	12:17	0.1i	20.4	7.1	320	205	8.8	97	--
35-0453	8/23/1995	19:18	0.2	20.5	7.1	331	212	8.1	89	--
35-0463	8/24/1995	3:47	**j	19.4	7.1	322	206	8.0	86	11i
35-0473	8/24/1995	12:03	**j	20.4	7.1	336	215	8.8	97	--
35-0483	8/24/1995	19:12	0.1i	20.8	7.1	337	216	7.6	85	--

Table 9 (continued). 1995 MA DEP Millers River Watershed *in-situ* Hydrolab® data.

OWMID ¹	Date	Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Conductivity (uS/cm)	TDS (mg/L)	DO (mg/L)	Saturation (%)	Turbidity (NTU)
OTTER RIVER (SARIS: 3523800) Station: M05, Mile Point: 4.0 Unique ID: W0046										
Description: below impoundment behind American Tissue Mills, Templeton										
35-0005	6/27/1995	4:57	**j	20.2	6.7	527	338	6.6	72	--
35-0015	6/27/1995	12:11	0.1i	21.8	6.8	464	297	7.8	87	--
35-0206	6/27/1995	19:45	0.1i	24.3	6.9	460	294	7.2	84	--
35-1015	6/28/1995	4:21	**j	18.1	6.8	475	304	6.6	68	20i
35-0115	6/28/1995	11:36	0.1i	19.1	6.8	451	288	7.9	84	--
35-0216	6/28/1995	19:21	**j	24.7	6.9	516	330	7.4	88	--
35-0025	6/29/1995	4:19	0.1i	18.2	6.8	499	319	6.6	69	20i
35-0125	6/29/1995	11:37	**j	18.9	6.8	463	297	7.9	84	--
35-0226	6/29/1995	19:11	**j	24.8	7.0	491	314	7.7	92	--
35-0304	7/25/1995	4:30	**j	24.1	7.0	700	448	5.3	63	6i
35-0314	7/25/1995	12:43	0.1i	24.5	6.9	549	351	6.7	80	--
35-0324	7/25/1995	19:50	0.2	26.7	7.1	551	353	7.6	94	--
35-0334	7/26/1995	4:16	**j	24.2	6.9	518	332	5.9	71	18i
35-0344	7/26/1995	11:56	**j	25.3	6.9	483	309	6.9	84	--
35-0354	7/26/1995	19:32	**j	26.4	7.0	503	322	6.7	83	--
35-0364	7/27/1995	4:05	0.1i	24.2	6.8	470	301	5.9	71	10i
35-0368	7/27/1995	4:12	0.1i	24.2	6.8	471	301	5.9	70	24i
35-0374	7/27/1995	12:04	0.3	25.6	6.9	455	291	6.9	84	--
35-0384	7/27/1995	18:35	0.4	29.4	7.1	479	307	7.3	95	--
35-0405	8/22/1995	3:49	**j	20.4	7.1	1,015	650	5.1	56	10i
35-0414	8/22/1995	11:55	**j	22.0	7.2	1,092	699	8.3	95	--
35-0424	8/22/1995	19:25	0.1i	24.3	7.7	810	518	8.6	103	--
35-0434	8/23/1995	3:36	**j	18.6	7.0	916	586	5.4	58	17i
35-0444	8/23/1995	12:01	0.1i	20.5	7.2	1,053	674	8.5	94	--
35-0454	8/23/1995	18:59	0.2	24.3	7.5	796	509	8.9	106	--
35-0464	8/24/1995	3:23	**j	18.8	7.1	853	546	5.9	63	15i
35-0467	8/24/1995	3:30	0.1i	18.8	7.1	855	547	6.2	66	19i
35-0474	8/24/1995	11:45	**j	21.0	7.2	836	535	8.3	93	--
35-0484	8/24/1995	18:58	0.1i	23.3	7.6	823	526	8.6	101	--
OTTER RIVER (SARIS: 3523800) Station: M06, Mile Point: 3.6 Unique ID: W0047										
Description: immediately downstream of Route 202 bridge, Templeton										
35-0006	6/27/1995	5:18	**j	20.2	7.1	640	410	7.0	77	--
35-0016	6/27/1995	13:04	0.3	23.0	7.2	579	370	8.1	93	--
35-0207	6/27/1995	19:15	0.1i	23.7	7.2	557	357	7.0	81	--
35-1016	6/28/1995	4:46	0.6	18.0	7.1	550	352	7.6	79	9i
35-0116	6/28/1995	11:57	0.1i	19.9	7.2	554	354	8.2	89	--
35-0217	6/28/1995	18:55	0.8	23.1	7.2	586	375	7.7	88	--
35-0026	6/29/1995	4:39	0.5	18.3	7.1	576	369	7.4	77	15i
35-0126	6/29/1995	11:54	0.1i	20.5	7.2	552	353	8.2	91	--
35-0227	6/29/1995	18:51	0.1i	23.6	7.1	569	364	6.9	81	--
35-0305	7/25/1995	4:45	0.8	23.8	7.1	706	452	5.7	68	18i
35-0315	7/25/1995	12:13	0.7	24.1	7.1	613	392	6.7	80	--
35-0325	7/25/1995	19:28	0.9	25.9	7.2	589	377	6.9	85	--
35-0335	7/26/1995	3:57	0.8	24.3	7.1	589	377	6.0	71	16i
35-0345	7/26/1995	11:38	0.7	25.3	7.2	535	343	7.9	96	--
35-0355	7/26/1995	19:15	0.8	26.2	7.1	569	364	5.9	73	--
35-0365	7/27/1995	3:49	0.8	24.3	7.0	519	332	5.9	71	8i
35-0375	7/27/1995	11:41	0.9	26.2	7.2	548	351	7.9	97	--
35-0385	7/27/1995	18:21	1.2	28.4	7.2	557	357	6.9	88	--
35-0406	8/22/1995	3:31	0.6	21.1	7.6	1,255	803	5.6	64	6i
35-0415	8/22/1995	11:40	0.7	22.3	7.8	1,408	901	8.9	103	--
35-0425	8/22/1995	19:03	0.7	22.7	7.8	1,235	790	7.5	87	--
35-0435	8/23/1995	3:20	0.7	19.6	7.6	1,238	792	6.1	66	13i
35-0445	8/23/1995	11:46	0.8	21.4	7.7	1,331	852	9.4	106	--
35-0455	8/23/1995	18:38	0.8	22.1	7.6	1,269	812	7.5	85	--
35-0465	8/24/1995	3:05	0.6	20.2	7.5	1,234	789	5.8	64	16i
35-0475	8/24/1995	11:27	0.7	21.4	7.7	1,220	781	8.9	101	--
35-0485	8/24/1995	18:45	0.8	21.9	7.6	1,281	820	6.5	74	--

Table 9 (continued). 1995 MA DEP Millers River Watershed *in-situ* Hydrolab® data.

OWMID ¹	Date	Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Conductivity (uS/cm)	TDS (mg/L)	DO (mg/L)	Saturation (%)	Turbidity (NTU)
OTTER RIVER (SARIS: 3523800) Station: M07, Mile Point: 0.2 Unique ID: W0045										
Description: abandoned railroad bridge, Winchendon										
35-0007	6/27/1995	5:45	**i	19.3	6.9	503	322	4.8	52	--
35-0017	6/27/1995	13:37	0.1i	23.6	7.0	482	309	7.2	83	--
35-0208	6/27/1995	18:28	0.1i	25.4	7.0	485	311	7.3	87	--
35-1017	6/28/1995	5:19	**i	17.6	6.9	440	282	5.2	53	20i
35-0117	6/28/1995	12:23	0.1i	19.9	6.9	416	266	7.0	75	--
35-0218	6/28/1995	18:26	0.1i	24.9	7.0	432	276	7.3	86	--
35-0027	6/29/1995	5:07	0.2	18.2	6.9	412	264	5.3	56	13i
35-0127	6/29/1995	12:19	**i	20.6	6.9	437	280	6.9	77	--
35-0228	6/29/1995	18:24	**i	25.3	7.0	444	284	7.9	95	--
35-0306	7/25/1995	5:16	0.2	24.5	6.8	453	290	5.2	62	9i
35-0316	7/25/1995	11:40	0.2	23.5	6.8	446	285	4.7	55	--
35-0326	7/25/1995	18:52	0.4	26.2	7.1	468	299	6.8	84	--
35-0336	7/26/1995	3:31	0.2	24.3	6.9	464	297	5.6	67	5i
35-0346	7/26/1995	11:16	0.1i	25.1	6.9	439	281	6.0	73	--
35-0356	7/26/1995	18:45	0.3	26.9	7.1	433	277	7.0	87	--
35-0366	7/27/1995	3:23	0.1i	23.6	6.8	377	242	4.9	57	18i
35-0376	7/27/1995	11:16	0.3	24.8	6.9	403	258	5.9	71	--
35-0386	7/27/1995	18:00	0.6	29.8	7.1	404	259	7.4	98	--
35-0407	8/22/1995	3:07	**i	22.4	7.2	633	405	6.3	72	7i
35-0416	8/22/1995	11:17	0.2	21.0	7.1	684	438	7.3	82	--
35-0426	8/22/1995	18:34	0.3	23.4	7.6	710	455	9.0	106	--
35-0436	8/23/1995	2:50	0.2	20.5	7.3	694	444	6.9	77	9i
35-0446	8/23/1995	11:21	0.3	19.5	7.3	789	505	7.7	83	--
35-0456	8/23/1995	18:11	0.3	21.8	7.7	912	584	9.8	110	--
35-0476	8/24/1995	**	0.1i	20.0	7.4	775	552	7.5	82	--
35-0466	8/24/1995	2:44	0.1i	20.4	7.5	863	496	7.2	80	14i
35-0486	8/24/1995	18:26	0.3	21.8	7.7	840	538	8.8	100	--
** = Censored or Missing Data, -- = No Data, M = Method Not Followed, U = Unstable, i = inaccurate readings from Hydrolab multiprobe likely *1 = > than cal. range (>718), *2 = > than cal. range (>1413), *3 = > than cal. range (>2760), *4 = > than cal. range (>6668), ? = Light interference, (1) = > than cal. range (>10), (2) = > than cal. range (>20), (3) = > than cal. range (>40)										

¹OWMID= field sample tracking number.

²Unique ID = unique station identification number.

Table 10. 1995 MA DEP Millers River Watershed instream physico/chemical data. (TSS = total suspended solids, TKN = total Kjeldahl nitrogen, NH3-N = ammonia-nitrogen, NO3-NO2-N = nitrate-nitrogen, and TP = total phosphorus).

OWMID ¹	QAQC	Date	Time (24hr)	Alkalinity (mg/L)	Hardness (mg/L)	Chloride (mg/L)	TSS (mg/L)	Total Solids	Turbidity (NTU)	TKN (mg/L)	NH3-N (mg/L)	NO3-NO2-N (mg/L)	TP (mg/L)
OTTER RIVER Station: M01 , Mile Point: 10.3				Unique ID ² : W0051		Description: Route 2A bridge, Gardner.							
35-0201		6/27/1995	21:55	11	23	46	8.0	168	13	0.68	0.11	0.07	0.07
35-0211	Not applicable	6/28/1995	20:51	12	21	44	6.5	82	10	0.71	0.06	0.03	0.07
35-0221		6/29/1995	20:38	10	21	44	8.5	144	9.5	0.59	0.06	0.06	0.05
35-0320	35-0327	7/25/1995	21:13	**	14	37	5.0	104	8.5	0.62	0.04	0.10	0.05
35-0327	35-0320	7/25/1995	21:13	14	**	37	7.0	58	8.5	0.68	0.04	0.10	0.05
35-0350	35-0357	7/26/1995	20:41	11	13	29	6.0	108	6.8	0.68	0.03	0.02	0.07
35-0357	35-0350	7/26/1995	20:41	11	13	30	7.0	98	6.4	0.58	<0.02	0.03	0.06
35-0380	35-0387	7/27/1995	19:30	12	14	42	6.0	116	7.0	0.62	0.09	0.06	0.07
35-0387	35-0380	7/27/1995	19:30	12	15	40	6.0	108	7.3	0.56	0.06	0.06	0.06
35-0420		8/22/1995	20:43	11	22	39	90j	--	7.4	0.53	<0.02	<0.02	0.09
35-0450	Not applicable	8/23/1995	20:23	10	25	47	6.0	--	8.6	0.49	0.02	<0.02	0.06
35-0480		8/24/1995	19:56	9.0	22	40	8.0	--	7.5	0.56	<0.02	0.02	<0.05
OTTER RIVER Station: M02 , Mile Point: 9.4				Unique ID: W0050		Description: Route 101 bridge, Gardner/Templeton border.							
35-0203	35-0202	6/27/1995	21:17	15	66	71	10	300	10	1.4	0.07	7.6	0.21
35-0202	35-0203	6/27/1995	21:20	17	65	70	8.5	280	10	1.3	0.07	7.8	0.23
35-0213	35-0212	6/28/1995	20:26	16	66	71	8.0	230	9.7	1.3	0.06	7.9	0.18
35-0212	35-0213	6/28/1995	20:31	18	67	69	8.5	260	9.5	1.2	0.06	8.0	0.20
35-0223		6/29/1995	20:14	--	--	--	--	--	--	--	--	--	--
35-0222		6/29/1995	20:18	14	69	70	12	276	9.8	1.2	0.06	8.5	0.18
35-0321	Not applicable	7/25/1995	20:48	**	31	64	7.0	176	9.3	1.2	0.05	7.8	0.15
35-0351		7/26/1995	20:19	14	28	55	7.0	204	6.9	1.1	0.03	6.8	0.14
35-0381		7/27/1995	19:15	13	34	61	5.0	250	6.8	1.3	0.06	8.2	0.18
35-0421	35-0427	8/22/1995	20:21	16	88	72	7.0	--	3.4	1.1	0.02	13	0.22
35-0427	35-0421	8/22/1995	20:21	17	88	60	7.0	--	3.5	1.2	0.02	13	0.22
35-0447	35-0451	8/23/1995	19:58	16	72	77	5.0	--	3.7	1.2	0.03	14	0.20
35-0451	35-0447	8/23/1995	19:58	15	90	76	6.0	--	3.7	1.2	0.04	15	0.24
35-0481	35-0487	8/24/1995	19:40	13	91	78	6.0	--	3.9	1.2	<0.02	15	0.22
35-0487	35-0481	8/24/1995	19:40	20	91	80	5.0	--	4.4	1.2	0.02	14	0.21
OTTER RIVER Station: M03 , Mile Point: 6.4				Unique ID: W0048		Description: Turner Street bridge, Templeton.							
35-0204		6/27/1995	20:43	12	57	66	11	240	12	1.2	0.09	5.9	0.19
35-0214		6/28/1995	19:56	12	53	56	12	180	15	1.2	0.06	5.5	0.23
35-0224		6/29/1995	19:50	16	61	57	11	244	12	1.0	0.07	5.8	0.22
35-0322		7/25/1995	20:22	**	31	54	8.0	174	11	1.0	0.08	7.0	0.14
35-0352	Not applicable	7/26/1995	20:02	13	27	53	9.0	194	9.8	0.90	0.03	5.5	0.14
35-0382		7/27/1995	18:58	14	25	50	10	192	9.6	1.0	0.05	5.2	0.16
35-0422		8/22/1995	19:57	14	67	58	105j	--	6.0	1.5	<0.02	8.2	0.25
35-0452		8/23/1995	19:33	15	62	61	17	--	5.1	1.3	0.02	8.9	0.19
35-0482		8/24/1995	19:24	23	70	61	18	--	4.7	1.3	<0.02	9.1	0.16

* = interference ** = missing/censored data -- = no data j = 'estimated' value

Table 10 (Continued). 1995 MA DEP Millers River Watershed instream physico/chemical data.

OWMID	QAQC	Date	Time (24hr)	Alkalinity (mg/L)	Hardness (mg/L)	Chloride (mg/L)	TSS (mg/L)	Total Solids	Turbidity (NTU)	TKN (mg/L)	NH3-N (mg/L)	NO3-NO2-N (mg/L)	TP (mg/L)
OTTER RIVER Station: M04 , Mile Point: 5.5 Unique ID: W0049 Description: below dam at Seaman Paper Company, Templeton.													
35-0205		6/27/1995	20:23	11	40	43	5.5	400	9.3	0.90	0.07	3.3	0.13
35-0215		6/28/1995	19:36	10	42	50	4.0	160	7.9	0.75	0.04	3.9	0.13
35-0225		6/29/1995	19:31	12	45	50	6.0	242	8.0	0.86	0.04	4.0	0.12
35-0323	Not applicable	7/25/1995	20:06	**	27	50	5.0	176	6.5	0.81	0.04	5.5	0.08
35-0353		7/26/1995	19:47	11	23	47	4.0	180	6.5	0.56	<0.02	4.2	0.12
35-0383		7/27/1995	18:47	13	24	44	<2.5	160	5.8	0.59	0.05	3.8	0.14
35-0423		8/22/1995	19:42	15	59	55	31	--	5.9	1.5	0.02	6.5	0.26
35-0453		8/23/1995	19:18	13	58	55	9.0	--	6.3	1.4	0.02	6.6	0.11
35-0483		8/24/1995	19:12	14	180	55	5.0	--	3.6	0.81	<0.02	6.6	0.06
OTTER RIVER Station: M05 , Mile Point: 4.0 Unique ID: W0046 Description: below impoundment behind American Tissue Mills, Templeton.													
35-0206		6/27/1995	19:45	13	88	78	8.0	280	10	0.95	0.07	3.2	0.15
35-0216		6/28/1995	19:21	18	101	84	6.0	350	8.3	1.0	0.08	3.8	0.15
35-0226		6/29/1995	19:11	18	97	75	9.0	310	8.6	2.9	1.4	4.0	0.08
35-0324	Not applicable	7/25/1995	19:50	**	46	95	7.0	284	9.3	1.0	0.06	4.2	0.13
35-0354		7/26/1995	19:32	19	44	86	7.0	310	7.9	0.83	<0.02	4.8	0.12
35-0384		7/27/1995	18:35	16	47	80	<2.5	284	5.9	0.99	0.11	2.8	0.10
35-0424		8/22/1995	19:25	30	181	100	14	--	3.1	1.2	0.03	4.4	0.11
35-0454		8/23/1995	18:59	28	173	115	6.0	--	3.1	1.3	0.04	4.6	0.08
35-0484		8/24/1995	18:58	28	175	126	7.0	--	2.6	1.5	0.02	4.6	0.13
OTTER RIVER Station: M06 , Mile Point: 3.6 Unique ID: W0047 Description: immediately downstream of Route 202 bridge, Templeton.													
35-0207		6/27/1995	19:15	32	112	80	8.5	330	10	1.5	0.22	2.8	0.30
35-0217		6/28/1995	18:55	41	119	81	5.5	240	10	1.5	0.06	4.0	0.39
35-0227		6/29/1995	18:51	31	88	79	5.0	380	9.8	2.9	0.85	4.5	0.41
35-0325	Not applicable	7/25/1995	19:28	**	52	90	7.0	324	7.7	1.3	0.07	3.8	0.22
35-0355		7/26/1995	19:15	39	52	90	9.0	328	9.2	1.2	0.04	3.2	0.40
35-0385		7/27/1995	18:21	36	55	84	4.0	334	6.1	1.2	0.07	1.8	0.30
35-0425		8/22/1995	19:03	146	340	125	2.5	--	2.0	2.6	0.04	2.3	0.33
35-0455		8/23/1995	18:38	163	248	125	3.0	--	1.6	2.3	0.04	1.6	0.30
35-0485		8/24/1995	18:45	154	245	135	8.0	--	1.8	2.4	0.03	1.9	0.30
OTTER RIVER Station: MA0100340 , Mile Point: 3.3 Unique ID: W0358 Description: Templeton WWTF (NPDES=MA0100340). Approximately 0.3 miles upstream of the Route 62/202 bridge.													
35-0500	Not applicable	5/22/1996	12:00	89	--	--	17	450	--	4.1	0.83	0.26	1.4
35-0510	applicable	5/29/1996	12:00	106	--	120	20	--	--	--	0.87	0.02	1.0
OTTER RIVER Station: M07 , Mile Point: 0.2 Unique ID: W0045 Description: abandoned RR bridge, Winchendon.													
35-0208		6/27/1995	18:28	25	96	84	7.0	290	8.9	1.4	0.28	1.8	0.19
35-0218		6/28/1995	18:26	24	81	64	8.5	180	8.2	1.0	0.09	1.8	0.18
35-0228		6/29/1995	18:24	22	88	65	7.5	280	7.4	1.0	0.10	2.3	0.20
35-0326	Not applicable	7/25/1995	18:52	**	45	75	6.0	262	5.8	0.92	0.09	2.5	0.13
35-0356		7/26/1995	18:45	27	39	71	10	248	8.4	0.78	<0.02	12	0.15
35-0386		7/27/1995	18:00	24	39	66	5.0	232	4.8	0.76	0.07	1.8	0.15
35-0426		8/22/1995	18:34	50	146	90	<2.5	--	2.5	1.2	0.05	1.9	1.1
35-0456		8/23/1995	18:11	99	185	98	3.0	--	3.3	1.5	0.04	0.80	0.09
35-0486		8/24/1995	18:26	96	167	90	4.0	--	2.8	1.3	0.03	0.84	0.09

¹OWMID= field sample tracking number.

²Unique ID = unique station identification number.

* = interference ** = missing/censored data -- = no data

Table 11. 1996 MA DEP Millers River Watershed fecal coliform bacteria data.

OWMID ¹	Date	Time (24hr)	Fecal Coliform (Colonies/100mL)
MILLERS RIVER Station: M104 , Mile Point: 33.5 Unique ID ² : W0359 Description: downstream of New Boston Road, Winchendon.			
35-0521	5/29/1996	13:50	200
OTTER RIVER Station: M01 , Mile Point: 10.3 Unique ID: W0051 Description: Route 2A bridge, Gardner.			
35-0503	5/22/1996	12:30	60
35-0513	5/29/1996	12:30	<20
OTTER RIVER Station: M02 , Mile Point: 9.4 Unique ID: W0050 Description: Route 101 bridge, Gardner/Templeton border.			
35-0504	5/22/1996	12:40	60
35-0514	5/29/1996	12:40	60
OTTER RIVER Station: M03 , Mile Point: 6.4 Unique ID: W0048 Description: Turner Street bridge, Templeton.			
35-0505	5/22/1996	12:50	80
35-0515	5/29/1996	12:50	120
OTTER RIVER Station: M04 , Mile Point: 5.5 Unique ID: W0049 Description: below dam at Seaman Paper Company, Templeton.			
35-0516	5/29/1996	13:00	40
OTTER RIVER Station: M05 , Mile Point: 4.0 Unique ID: W0046 Description: below impoundment behind American Tissue Mills, Templeton.			
35-0506	5/22/1996	13:00	140
35-0517	5/29/1996	13:10	1,100
OTTER RIVER Station: M06 , Mile Point: 3.6 Unique ID: W0047 Description: immediately downstream of Route 202 bridge, Templeton.			
35-0507	5/22/1996	13:10	50
35-0518	5/29/1996	13:20	1,000
OTTER RIVER Station: M07 , Mile Point: 0.2 Unique ID: W0045 Description: abandoned RR bridge, Winchendon.			
35-0519	5/29/1996	13:30	140
PRIEST BROOK Station: M105 , Mile Point: 0.7 Unique ID: W0360 Description: downstream of Goodnow Road, Winchendon.			
35-0520	5/29/1996	13:40	<20

¹OWMID= field sample tracking number.²Unique ID = unique station identification number.Table 12. 1998/1999 MA DEP Connecticut River Nutrient Loading Project instream physico/chemical data (All units in mg/L unless otherwise noted.) (Excerpted from the *Connecticut River Basin 1998 Water Quality Assessment Report* (MA DEP 2000b).

OWMID ¹	Date	Time (24hr)	Chloride	Total Suspended Solids	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
MILLERS RIVER Station: CT05, Mile Point: 1.7, Unique ID ² : W0477 Description: off the upstream/east side of the Route 63 bridge, Erving/Montague. Center stream bucket drop.								
34-0005	06/30/98	11:30	--	--	--	<0.02	0.20	0.06
34-0013	07/28/98	13:30	--	1.0	--	<0.02	0.21	0.04
34-0022	08/26/98	11:35	--	0.4	--	<0.02	0.53	0.04
34-0030	09/23/98	11:21	--	2.4	--	0.04	0.83	0.07
34-0038	10/20/98	11:35	25	**	0.35	<0.02	0.31	0.06
34-0046	11/17/98	11:45	31	1.8	0.28	<0.02	0.59	0.06
34-0054	12/14/98	11:25	24	1.7	0.32	0.03	0.55	0.06
34-0062	01/11/99	12:25	66	1.8	0.56	0.15	0.42	0.05
34-0070	02/09/99	11:30	22	2.0	0.27	0.02	0.18	0.03
34-0078	03/10/99	12:15	21	2.3	0.27	<0.02	0.15	0.03
34-0086	03/23/99	12:20	13	4.0	0.20	<0.02	0.10	0.03
34-0094	04/06/99	11:30	20	1.1	0.17	<0.02	0.13	0.25
34-0102	04/21/99	11:30	24	1.7	0.81	<0.02	0.18	0.03
34-0110	05/12/99	11:40	28	3.3	0.34	<0.02	0.34	0.06

¹OWMID= field sample tracking number, ²Unique ID = unique station identification number.

** = missing/censored data -- = no data Note: These samples were collected via a bucket.

Fish Population Surveys

Results of the fish population surveys conducted in the Millers River Watershed in 1996, 1998, and 2000 can be found in Table 13. A site-by-site review of the fish community sampling is provided below.

Otter River, Gardner/Templeton (FP0012, Numeric Biocriteria Project station WM05OTT)

The Otter River was sampled in 1996 at a location upstream of the USGS gaging and Turner Road, Templeton/Gardner. The fish sample was dominated by fallfish (*Semotilus corporalis*, n=29). Other species present were white sucker (*Catostomus commersoni*, n=9), pumpkinseed (*Lepomis gibbosus*, n=2), and one each of brook trout (*Salvelinus fontinalis*), yellow perch (*Perca flavescens*), and longnose dace (*Rhinichthys cataractae*).

Overall numbers of fish were low. The dominance by fallfish and the presence of only two individual fish that are considered intolerant (one of which may have been stocked) supports the observations noted in the habitat assessment conducted at the time of sampling. Habitat problems included channelization, sedimentation, and riparian impacts. It is unclear whether the brook trout collected was a "stocked fish", however, the presence of four "fluvial" dependant species indicates that water quality and flow at this site continue to support a stream fish fauna. The relative absence of intolerant fishes and the impaired habitat threaten the fish community present at this location.

Boyce Brook, Royalston (FP0005 and FP0006, Numeric Biocriteria Project stations WM17BOY and WM17BOY-R, respectively)

Boyce Brook was sampled at a location approximately 125 meters upstream from Falls Road in Royalston. Habitat in this segment during the 2000 survey was primarily riffle and run. Pools and undercut banks were scarce and the predominant cover for fish was comprised of instream boulders and rocks. The reach was well shaded. Habitat assessment conducted in 1996 also noted a lack of instream cover for fish due to low streamflow.

The fish sample was comprised of multiple age classes of brook trout (n=29). This reach was previously sampled in 1996 as part of the DWM Numeric Biocriteria Project at which time fourteen brook trout were collected. A replicate of this station (WM17BOY-R, FP0006), just upstream from the primary reach, yielded 21 brook trout in 1996. The presence of multiple age classes of brook trout is indicative of excellent water quality, however, it appears that natural low flow conditions may limit the numbers of trout present. It is unclear whether barriers such as waterfalls or dams limit the ability of other species to migrate into this reach from downstream areas following low flow years.

Lawrence Brook, Royalston (FP0011, Numeric Biocriteria Project station WM19LAW)

Lawrence Brook was sampled at a location approximately 800 feet upstream of Chestnut Hill Avenue/Athol Road, Royalston. The bottom substrates at this location were primarily bedrock and boulder and the instream habitat was considered optimal. The 14 fish sample was comprised of five white sucker, five chain pickerel (*Esox niger*), three brown bullhead (*Ameiurus nebulosus*) and one largemouth bass (*Micropterus salmoides*). The fish community was comprised primarily of macrohabitat generalists and one tolerant fluvial dependant species. The numbers of fish were very low and atypical of the good habitat quality. It is unclear what is limiting the fish community in this stream reach, however, there are large areas of riparian wetlands located upstream from this site and a large section of waterfalls and gorge located just downstream. Fish migration from downstream areas is impossible and the presence of slow moving wetland habitat located upstream is most likely responsible for the fish community at this location.

East Branch Tully River, Athol (FP0009, Numeric Biocriteria Project station WM16EBT)

The East Branch Tully River was sampled approximately 80 feet upstream of Tully Road/Pinedale Avenue Orange/Athol. Diversity was very high with a total of ten species were represented in the sample. The 37 fish sample included eleven longnose dace, eight tessellated darter (*Etheostoma olmstedi*), five brown trout (*Salmo trutta*), five fallfish, two white sucker, two blacknose dace (*Rhinichthys atratulus*), and one each of chain pickerel, common shiner (*Luxilus cornutus*), yellow bullhead (*Ameiurus natalis*), and brook trout. It was noted that four of the eleven longnose dace had tumors. In addition, two brown trout were noted as having deformed pectoral fins, however, these types of deformities are common with hatchery-reared fish like brook trout. Although this community was comprised primarily of fluvial species,

the overall numbers were very low. The presence of three intolerant species suggests excellent water quality.

West Branch Tully River, Orange (FP0010, Numeric Biocriteria Project station WM15WBT)

The West Branch Tully River was sampled upstream of Flagg Road, Orange. It was noted that the water was slightly tea stained and there was a substantial accumulation of organic debris in this segment. The stream reach was comprised primarily of boulder substrates with lesser amounts of cobble and gravel. Some pool areas were present although depth was limited in the riffles and runs and the channel flow status was marginal.

The fish population at this location (sampling conducted on 2 October 1996) was comprised of 14 fish of six species including, in order of abundance: blacknose dace (*Rhinichthys atratulus*), brown trout (*Salmo trutta*), brown bullhead (*Ameiurus nebulosus*) and longnose dace (*Rhinichthys cataractae*), an individual chain pickerel (*Esox niger*) and an individual white sucker (*Catostomus commersoni*). Four of these species were fluvial specialists/dependants and two were intolerant (one of which (brown trout) was likely stocked.). It should be noted that the fish numbers were very low, however, it is unclear whether this was due to potential impairment or a combination of slightly colored water and/or leaf fall obscuring visibility and, therefore, affecting electroshocking collection efficiency.

Whetstone Brook, Wendell (FP0004, Numeric Biocriteria Project station WM04WHE)

Whetstone Brook was sampled at a location downstream from the first (northernmost) bridge on Kempfield Road in Wendell (Kentfield Road on USGS quad). This location was sampled in 1996, 1998, (as part of the DWM Numeric Biocriteria Project) and again in 2000. The segment contained a mix of low gradient (60%) pool and run habitat and higher gradient (40%) riffle/ pool/ run habitat. Fish habitat was rated within the optimal category, but was clearly much better within the higher gradient section. The lower gradient section was somewhat lacking in stream cover for fish. Water was clear but slightly colored. The reach was well shaded by trees. Sediment was noted at all road culverts and results in sub-optimal ratings for the sediment deposition, embeddedness, and epifaunal substrate parameters on habitat assessment forms in both 1996 and 2000.

The fish population in Whetstone Brook (station WM04WHE) was comprised of multiple age classes of brook trout (*Salvelinus fontinalis*) and an individual brown trout (*Salmo trutta*) in 1996 and 2000 and only *S. fontinalis* in 1998 (sampling conducted on 27 September 1996, 21 September 1998, and 21 September 2000) (Table 13). The total number of fish sampled in 1996 was 10, 1998 was 15, and 2000 was 16.

The absence of fish species other than trout may be due to natural barriers to migration from downstream sections and the Millers River. The presence of multiple age classes of brook trout (and brown trout) is indicative of excellent water and habitat quality, however, the lack of instream cover for fish, sedimentation, and acid impacts may be limiting numbers of trout within this reach. Whetstone Brook was the location of an experimental liming project conducted as part of the U.S. Fish and Wildlife Service's Acid Precipitation Mitigation Program (Simmons *et al.* 1996). This program has been discontinued.

Keyup Brook, Erving (FP0007, Numeric Biocriteria Project station WM13KEY)

Keyup Brook was sampled approximately 100 feet downstream of Laurel Lake Road (east of Swamp Road), Erving. The reach was comprised of pool, riffle, and run habitat of a moderate gradient although instream cover was somewhat limited by the marginal channel flow status.

The fish sample was comprised of thirty brook trout. The presence of large numbers of brook trout, an intolerant, fluvial specialist, is indicative of excellent water quality and a stable flow regime. It is unclear why blacknose dace, longnose dace, and white sucker fall out of the assemblage at this location, but, it is most likely due to stream gradient at the bridge located between this station and WM13KEYa described below.

Keyup Brook, Erving (FP0001, Numeric Biocriteria Project station WM13KEYa)

Keyup Brook was sampled upstream of the confluence with Jacks Brook and downstream of the first Laurel Lake Road crossing in Erving. The reach was comprised of pool, riffle, and run habitat of a moderate gradient with excellent cover in the form of boulders and some undercut banks. There was a

house and barn located very close to the streams southern bank. A large area of erosion upstream from the reach (next to the driveway on the southern bank/right hand side looking upstream) seriously compromised the habitat integrity of the sampled section and downstream reaches. This area constituted a high risk for significant additional erosion and subsequent sedimentation. This information was conveyed verbally to EOEAs Millers River Watershed Team Leader at the time of the survey in an effort to facilitate follow-up action/mitigation. It was also noted that the riparian zone on the southern side of the stream was stabilized with tires and cement slabs at locations adjacent to the house and barn, respectively. This stabilization effort appeared to be a number of years old and relatively effective in preventing erosion.

Blacknose dace dominated the fish sample (n=79). Brook trout (n=25) and brown trout (n=26) were also fairly abundant with individuals from a number of different age classes represented. White sucker, were also present (n=10).

The presence of multiple age classes of brook and brown trout (including young of the year) is indicative of excellent habitat and water quality. All fish collected are examples of fluvial specialists or fluvial dependant species, which suggests that the flow regime has not been compromised at this location. Continued long-term stabilization of the southern stream bank in the vicinity of the house and barn is essential to maintaining the habitat quality within this and downstream reaches. Stabilization of the southern bank of the stream near the driveway would help to improve habitat quality.

Keyup Brook, Erving (FP0008, Numeric Biocriteria Project station WM11KEY)

Keyup Brook was sampled approximately 75 feet south of Swamp Road (east of North Road), Erving. Water was tea-stained at this location. The reach sampled was comprised primarily of stable instream cover and epifaunal substrates and was most limited by embeddedness and sediment deposition as well as velocity/depth combinations and a marginal channel flow status (MA DEP 1996a).

The fish sample was dominated by blacknose dace (n=48) but also included longnose dace (n=8), brown trout (n=6), white sucker (n=3), and brook trout (n=1). Although the presence of the small impoundment and wetland immediately upstream may be limiting the number of salmonids at this location, all fish collected are examples of fluvial specialists or fluvial dependant species, which suggests that streamflow is adequate at this location.

Mormon Hollow Brook, Wendell (FP0003, Numeric Biocriteria Project station WM09MOR)

Mormon Hollow Brook was sampled off Farley Road downstream from the confluence of Baker Brook. This segment contained a diverse mix of pool, riffle, and run/glide habitat containing excellent fish cover in the form of snags, undercut banks, and boulders. Water was clear but highly colored. The reach was well shaded by trees.

The 2000 fish sample was comprised of multiple age classes of brook trout (n=35). This reach was previously sampled in both 1998 and 1996 as part of the DWM Numeric Biocriteria Project. In 1998, forty-four brook trout, one pumpkinseed and one brown trout were collected. In 1996, twenty-five brook trout were collected. The presence of numerous size/age classes of brook trout indicates excellent water quality. Stream gradient may be limiting fish species distribution in Mormon Hollow Brook.

Lyons Brook, Montague/Wendell (FP0002, LB01)

Lyons Brook was sampled just upstream from its confluence with the Millers River in Montague/Wendell. Habitat was primarily comprised of shallow and deep riffles. There was a scarcity of both pools and instream cover for fish within the sampled reach. Sparse amounts of trash and debris were found in the brook downstream from the landfill (see Appendix C of this report).

A total of 54 fish were collected, despite the sub-optimal fish habitat. The dominance of longnose dace (n=22) and the presence of multiple age classes of brook trout (n=14) indicate excellent water quality. White sucker (n=9) and fallfish (n=9) were also collected. All fish collected are examples of fluvial specialists or fluvial dependant species, which suggests that the flow regime has not been seriously compromised at this location. Continued sedimentation of upstream areas could eventually impact habitat quality both upstream and downstream of the gorge.

Table 13. Fish population sampling data collected by MA DEP biologists in 1996, 1998, and 2000 in the Millers River Watershed at the Numeric Biocriteria Development Project sites.

Station Description	Collection Date	Species Code ¹														Comments	
		LMB	BB	YP	P	YB	CS	TD	CP	BND	LND	FF	WS	EBT	BT		
WM05OTT FP0012 Otter River , upstream of Bridge Street/Turner Street, Gardner/Templeton	18 Oct. 1996			1	2							1	29	9	1		Two backpack electrofishing units were used to sample this reach. Units were run side by side to cover entire stream width.
WM17BOY FP0005 Boyce Brook , upstream of Falls Road, Royalston	2 Oct. 1996														14		Brook trout looked healthy.
	21 Sept. 2000														29(9) ²		EBT less than 80 mm counted as young of the year
replicate WM17BOY-R FP0006 Boyce Brook	2 Oct. 1996														21		This was a 100 meter reach starting at the upstream edge of the primary reach. All fish looked healthy.
WM19LAW FP0011 Lawrence Brook , upstream of Doane's Falls, Royalston	18 Oct. 1996	1	3							5				5			Two backpack electrofishing units were used to sample this reach. Units were run side by side to cover entire stream width.
WM16EBT FP0009 East Branch Tully River , upstream from Tully Road/ Pinedale Avenue, Orange/Athol	18 Oct. 1996					1	1	8	1	2	11	5	2	1	5		Sampled reach using two backpack electrofishing units to cover entire stream width.
WM15WBT FP0010 West Branch Tully River , upstream of Flagg Road, Orange	2 Oct. 1996		2							1	5	2		1		3	Substantial accumulation of organic debris on stream bottom. Leaves were beginning to fall from trees - slightly obstructing visibility.
WM04WHE FP0004 Whetstone Brook , adjacent to Kempfield Road, Wendell	27 Sept. 1996														9	1	All fish looked healthy.
	21 Sept. 1998														15		No comments.
	21 Sept. 2000														15(7) ²	1	EBT less than or equal to 80 mm counted as young of the year.
WM13KEYa FP0001 Keyup Brook , upstream from confluence with Jacks Brook and downstream from the first Laurel Lake Road crossing in Erving, MA	19 Sept. 2000											79		10	25(11) ²	26(11) ₂	BT and EBT less than or equal to 75 mm counted as young of the year
WM13KEY FP0007 Keyup Brook , downstream of Swamp Road, Erving	26 Sept. 1996														30		All fish looked healthy.
WM11KEY FP0008 Keyup Brook , adjacent to North Street, Erving	26 Sept. 1996										48	8		3	1	6	No comments.

Table 13 (Continued). Fish population sampling data collected by MA DEP biologists in 1996, 1998, and 2000 in the Millers River Watershed at the Numeric Biocriteria Development Project sites.

Station Description	Collection Date	Species Code ¹														Comments
		LMB	BB	YP	P	YB	CS	TD	CP	BND	LND	FF	WS	EBT	BT	
WM09MOR FP0003 Mormon Hollow Brook , adjacent to Farley Road, Wendell	27 Sept. 1996													24		All fish appeared healthy.
	21 Sept. 1998				1									44(12) ²	1	No comments.
	21 Sept. 2000													35(15) ²		EBT less than or equal to 80 mm counted as young of the year
LB01* FP0002 Lyons Brook , upstream from its confluence with the Millers River in Montague/Wendell.	19 Sept. 2000										22	9(3) ²	9(4) ²	14(3) ²		EBT less than 85 mm and WS less than 65 mm counted as young of the year (YOY). FF less than 40 mm counted as YOY.

<u>¹Species Code</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>¹Species Code</u>	<u>Common Name</u>	<u>Scientific Name</u>
BND	blacknose dace	<i>Rhinichthys atratulus</i>	LMB	largemouth bass	<i>Micropterus salmoides</i>
BB	brown bullhead	<i>Ameiurus nebulosus</i>	LND	longnose dace	<i>Rhinichthys cataractae</i>
BT	brown trout	<i>Salmo trutta</i>	P	pumpkinseed	<i>Lepomis gibbosus</i>
CP	chain pickerel	<i>Esox niger</i>	TD	tessellated darter	<i>Etheostoma olmstedi</i>
CS	common shiner	<i>Luxilus cornutus</i>	WS	white sucker	<i>Catostomus commersoni</i>
EBT	brook trout	<i>Salvelinus fontinalis</i>	YB	yellow bullhead	<i>Ameiurus natalis</i>
FF	fallfish	<i>Semotilus corporalis</i>	YP	yellow perch	<i>Perca flavescens</i>

² number in parentheses indicate young-of-the-year

* stream sampled as part of 2000 Millers River Watershed survey not as part of the Numeric Biocriteria Development Project.

Fish Contaminant Monitoring

The results of MA DEP 1995/1996 Millers River Watershed fish contaminant monitoring surveys (Figure 3) are described below for each sampling event (MA DEP 1995b, 1996b). Data for these surveys are presented in Table 14.

Lake Rohunta, Athol/Orange/New Salem (F0003)

Samples of largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), chain pickerel (*Esox niger*), and yellow bullhead (*Ameiurus natalis*) were collected in July 1995 from the middle and northern basins of Lake Rohunta in Athol/Orange/New Salem. While only two of the three basins in Lake Rohunta were sampled, the lack of a fish barrier between all basins allows the results to be interpreted as representative of the entire lake. Mercury in the fish tissue from Lake Rohunta ranged from 0.379 to 0.856 mg/kg wet weight (Table 14). The mercury data triggered a site-specific advisory against the consumption of fish from Lake Rohunta (*"Children younger than 12 years, pregnant women, and nursing mothers should not eat fish from this water body." "The general public should limit consumption of all fish from this water body to two meals per month."* MDPH 1996). Selenium levels ranged from 0.081 to 0.129 mg/kg wet weight. PCB arochlors and congeners, pesticides, cadmium, arsenic, and lead were not detected in the edible fillets of all samples analyzed from Lake Rohunta (Table 14).

Lake Dennison, Winchendon (F0002)

Samples of largemouth bass (*Micropterus salmoides*), white perch (*Morone americana*), white sucker (*Castomus commersoni*), and bluegill (*Lepomis macrochirus*) were collected from Lake Dennison in Winchendon in August 1995. Mercury in the fish tissue from Lake Dennison ranged from 0.275 to 0.610 mg/kg wet weight (Table 14). The mercury value (0.610 mg/kg wet weight) from sample LDF95-9 (comprised of an individual largemouth bass) slightly exceeded the MDPH fish consumption advisory trigger level. No advisory was issued based on an individual sample, therefore, MDPH requested additional data from the waterbody. Selenium levels ranged from 0.081 to 0.306 mg/kg wet weight. PCB arochlors and congeners were below detection levels in all but one sample. Aroclor 1254 was detected at 0.25 µg/g in a composite sample of white perch. Pesticides, cadmium, arsenic, and lead were not detected in edible fillets analyzed from Lake Dennison.

Additional samples of largemouth bass (*Micropterus salmoides*), as well as yellow bullhead (*Ameiurus natalis*), and brown bullhead (*Ameiurus nebulosus*) were collected from Lake Dennison in Winchendon in June 1996. Mercury in the fish tissue from Lake Dennison ranged from 0.366 to 0.966 mg/kg wet weight (Table 14). The mercury data triggered a site-specific advisory against the consumption of fish from Lake Dennison in Winchendon (*"Children younger than 12 years, pregnant women, and nursing mothers should not eat any largemouth bass from this water body" "The general public should limit consumption of largemouth bass from this water body to two meals per month."* MDPH 1996). Selenium levels ranged from 0.144 to 0.190 mg/kg wet weight. PCB arochlors and congeners, pesticides, cadmium, arsenic, and lead were not detected in the edible fillets analyzed from Lake Dennison.

The results (Table 15) of MA DEP 2000 Millers River Watershed fish contaminant monitoring surveys described below are excerpted from *2000 Fish Toxics Monitoring Public Request and Year 2 Watershed Surveys* (Maietta and Colonna-Romano 2000).

Otter River: The Otter River was sampled just upstream from the railroad crossing near the confluence with the Millers River in Winchendon. The river meanders slowly through a large wetland at this location. It is relatively shallow and very turbid. The immediate watershed and riparian zone is undeveloped, however, the sampling location is at the lowermost portion of a relatively large watershed (60.4 sq mi.). The river receives a number of point and non-point source discharges, as well as stormwater. Historic fish toxics monitoring has revealed elevated PCBs and mercury in Otter River fishes.

Mercury was below the MDPH trigger level in all five samples of white suckers. This is not surprising in light of the white suckers trophic guild (bottom feeding omnivore). Cadmium, lead, and arsenic were below MDLs in all samples analyzed and selenium concentrations are consistent with those found in waterbodies throughout the Commonwealth.

PCB Arochlors and congeners were detected in all five samples of white suckers from the Otter River. PCB Arochlors exceeded the MDPH trigger level for PCBs (1.0 mg/kg) in four of the five samples analyzed. While the concentrations of PCBs in samples of white sucker analyzed in 2000 (range= 0.88-2.83 mg/kg) are quite a bit lower than those found in a composite sample analyzed in 1988 (7.3 mg/kg), this site still contained the highest PCBs concentrations of the four Millers River and Otter River sites sampled in 2000 just as it did in 1988. Fish analyzed during the two surveys were comparable in size/age.

Mixtures of PCB congeners were detected in each sample analyzed (See general Discussion on Page 7). Organochlorine pesticides were below MDLs in all five samples analyzed from the Otter River.

Millers River (Athol): The Millers River (Athol) was sampled just above the dam upstream from Route 32 (West Royalston Road) in Athol. Habitat consists of an impoundment with rocky shoreline and bottom.

Mercury was below the MDPH trigger level in all five samples of white sucker. This is not surprising in light of the white suckers trophic guild (bottom feeding omnivore). Cadmium, lead, and arsenic were below MDLs in all samples analyzed and selenium concentrations are consistent with those found in waterbodies throughout the Commonwealth.

PCB Arochlor 1242 was detected in one of five samples analyzed. The concentration of Arochlor 1242 (0.30 mg/kg) was well below the MDPH trigger level for PCBs (1.0 mg/kg). The concentrations of PCB Arochlors found in 2000 were much lower than those found in 1987 (1.81 mg/kg). Fish sampled in 1987 were a little smaller than those sampled in 2000.

Mixtures of PCB toxic congeners were detected in each sample analyzed (See general Discussion on Page 7). Organochlorine pesticides were below MDLs in all samples analyzed from the Millers River in Athol.

Millers River (Orange): The Millers River (Orange) was sampled upstream from the dam located at Route 122 (Main Street) in Orange. The river here is a long slow-moving meander with streamside cover and soft sediments. Riparian habitat is primarily forested with a moderate amount of contiguous wetlands.

Mercury concentrations in white suckers ranged from 0.23 mg/kg to 0.60 mg/kg with four of the five samples exceeding the MDPH "trigger level" of 0.50 mg/kg. Although elevated mercury in white suckers is rare, sucker samples collected and analyzed in 1987 were found to contain slightly elevated concentrations of mercury as well (0.27–0.70 mg/kg). The presence of streamside wetlands at this station may be enhancing methylization and bioaccumulation of mercury. The existing advisory appears to be stringent enough to preclude the need for an advisory update. The following fish consumption advisory is currently in effect for the Millers River.

"Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this water body."

"The general public should not consume any brown trout or American eel from this water body."

"The general public should limit consumption of all other fishes from this water body to two meals per month." (MDPH 2001).

Cadmium, lead, and arsenic were below MDLs in all samples analyzed and selenium concentrations are consistent with those found in waterbodies throughout the Commonwealth (See general Discussion, Page 6 and 7). PCB Arochlors 1242 and 1254 were detected in one of five samples analyzed. In this sample, the concentration of total PCB (Arochlors 1242 and 1254 (1.06 mg/kg)) exceeded the MDPH trigger level for PCBs (1.0 mg/kg). The concentration of PCB Arochlors found in 2000 were lower than that found in 1987 (1.98 mg/kg). Fish sampled in 1987 were a little larger than those sampled in 2000.

Mixtures of PCB toxic congeners were detected in each sample analyzed (See general Discussion on Page 7). Organochlorine pesticides were below MDLs in all samples analyzed from the Millers River in Orange.

Millers River (Erving): The Millers River (Erving) was sampled at the pool under the railroad trestle at Farley Flats in Erving. This location is a large deep pool located within a free flowing section of the Millers River. Streamside habitat is primarily forested and substrates are primarily boulders, rocks, and gravel. There are a number of wastewater discharges located within the watershed.

Mercury was below the MDPH trigger level of 0.5 mg/kg in all five samples. Cadmium, lead, and arsenic were below MDLs in all samples analyzed and selenium concentrations are consistent with those found in waterbodies throughout the Commonwealth. Selenium does not appear to be of concern (See general Discussion, Page 6).

PCB Arochlors were detected in two of the five samples analyzed. Arochlors 1242 and 1254 were detected in one sample (Mrf00-18) resulting in a total PCB concentration of 0.81 mg/kg. This is just below the MDPH trigger level for PCBs (1.0 mg/kg). PCB Arochlor 1242 was also detected in Mrf00-20. Concentrations found in Mrf00-20 (0.35 mg/kg) were well below the MDPH trigger level of 1.0 mg/kg. The concentrations of PCB Arochlors found in 2000 were lower than those found in a ten fish composite of suckers (Mrf87-116-125) sampled in 1987 (1.60 mg/kg). Fish sampled in 1987 were of similar size/age to those sampled in 2000.

Mixtures of PCB toxic congeners were detected in each sample analyzed (See general Discussion on Page 7). Organochlorine pesticides were below MDLs in all samples analyzed from the Millers River in Erving.

Table 14. 1995/1996 MA DEP Millers River Watershed fish contaminant monitoring data. Analytical Results for Public Request and Year 2 Watershed Surveys. Results, reported in wet weight, are from individual or composite samples of fish fillets with skin off.

Sample ID	Collection Date	Species Code ¹	Length (cm)	Weight (g)	Sample ID (laboratory sample #)	Cd (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	As (mg/kg)	Se (mg/kg)	% Lipids (%)	PCB Arochlors and Congeners ² (µg/g)	Pesticides ² (µg/g)
1995 Lake Rohunta, Athol/Orange/New Salem (F0003)													
LRF95-1	7/13/95	LMB	31.8	440	95024 (95-2752)	<0.20	<1.00	0.788	<0.040	0.120	0.080	ND	ND
LRF95-2	7/13/95	LMB	34.0	650									
LRF95-3	7/13/95	LMB	35.0	700									
LRF95-4	7/13/95	B	21.9	240	95025 (95-2753)	<0.20	<1.00	0.599	<0.040	0.129	0.13	ND	ND
LRF95-5	7/13/95	B	20.2	210									
LRF95-6	7/13/95	B	20.5	210									
LRF95-7	7/13/95	YP	23.0	160	95026 (95-2754)	<0.20	<1.00	0.856	<0.040	0.118	0.098	ND	ND
LRF95-8	7/13/95	YP	25.8	200									
LRF95-9	7/13/95	YP	24.9	200									
LRF95-10	7/13/95	BC	24.1	220	95027 (95-2755)	<0.20	<1.00	0.379	<0.040	0.103	0.014	ND	ND
LRF95-11	7/13/95	BC	23.1	200									
LRF95-12	7/13/95	BC	22.0	160									
LRF95-13	7/13/95	CP	38.5	340	95028 (95-2756)	<0.20	<1.00	0.759	<0.040	0.094	0.031	ND	ND
LRF95-14	7/13/95	CP	34.2	260									
LRF95-15	7/13/95	CP	35.1	260									
LRF95-16	7/13/95	YB	27.6	300	95029 (95-2757)	<0.20	<1.00	0.486	<0.040	0.081	0.047	ND	ND
1995 Lake Dennison, Winchendon (F0002)													
LDF95-1	8/1/95	WS	35.2	380	95039 (95-2830)	<0.20	<1.00	0.275	<0.040	0.237	0.28	ND	ND
LDF95-2	8/1/95	WS	32.0	340									
LDF95-3	8/1/95	WS	30.8	280									
LDF95-4	8/1/95	WP	20.5	100	95040 (95-2831)	<0.20	<1.00	0.432	<0.040	0.306	0.13	PCB A1254 0.25	ND
LDF95-5	8/1/95	WP	20.6	100									
LDF95-6	8/1/95	WP	20.6	100									
LDF95-7	8/1/95	B	18.7	110	95041 (95-2832)	<0.20	<1.00	0.411	<0.040	0.158	0.19	ND	ND
LDF95-8	8/1/95	B	16.8	80									
LDF95-9	8/22/95	LMB	NR	NR	95042 (95-3300)	<0.20	<1.00	0.610	<0.040	0.103	0.043	ND	ND

Table 14 (continued). 1995/1996 MA DEP Millers River Watershed fish contaminant monitoring data. Analytical Results for Public Request and Year 2 Watershed Surveys. Results, reported in wet weight, are from individual or composite samples of fish fillets with skin off.

Sample ID	Collection Date	Species Code ¹	Length (cm)	Weight (g)	Sample ID (laboratory sample #)	Cd (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	As (mg/kg)	Se (mg/kg)	% Lipids (%)	PCB Arochlors and Congeners ² (µg/g)	Pesticides ² (µg/g)
1996 Lake Dennison, Winchendon (F0002)													
LDF96-01	6/11/96	LMB	30.9	490	96013 (96-1031)	<0.20	<1.0	0.488	<0.040	0.190	0.17	ND	ND
LDF96-02	6/11/96	LMB	31.8	510									
LDF96-03	6/11/96	LMB	31.7	480									
LDF96-04	6/11/96	LMB	40.6	1020	96014 (96-1032)	<0.20	<1.0	0.966	<0.040	0.166	0.11	ND	ND
LDF96-05	6/11/96	LMB	43.1	1230									
LDF96-06	6/11/96	YB	28.5	350	96015 (96-1030)	<0.20	<1.0	0.366	<0.040	0.144	0.13	ND	ND
LDF96-07	6/11/96	BB	27.2	290									
LDF96-08	6/11/96	YB	23.9	200									

¹ Species
 bluegill (B) *Lepomis macrochirus*
 black crappie (BC) *Pomoxis nigromaculatus*
 brown bullhead (BB) *Ameiurus nebulosus*
 chain pickerel (CP) *Esox niger*
 largemouth bass (LMB) *Micropterus salmoides*
 white perch (WP) *Morone americana*
 white sucker (WS) *Castomus commersoni*
 yellow bullhead (YB) *Ameiurus natalis*
 yellow perch (YP) *Perca flavescens*

² Analytes included in the analysis for Pesticides and PCBs are listed in Appendix 3 Table A7 along with methods and detection limits.

ND = Not Detected
NR = Not Recorded

Table 15. 2000 MA DEP Millers River Watershed fish contaminant monitoring data excerpted from *2000 Fish Toxics Monitoring Public Request and Year 2 Watershed Surveys* (Maietta and Colonna-Romano 2000). Results, reported in wet weight, are from individual fish fillets with skin off.

Sample ID	Collection Date	Species Code ¹	Length (cm)	Weight (g)	Sample ID (laboratory sample #)	Cd (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	As (mg/kg)	Se (mg/kg)	% Lipids (%)	PCB Arochlors and Congeners ² (µg/g)	Pesticides ² (µg/g)
Otter River, Winchendon, Millers R. Watershed (F0109)													
MRF00-6	8/25/00	WS	37.9	480	2000041 (L2000378-1 metals) (L2000375-1 organics)	<0.02	<0.20	0.37	<0.04	0.17	1.2	A1242-1.6 A1254-0.71 BZ#81-0.0470 BZ#77-0.1200 BZ#118-0.0660 BZ#114-0.0030 BZ#105-0.0230 BZ#156-0.0036 BZ#180-0.0087 BZ#170-0.0029	ND
MRF00-7	8/25/00	WS	39.4	610	2000042 (L2000378-2 metals) (L2000375-2 organics)	<0.02	<0.20	0.26	<0.04	0.15	0.68	A1242-0.88 BZ#81-0.0200 BZ#77-0.0470 BZ#118-0.0250 BZ#105-0.0095 BZ#180-0.0041	ND
MRF00-8	8/31/00	WS	38.5	560	2000043 (L2000378-3 metals) (L2000375-3 organics)	<0.02	<0.20	0.40	<0.04	0.21	1.2	A1242-1.20 A1254-0.43 BZ#81-0.0270 BZ#77-0.0780 BZ#118-0.0420 BZ#114-0.0038 BZ#105-0.0170 BZ#156-0.0025 BZ#180-0.0057	ND
MRF00-09	8/31/00	WS	37.4	530	2000044 (L2000378-4 metals) (L2000375-4 organics)	<0.02	<0.20	0.20	<0.04	0.25	1.2	A1242-1.10 A1254-0.55 BZ#81-0.0330 BZ#77-0.0980 BZ#118-0.0510 BZ#105-0.0190 BZ#156-0.0029 BZ#180-0.0070 BZ#170-0.0024	ND
MRF00-10	8/31/00	WS	38.1	540	2000045 (L2000378-5 metals) (L2000375-5 organics)	<0.02	<0.20	0.25	<0.04	0.21	1.2	A1242-1.70 A1254-0.96 A1260-0.17 BZ#81-0.0630 BZ#77-0.1500 BZ#118-0.0900 BZ#114-0.0041 BZ#105-0.0340 BZ#156-0.0053 BZ#180-0.0110 BZ#170-0.0043	ND

Table 15 (continued). 2000 MA DEP DWM Millers River Watershed fish contaminant monitoring data excerpted from *2000 Fish Toxics Monitoring Public Request and Year 2 Watershed Surveys* (Maietta and Colonna-Romano 2000). Results, reported in wet weight, are from individual fish fillets with skin off.

Sample ID	Collection Date	Species Code ¹	Length (cm)	Weight (g)	Sample ID (laboratory sample #)	Cd (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	As (mg/kg)	Se (mg/kg)	% Lipids (%)	PCB Arochlors and Congeners ² (µg/g)	Pesticides ² (µg/g)
Millers River, Athol, Millers River Watershed (F0110)													
MRF00-11	8/25/00	WS	40.5	780	2000046 (L2000346-1 metals) (L2000353-1 organics)	<0.04	<0.40	0.37	<0.04	0.14	0.68	BZ#81-0.0073 BZ#77-0.0140 BZ#118-0.0120 BZ#105-0.0057 BZ#180-0.0022	ND
MRF00-12	8/25/00	WS	40.9	760	2000047 (L2000346-2 metals) (L2000353-2 organics)	<0.04	<0.40	0.23	<0.04	0.24	0.54	BZ#81-0.0110 BZ#77-0.0250 BZ#118-0.0170 BZ#180-0.0030	ND
MRF00-13	8/25/00	WS	35.0	520	2000048 (L2000346-3 metals) (L2000353-3 organics)	<0.04	<0.40	0.36	<0.04	0.11	0.56	BZ#81-0.0100 BZ#77-0.0240 BZ#118-0.0180 BZ#180-0.0039	ND
MRF00-14	8/25/00	WS	34.9	420	2000049 (L2000346-4 metals) (L2000353-4 organics)	<0.04	<0.40	0.25	<0.04	0.20	0.49	BZ#81-0.0094 BZ#77-0.0190 BZ#118-0.0140 BZ#180-0.0029	ND
MRF00-15	8/25/00	WS	33.5	400	2000050 (L2000346-5 metals) (L2000353-5 organics)	<0.04	<0.40	0.32	<0.04	0.15	0.69	A1242-0.30 BZ#81-0.0120 BZ#77-0.0290 BZ#118-0.0190 BZ#180-0.0034	ND
Millers River, Orange, Millers River Watershed (F0111)													
MRF00-01	8/22/00	WS	39.5	620	2000036 (L2000349-1 metals) (L2000356-1 organics)	<0.02	<0.20	0.56	<0.04	0.22	0.47	BZ#81-0.0120 BZ#77-0.0280 BZ#118-0.0180 BZ#180-0.0035	ND
MRF00-02	8/22/00	WS	40.0	630	2000037 (L2000349-2 metals) (L2000356-2 organics)	<0.02	<0.20	0.59	<0.04	0.24	0.63	BZ#81-0.0230 BZ#77-0.0610 BZ#118-0.0460 BZ#105-0.0100 BZ#180-0.0090 BZ#170-0.0040	ND
MRF00-03	8/22/00	WS	38.9	600	2000038 (L2000349-3 metals) (L2000356-3 organics)	<0.02	<0.20	0.60	<0.04	0.27	0.62	BZ#81-0.0059 BZ#77-0.0140 BZ#118-0.0087 BZ#180-0.0022	ND
MRF00-04	8/22/00	WS	36.3	530	2000039 (L2000349-4 metals) (L2000356-4 organics)	<0.02	<0.20	0.23	<0.04	0.22	0.69	BZ#81-0.0027 BZ#77-0.0038	ND

Table 15 (continued). 2000 MA DEP DWM Millers River Watershed fish contaminant monitoring data excerpted from 2000 *Fish Toxics Monitoring Public Request and Year 2 Watershed Surveys* (Maietta and Colonna-Romano 2000). Results, reported in wet weight, are from individual fish fillets with skin off.

Sample ID	Collection Date	Species Code ¹	Length (cm)	Weight (g)	Sample ID (laboratory sample #)	Cd (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	As (mg/kg)	Se (mg/kg)	% Lipids (%)	PCB Arochlors and Congeners ² (µg/g)	Pesticides ² (µg/g)
Millers River, Orange, Millers River Watershed (F0111) – continued from previous page													
MRF00-05	8/22/00	WS	38.9	580	2000040 (L2000349-5 metals) (L2000356-5 organics)	<0.02	<0.20	0.57	<0.04	0.18	0.86	A1242-0.53 A1254-0.53 BZ#81-0.0320 BZ#77-0.0920 BZ#118-0.0570 BZ#114-0.0028 BZ#105-0.0100 BZ#156-0.0040 BZ#180-0.0085 BZ#170-0.0035	ND
Millers River, Erving, Millers River Watershed (F0112)													
MRF00-16	8/31/00	WS	34.5	510	2000055 (L2000379-1 metals) (L2000376-1 organics)	<0.02	<0.20	0.12	<0.04	0.20	1.2	BZ#81-0.0074 BZ#77-0.0140 BZ#118-0.0086 BZ#105-0.0083J*	ND
MRF00-17	8/31/00	WS	39.0	700	2000056 (L2000379-2 metals) (L2000376-2 organics)	<0.02	<0.20	0.18	<0.04	0.21	2.3	BZ#81-0.0090 BZ#77-0.0220 BZ#118-0.0130 BZ#180-0.0024J	ND
MRF00-18	8/31/00	WS	44.0	1100	2000057 (L2000379-3 metals) (L2000376-3 organics)	<0.02	<0.20	0.33	<0.04	0.20	1.8	A1242-0.43 A1254-0.38 BZ#81-0.0230 BZ#77-0.0700 BZ#118-0.0400 BZ#105-0.0270 BZ#156-0.0029 BZ#180-0.0063J BZ#170-0.0026J	ND
MFR00-19	8/31/00	WS	38.6	730	2000058 (L2000379-4 metals) (L2000376-4 organics)	<0.02	<0.20	0.14	<0.04	0.29	1.3	BZ#81-0.0081 BZ#77-0.0200 BZ#118-0.0110 BZ#105-0.0068 BZ#180-0.0022J	ND
MRF00-20	8/31/00	WS	38.7	780	2000059 (L2000379-5 metals) (L2000376-5 organics)	<0.02	<0.20	0.20	<0.04	0.16	3.0	A1242-0.35 BZ#81-0.0130 BZ#77-0.0350 BZ#118-0.0210 BZ#105-0.0087 BZ#180-0.0036J	ND
¹ Species: (WS) white sucker <i>Catostomus commersoni</i> ² Analytes included in the analysis for Pesticides and PCBs are listed in Appendix 3 Table A6 along with methods and detection limits. ND - not detected at or above the established method detection limit (MDL). J – estimated value (*co-elution with contaminant peak)													

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Table A1. 2000 Field Blank Results (Sample replicate (split) data shown in data tables)

Field Blank Sample
 Station: BLANK
 Description: QAQC: Field Blank Sample

Date	OWMID	QAQC	Time (24hr)	Alkalinity (mg/L)	Hardness (mg/L)	Chloride (mg/L)	SSolids (mg/L)	Turb (NTU)	TKN (mg/L)	NH3-N (mg/L)	NO3-NO2-N (mg/L)	TPhos (mg/L)
3/22/2000	SM-0021	BLANK	**	<2	<0.66	<1.0	<1.0	<0.1	<0.10	<0.02	<0.02	<0.005
5/10/2000	SM-0054	BLANK	13:05	<2	<0.66	<1.0	<1.0	<0.1	<0.10	<0.02	<0.02	<0.010
7/05/2000	SM-0094	BLANK	13:12	<2	<0.66	<2.0	<1.0	<0.1	<0.10	<0.02	<0.02	<0.010
7/05/2000	SM-0087	BLANK	13:45	<2	<0.66	<2.0	<1.0	<0.1	<0.10	<0.02	<0.02	<0.010
8/23/2000	SM-0141	BLANK	12:37	<2	<0.66	<2.0	<1.0	<0.1	<0.10	** d	<0.02	<0.010
8/23/2000	SM-0134	BLANK	13:00	<2	<0.66	<2.0	<1.0	<0.1	<0.10	** d	<0.02d	<0.010
11/08/2000	SM-0181	BLANK	12:58	<2	<0.66	<1.0	<1.0	<0.1	<0.10	<0.02	<0.02	<0.010

" ** " = Censored or missing data (i.e., data that should have been reported)

" d " = precision of field duplicates (as RPD) did not meet project data quality objectives identified for program. Batched samples may also be affected.

Table A2. 2000 Hydrolab Data: Censoring and Qualification Decisions.

Table excerpted from the *DATA VALIDATION REPORT for Year 2000 Project Data* (MA DEP 2003; CN 83.0). See report for more detail.

Censored and qualified data for the 2000 Hydrolab® records are shown below for non-logged data only (due to the quantity of decisions and to avoid duplication, all Hydrolab® data decisions are not shown in this table).

Watershed	Survey Date(s)	OWMID #s	Censored/ Qualified Hydrolab Parameters	Censored/ Qualified	Reason and/or Clarification
Hydrolab Data---- Exceptions and data decisions for non-logged data (only):					
Deerfield, Millers and Buzzards Bay lakes (6)	Rounds 1 and 2 for 2002 MA Division of Fisheries and Wildlife (DFW) surveys (12 lake surveys)	LB-1022 LB-1018 LB-1006 LB-1010 LB-1033 LB-1040 LB-1049 LB-1053 LB-1073 LB-1080 LB-1065 LB-1061	All Hydrolab data	Censor (m)	No acceptable documentation for Hydrolab pre-calibration or post-calibration
Deerfield, Millers and Buzzards Bay lakes	Round 3 (DFW lake surveys)	LB-1091 LB-1095	T, pH, D.O., Cond., depth	Accept last line of data at each depth	No linearity check performed for Cond.; took bottom readings at max. depth level; pre- and post-cal checks performed and OK.
		LB-1107 LB-1103 LB-1103 LB-1107	T, pH, D.O., Cond., depth D.O. D.O. and Spec. Cond.	Accept last line of data at each depth, except for: Qualify (u) @ 0.0 and 2.0m Qualify (u) @ 1.0m for DO and @2.0m for Spec. Cond.	No linearity check performed for Cond.; pre-cal check showed slightly high Cond. for both LI and DI solutions (poss. from poor rinsing); post-cal check performed OK Unstable readings Unstable readings
		LB-1116 LB-1123 LB-1116 LB-1123	T, pH, D.O., Cond., depth D.O. D.O.	Accept last line of data at each depth, except for: Qualify (u) @ 1.5m for DO Qualify (u) @ 2.0m for DO	No linearity check performed for Cond.; pre-cal and post-cal checks performed OK (except for postcal DI pH low compared to pre-cal) Unstable readings Unstable readings
Long Pond	7/11/2000	LB-0606, 0880	T, pH, D.O., Cond., depth	Qualify (m) last line of data at each depth (except for DO/ DOsat at 0.5m for LB-0880 (see below).	No electronic record (data logger malfunction); manual record used.
		LB-0880	DO and DOsat	Censor (u) at 0.5m depth	Unstable readings, such that data are unusable.
		LB-0606	TEMP, DO and DOsat DO and DOsat TEMP	Qualify (u) at 0.5m depth Qualify (u) at 1.5m depth Qualify (u) at 1.8m depth	Unstable readings Unstable readings Unstable readings

Table A3. 2000 Sample Data: Censoring and Qualification Decisions. Table excerpted from the *DATA VALIDATION REPORT for Year 2000 Project Data* (MA DEP 2003; CN 83.0). See report for more detail.

Watershed/ water body	Sample Date	OWMID #s	Analyte	Censored/ Qualified	Reason
Millers -Stoddard and Whitney Ponds	9/13/2000	LB-1097, 1098, 1099, 1100, 1101, 1104, 1105	TP	<i>Qualify (b)</i>	Ambient (equipment) field blank >> MDL for survey; survey crew samples qualified.
Millers- Whitney Pond	9/13/2000	LB-1100; 1097, 1098, 1099, 1101, 1104 and 1105	App. Color	<i>Qualify (b)</i>	Ambient (equipment) field blank >> MDL for survey; survey crew/batch samples qualified.
Millers- Whitney Pond	9/13/2000	LB-1101	App. Color	<i>Qualify (m)</i>	Sample not diluted properly
Millers- Whitney Pond	9/13/2000	LB-1099	App. Color	<i>Qualify (d)</i>	RPD for duplicates 23%; insufficient reason to qualify batched samples
Millers- Stoddard Pond	7/18/2000	LB-1019, LB-1020	App. Color	<i>Qualify (m)</i>	Samples diluted unnecessarily
Millers- Stoddard Pond	9/13/2000	LB-1106	Chl a	<i>Qualify (h)</i>	Holding time violation
Millers- Whitney Pond	7/18/2000	LB-1013, 1014	ALK	accept	Slight exceedance of DQO for RPD precision due to low number effect; insufficient evidence to censor or qualify
Millers- Whitney Pond	8/17/2000	LB-1055, 1056	ALK	accept	Slight exceedance of DQO for RPD precision due to low number effect; insufficient evidence to censor or qualify
Millers Year 2	8/23/2000	SM-0135, 136, 137, 138, 139, 140 and 141	NH3	<i>Censor (d)</i>	DQO for RPD duplicate (split) precision exceeded. Associated survey data for NH3 also censored due to lab sample mix-up (see text).
Millers Year 2	8/23/2000	SM-0137	TKN	<i>Qualify (e)</i>	Potential accuracy problem (< NH3 result).
Millers Year 2	8/23/2000	SM-0137	NH3	<i>Censor (e)</i>	In addition to being already censored above, potential accuracy problem (> TKN result).
Millers CERO/SMART	8/23/2000	SM-0128, 129, 130, 131, 132, 133 and 134	NH3	<i>Censor (d)</i>	DQO for RPD duplicate (split) precision exceeded. Associated survey data for NH3 also censored due to lab sample mix-up (see text).
Millers CERO/SMART	8/23/2000	SM-0129 and 130	NO3-NO2	<i>Censor (d)</i>	Very poor split precision for RPD dups (this crew).
Millers CERO/SMART	8/23/2000	SM-0128, 131, 132, 133 and 134	NO3-NO2	<i>Qualify (d)</i>	Associated survey data qualified for NO3-NO2 due to exceedance of DQO for RPD duplicate (split) precision (splits censored for crew samples, but other crew sample precision for NO3-NO2 OK).
Millers CERO/SMART	8/23/2000	SM-0132	TKN	<i>Qualify (e)</i>	Potential accuracy problem (< NH3 result).
Millers CERO/SMART	8/23/2000	SM-0132	NH3	<i>Censor (e)</i>	In addition to being already censored above for NH3, potential accuracy problem (> TKN result).
Millers CERO/SMART	7/5/2000	SM-0082, 0083	TSS	accept	Slight exceedance of DQO for RPD precision due to low number effect; insufficient evidence to censor or qualify
Millers- CERO/SMART	7/5/2000	SM-0082, 0083	NH3	<i>Qualify (d)</i>	RPD > DQO for split precision
Millers- CERO/SMART	7/5/2000	SM-0082, 0083	TSS	accept	Slight exceedance of DQO for RPD precision; insufficient evidence to censor or qualify
Millers- CERO/SMART	11/1/2000	IMBL01	Chronic Microtox-LOEC	<i>Qualify(j)</i>	WES-estimated data, based on unstable pH
Millers- CERO/SMART	8/23/2000	SM0132T	Chronic Microtox-LOEC and NOEC	<i>Qualify(j)</i>	WES-estimated data, based on poor lab duplicate precision
Millers- CERO/SMART	8/23/2000	SM0133 and 0134	Chronic Microtox-LOEC	<i>Qualify(j)</i>	WES-estimated data, based on exceedance of 36 hour holding time

Table A4. 1998-99 Field Blank Data for the Connecticut River Nutrient Loading Project
 (All units expressed in mg/L unless otherwise specified.) Excerpted from the *Connecticut River Basin
 1998 Water Quality Assessment Report* (MA DEP 2000b).

OWMID	QA/QC	Date	Time (24hr)	Chloride	Suspended Solids	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
Field Blank Sample									
34-0008	BLANK	06/30/98	12:00	--	--	--	<0.02	<0.02	<0.01
34-0016	BLANK	07/28/98	14:00	--	<1.0	--	<0.02	<0.02	<0.01
34-0025	BLANK	08/26/98	12:05	--	<1.0	--	<0.02	<0.02	<0.01
34-0033	BLANK	09/23/98	11:43	--	<1.0	--	<0.02	<0.02	0.01
34-0041	BLANK	10/20/98	11:58	<1.0	<1.0	<0.10	<0.02	<0.02	<0.01
34-0049	BLANK	11/17/98	12:10	<1.0	<1.0	<0.10	<0.02	<0.02	<0.01
34-0057	BLANK	12/14/98	11:45	<2.0	<0.5	<0.10	<0.02	<0.02	<0.01
34-0065	BLANK	01/11/99	12:50	<2.0	<0.5	<0.10	<0.02	0.02	0.01
34-0073	BLANK	02/09/99	11:55	<1.0	<1.0	<0.10	<0.02	<0.02	<0.01
34-0081	BLANK	03/10/99	12:35	<2.0	<1.0	<0.10	<0.02	<0.02	<0.01
34-0089	BLANK	03/23/99	12:45	<1.0	<0.5	<0.10	<0.02	<0.02	<0.01
34-0097	BLANK	04/06/99	11:55	<1.0	<1.0	<0.10	<0.02	<0.02	<0.01
34-0105	BLANK	04/21/99	11:55	<1.0	<1.0	<0.10	<0.02	<0.02	<0.01
34-0113	BLANK	05/12/99	12:00	<1.0	<1.0	<0.10	<0.02	<0.02	<0.01

Table A5. 1995/96 Data Decisions and Discussion

35-0320-327:	No field blank had been collected for the 7/25/95 sampling survey and the replicate sample failed to meet the stated quality objective of 20% RPD. Therefore, censor the Alkalinity results.
35-0503-507 35-0513-521:	No field blank or field replicate had been collected during the 5/22/96 and 5/29/96 Fecal Coliform sampling surveys (see condition "a").
35-0420-427 35-0380-387 35-0350-357 35-0201-208 35-0211-218:	No field blank had been collected for the following Millers River Watershed survey: 8/22/95, 7/27/95, 7/26/95, 7/25/95, 6/27/95 and 6/28/95 (see condition "a").
35-0320/327:	These total suspended solids replicate samples fell outside of the stated quality objective of 20% RPD. No problems or aberrant trends were noted on the chain of custody or the OWM field sheet. There was not enough evidence to censor these replicate results.
35-0320/327 83-0008/009:	These total solids replicate samples fell outside of the stated quality objective of 20% RPD. No problems or aberrant trends were noted on the chain of custody or the OWM field sheet. There was not enough evidence to censor these replicate results.
35-0380/387 35-0350/357:	Most of these ammonia replicate concentrations were reported close to the established laboratory MDL (see condition "d"). No problems or aberrant trends were noted on the chain of custody or the OWM field sheet. There was not enough evidence to censor these replicate results.
35-0350/357:	These replicate samples fell outside of the stated quality objective of 30% RPD. No problems or aberrant trends were noted on the chain of custody or the OWM field sheet. There was not enough evidence to censor these replicate results.

NOTE: Chemistry & Suspended Solid results for 1995 Millers Watershed at the M05, M06 & M07 Otter River stations in August 1995 are considerably higher in concentration compared to associated station data. The following data is being confirmed by WES :

8/22/1995	35-0424 35-0425 35-0426 35-0420 35-0422 35-0423	Chemistry, Total Suspended Solids Chemistry Chemistry, Total Suspended Solids Total Suspended Solids Total Suspended Solids Total Suspended Solids
8/23/1995	35-0454 35-0455 35-0456	Chemistry, Total Suspended Solids Chemistry, Total Suspended Solids Chemistry, Total Suspended Solids
8/24/1995	35-0484 35-0485 35-0486 35-0483	Chemistry, Total Suspended Solids Chemistry, Total Suspended Solids Chemistry, Total Suspended Solids Hardness

WES confirmed results on 2/18/00. No calculation or transcription errors were found. No problems or aberrant trends were noted on the chain of custody or the OWM field sheet. There is not enough evidence to censor these aberrant results.

Appendix B
Millers 2000 Data Symbols and Qualifiers

The following data qualifiers or symbols are used in the MADEP/DWM WQD database for qualified and censored water quality and hydrolab data. Decisions regarding censoring vs. Qualification for specific, problematic data are made based on a thorough review of all pertinent information related to the data, including the magnitude or extent of the problem(s).

General Symbols (Applicable To All Types):

“ ** ” = censored or missing data (i.e., data that should have been reported)

“ -- ” = no data (i.e., data not taken/not required)

“ <mdl ” = less than method detection limit (mdl). Denotes a sample result that went undetected using a specific analytical method. The actual, numeric mdl is typically specified (eg. <0.2).

Hydrolab-Specific Qualifiers:

“ i ” = Inaccurate readings from hydrolab multiprobe likely; may be due to significant pre-survey calibration problems, post-survey calibration readings outside typical acceptance range for the low ionic check and for the deionized blank water check, lack of calibration of the depth sensor prior to use, or to checks against laboratory analyses.

Qualification Criteria For Depth (I):

General Depth Criteria: Apply to each OWMID#

- clearly erroneous readings due to faulty depth sensor: censor (i)
- negative and zero depth readings: censor (i); (likely in error)
- 0.1 m depth readings: qualify (i); (potentially in error)
- 0.2 and greater depth readings: accept without qualification; (likely accurate)

Specific Depth Criteria: apply to entirety of depth data for survey date

- If zero and/or negative depth readings occur more than once per survey date, censor all negative/zero depth data, and qualify all other depth data for that survey (indicates that erroneous depth readings were not recognized in the field and that corrective action (field calibration of the depth sensor) was not taken, i.e. that all positive readings may be in error.)

“ m ” = method not followed; one or more protocols contained in the DWM hydrolab sop not followed, i.e. Operator error (eg. Less than 3 readings per station (rivers) or per depth (lakes), or instrument failure not allowing method to be implemented.

“ s ” = field sheet recorded data were used to accept data, not data electronically recorded in the hydrolab surveyor unit, due to operator error or equipment failure.

“ u ” = unstable readings, due to lack of sufficient equilibration time prior to final readings, non-representative location, highly-variable water quality conditions, etc.

“ c ” = greater than calibration standard used for pre-calibration, or outside the acceptable range about the calibration standard. Typically used for conductivity (>718, 1,413, 2,760, 6,668 or 12,900 us/cm) or turbidity (>10, 20 or 40 ntu). It can also be used for TDS and salinity calculations based on qualified (“c”) conductivity data, or that the calculation was not possible due to censored conductivity data (TDS and salinity are calculated values and entirely based on conductivity reading).

“ ? ” = light interference on turbidity sensor (hydrolab error message). Data is typically censored.

Sample-Specific Qualifiers:

“ **a** ” = Accuracy as estimated at WES lab via matrix spikes, pt sample recoveries, internal check standards and lab-fortified blanks did not meet project data quality objectives identified for program or in QAPP.

“ **b** ” = Blank contamination in lab reagent blanks and/or field blank samples (indicating possible bias high and false positives).

“ **d** ” = Precision of field duplicates (as RPD) did not meet project data quality objectives identified for program or in QAPP. Batched samples may also be affected.

“ **e** ” = Not theoretically possible. Specifically, used for bacteria data where colonies per unit volume for e-coli bacteria > fecal coliform bacteria, for lake secchi and station depth data where a specific secchi depth is greater than the reported station depth, and for other incongruous or conflicting results.

“ **f** ” = Frequency of quality control duplicates did not meet data quality objectives identified for program or in QAPP.

“ **h** ” = holding time violation (usually indicating possible bias low)

“ **j** ” = ‘Estimated’ value; used for lab-related issues where certain lab qc criteria are not met and re-testing is not possible (as identified by the WES lab only). Also used to report sample data where the sample concentration is less than the ‘reporting’ limit or RDL and greater than the method detection limit or mdl (MDL < x < RDL). Also used to note where values have been reported at levels less than the mdl.

“ **m** ” = method sop not followed, only partially implemented or not implemented at all, due to complications with sample matrix (eg. Sediment in sample, floc formation), lab error (eg. Cross-contamination between samples), additional steps taken by the lab to deal with matrix complications, lost/unanalyzed samples, and missing data.

“ **p** ” = Samples not preserved per sop or analytical method requirements.

“ **r** ” = Samples collected may not be representative of actual field conditions, based on documented or suspected field sampling error, or inexplicable or improbable (“outliers”) values.

Appendix C
Fish Toxics Monitoring Methods and Detection Limits

Table C1. 2000 Fish Toxics *Analytical Methods and Detection Limits* (all values in wet weight). Table excerpted from the *DATA VALIDATION REPORT for Year 2000 Project Data*. (MA DEP 2003; CN 83.0).

Fish Tissue Analytes	EPA Method*	Other Methods	Method Detection Limit	Reporting Detection Limit
PCB A1242		AOAC 983.21**	0.26 µg/g	0.26 µg/g
PCB A1254		AOAC 983.21**	0.37 µg/g	0.37 µg/g
PCB A1260		AOAC 983.21**	0.11 µg/g	0.11 µg/g
Chlordane		AOAC 983.21**	0.11 µg/g	0.11 µg/g
Toxaphene		AOAC 983.21**	0.59 µg/g	0.59 µg/g
a-BHC		AOAC 983.21**	0.009 µg/g	0.009 µg/g
b-BHC		AOAC 983.21**	0.011 µg/g	0.011 µg/g
Lindane		AOAC 983.21**	0.009 µg/g	0.009 µg/g
d-BHC		AOAC 983.21**	0.043 µg/g	0.043 µg/g
Hexachlorcyclopentadienne		AOAC 983.21**	0.33 µg/g	0.33 µg/g
Trifluralin		AOAC 983.21**	0.18 µg/g	0.18 µg/g
Hexachlorobenzene		AOAC 983.21**	0.18 µg/g	0.18 µg/g
Heptachlor		AOAC 983.21**	0.012 µg/g	0.012 µg/g
Heptachlor Epoxide		AOAC 983.21**	0.015 µg/g	0.015 µg/g
Methoxychlor		AOAC 983.21**	0.029 µg/g	0.029 µg/g
DDD		AOAC 983.21**	0.011 µg/g	0.011 µg/g
DDE		AOAC 983.21**	0.010 µg/g	0.010 µg/g
DDT		AOAC 983.21**	0.011 µg/g	0.011 µg/g
Aldrin		AOAC 983.21**	0.016 µg/g	0.016 µg/g
PCB Congener BZ#81		AOAC 983.21**	0.0005 µg/g	0.0015 µg/g
PCB Congener BZ#77		AOAC 983.21**	0.0005 µg/g	0.0015 µg/g
PCB Congener BZ#123		AOAC 983.21**	0.0011 µg/g	0.0033 µg/g
PCB Congener BZ#118		AOAC 983.21**	0.0025 µg/g	0.0075 µg/g
PCB Congener BZ#114		AOAC 983.21**	0.0008 µg/g	0.0024 µg/g
PCB Congener BZ#105		AOAC 983.21**	0.0019 µg/g	0.0057 µg/g
PCB Congener BZ#126		AOAC 983.21**	0.0004 µg/g	0.0012 µg/g
PCB Congener BZ#167		AOAC 983.21**	0.0009 µg/g	0.0027 µg/g
PCB Congener BZ#156		AOAC 983.21**	0.0007 µg/g	0.0021 µg/g
PCB Congener BZ#157		AOAC 983.21**	0.0007 µg/g	0.0021 µg/g
PCB Congener BZ#180		AOAC 983.21**	0.0007 µg/g	0.0021 µg/g
PCB Congener BZ#169		AOAC 983.21**	0.0003 µg/g	0.0009 µg/g
PCB Congener BZ#170		AOAC 983.21**	0.0007 µg/g	0.0021 µg/g
PCB Congener BZ#189		AOAC 983.21**	0.0007 µg/g	0.0021 µg/g
Mercury	EPA 245.6		0.01 mg/kg 0.010 mg/kg 0.020 mg/kg	0.020 mg/kg
Cadmium	EPA 200.7		0.02 mg/kg 0.020 mg/kg 0.04 mg/kg 0.040 mg/kg 0.10 mg/kg 0.20 mg/kg	0.020 mg/kg 0.040 mg/kg
Lead	EPA 200.7		0.2 mg/kg 0.20 mg/kg 0.40 mg/kg 0.400 mg/kg 1.0 mg/kg	0.20 mg/kg
Arsenic	EPA 200.9		0.04 mg/kg 0.040 mg/kg	0.040 mg/kg
Selenium	EPA 200.9		0.04 mg/kg 0.040 mg/kg	0.040 mg/kg

Table C1. Continued. 2000 Fish Toxics *Analytical Methods and Detection Limits* (all values in wet weight).

Fish Tissue Analytes	EPA Method*	Other Methods	Method Detection Limit	Reporting Detection Limit
Chromium	EPA 200.7		0.10 mg/kg	NR
Copper	EPA 200.7		0.20 mg/kg	NR
Barium	EPA 200.7		1.0 mg/kg	NR
Nickel	EPA 200.7		0.10 mg/kg	NR
Zinc	EPA 200.7		0.10 mg/kg	NR
Cobalt	EPA 200.7		0.10 mg/kg	NR

* - "Methods for Chemical Analysis of Water and Wastes", Environmental Protection Agency, Environmental Monitoring Systems Laboratory – Cincinnati (EMSL-CI), EPA-600/4-79-020, Revised March 1983 and 1979 where applicable.
 ** - WES SOP *Determination of Chlorinated Pesticides, PCB Arochlor(s) and PCB Congeners in Fish and Biological Tissue* (modified AOAC 983.21)
 NR – not reported
 NOTES: 1. PCB Toxic Congeners are listed according to a numbering system developed by Ballsmiter and Zell (BZ#).
 2. Multiple MDLs and/or RDLs reflect different detection levels established by WES for unique batches of fish tissue samples analyzed at different times.

Table C2. 1995/1996 Fish Toxics *Analytical Methods and Method Detection Limits* (all values expressed as wet weight). Table excerpted from the *DATA VALIDATION REPORT for Year 2000 Project Data*. (MA DEP 2003; CN 83.0).

Fish Tissue Analytes	EPA Method ¹	Other Methods ²	1995 Method Detection Limit ³	1996 Method Detection Limit ³
PCB Arochlor 1242		AOAC 983.21**	0.06 µg/g	0.06 µg/g
PCB Arochlor 1254		AOAC 983.21**	0.17 µg/g	0.17 µg/g
PCB Arochlor 1260		AOAC 983.21**	0.16 µg/g	0.16 µg/g
Chlordane		AOAC 983.21**	0.11 µg/g	0.11 µg/g
Toxaphene		AOAC 983.21**	0.11 µg/g	0.11 µg/g
a-BHC		AOAC 983.21**	0.19 µg/g	0.0062 µg/g
b-BHC		AOAC 983.21**	0.09 µg/g	0.0019 µg/g
Lindane		AOAC 983.21**	0.16 µg/g	0.0059 µg/g
d-BHC		AOAC 983.21**	0.02 µg/g	0.020 µg/g
Hexachlorocyclopentadiene		AOAC 983.21**	0.10 µg/g	0.0077 µg/g
Trifluralin		AOAC 983.21**	0.11 µg/g	0.0062 µg/g
Hexachlorobenzene		AOAC 983.21**	0.04 µg/g	0.0091 µg/g
Heptachlor		AOAC 983.21**	0.08 µg/g	0.012 µg/g
Heptachlor Epoxide		AOAC 983.21**	0.59 µg/g	0.030 µg/g
Methoxychlor		AOAC 983.21**	1.07 µg/g	1.07 µg/g
DDD		AOAC 983.21**	0.13 µg/g	0.0052 µg/g
DDE		AOAC 983.21**	0.39 µg/g	0.015 µg/g
DDT		AOAC 983.21**	0.25 µg/g	0.0083 µg/g
Aldrin		AOAC 983.21**	0.15 µg/g	0.0075 µg/g
Arsenic	EPA 200.9		0.040 mg/kg	0.04 mg/kg
	EPA 206.2			0.04 mg/kg
Mercury	EPA 245.1		0.0002 mg/kg 0.020 mg/kg	
	EPA 245.6			0.008 mg/kg 0.020 mg/kg

Table C2. Continued. 1995/1996 Fish Toxics *Analytical Methods and Method Detection Limits* (all values expressed as wet weight).

Fish Tissue Analytes	EPA Method ¹	Other Methods ²	1995 Method Detection Limit ³	1996 Method Detection Limit ³
Lead	EPA 200.7		1.0 mg/kg	0.14 mg/kg 1.0 mg/kg
	EPA 239.1		1.0 mg/kg	1.0 mg/kg
Selenium	EPA 200.9		0.040 mg/kg	0.04 mg/kg
	EPA 270.2		0.040 mg/kg	0.04 mg/kg
Cadmium	EPA 200.7		0.02 mg/kg 0.20 mg/kg	0.02 mg/kg 0.20 mg/kg
	EPA 213.1		0.20 mg/kg	0.20 mg/kg
Chromium	EPA 200.7		0.20 mg/kg	0.04 mg/kg
	EPA 218.1			0.20 mg/kg
Copper	EPA 200.7			0.04 mg/kg
	EPA 220.1			0.020 mg/kg
Zinc	EPA 200.7		0.20 mg/kg	0.02 mg/kg
	EPA 289.1		0.20 mg/kg	0.40 mg/kg
Barium	EPA 200.7		0.20 mg/kg	not analyzed
Silver	EPA 200.7		0.20 mg/kg	
	EPA 272.1		0.20 mg/kg	
Nickel	EPA 200.7		0.60 mg/kg	
	EPA 249.1		0.60 mg/kg	

¹ "Methods for Chemical Analysis of Water and Wastes", Environmental Protection Agency, Environmental Monitoring Systems Laboratory – Cincinnati (EMSL-CI), EPA-600/4-79-020, Revised March 1983 and 1979 where applicable.

² AOAC Official Methods of Analysis, 1990.

³ Multiple MDLs reflect different detection levels established by WES for unique batches of fish tissue samples analyzed at different times.

** - WES SOP *Determination of Chlorinated Pesticides, PCB Arochlor(s) and PCB Congeners in Fish and Biological Tissue*. (Samples were extracted and analyzed according to the modified AOAC 983.21 procedure for the analysis of PCB Arochlors and Congeners and Organochlorine Pesticides.)

APPENDIX B

DWM LAKES SURVEY DATA 1995 AND 2000 IN THE MILLERS RIVER WATERSHED

1995

In the Millers River Watershed, DWM conducted synoptic surveys at 64 lakes during the 1995 field season. Observations, from at least one access point on each lake (multiple access points on larger lakes) were recorded on standardized field sheets and are summarized in Table B1. An attempt was made to observe the entire surface area of each lake to determine the extent of aerial macrophyte cover. At each sampling location general water quality conditions, identification and abundance of aquatic and wetland macrophyte plant species, and estimates of total percent aerial coverage were recorded. Macrophyte visual observations were augmented at each station by identifying plant specimens collected from the lake bottom. Specimens were retrieved using a "rake" (a short handled, double-sided garden rake on a 50 foot line) thrown to its maximum extension in multiple directions at each station. Macrophytes collected in the "rake" were identified (*in-situ* or in the laboratory) and recorded on the field sheets. Transparency was measured where possible using a standard 20-centimeter diameter Secchi disk. Where Secchi disk measurements were not feasible, transparency was estimated as being above or below 1.2 meter (the MDPH bathing beach standard). Trophic status was estimated primarily using visual observations of macrophyte cover and phytoplankton populations. A more definitive assessment of trophic status would require more extensive collection of water quality and biological data.

Table B1. Millers River Watershed 1995 Lake Synoptic Survey Data and Trophic Status Estimates.

Lake	Waterbody Identification Code (WBID)	Trophic Status Estimate	Survey Observations (Objectionable Conditions)
Bassett Pond, New Salem	MA35002	M	Slight turbidity, slight stain, vegetated bottom, sparse to moderate cove of aquatic plants around perimeter, masses of submerged bladderwort, some beaver activity evident
Beaver Flowage Pond (Beaver Pond), Royalston	MA35005	E	Heavily tea-stained and turbid, secchi disk 1.0 m, large rocks covered with silt and algae, 100% vegetation cover with very dense floating leaf cover, beaver activity apparent
Bents Pond, Hubbardston	MA35006	U	Slightly turbid, some scum (debris) on surface, stumps, rocks and sand bars visible, gravel bottom with brown silt and undecomposed matter, sparse vegetation
Bents Pond, Gardner	MA35007	E	Very turbid, brown in color, evidence of blue-green bloom on shore, mucky bottom, low water level, non-native present (Ls), 1/3 of pond filled in or with emergent or floating vegetation
Bourn-Hadley Pond, Templeton	MA35008	E	Tea-stained and brown turbidity, secchi disk 1.4 m bottom muck and partially decomposed matter, very dense floating vegetation at south end of south basin (approximately 75% of basin), very dense floating and submergent vegetation over 25 % of north basin
Bowens Pond, Wendell	MA35009	M	Slightly turbid, dark tea-stain, bottom consists of fine muck and undecomposed leaf and twig debris, a few patches of very dense floating leaf, most of pond open
Brazell Pond, Templeton	MA35010	M	Slight brown turbidity, slight stain, sandy bottom with much silt and partially decomposed matter, very dense floating and submergent vegetation in coves at north end of pond and east shore, small patches of very dense floating plants in center, total cover approximately 1/3 of pond

Table B1 (cont). Millers River Watershed 1995 Summer Lake Status.

Lake	Waterbody Identification Code (WBID)	Trophic Status Estimate	Survey Observations (Objectionable Conditions)
Cowee Pond, Gardner	MA35013	M	Slight brown turbidity, slight stain, much periphytic algae, sand/gravel bottom with silt and debris, patches of very dense floating leaf plants along west and east side, north end had very dense vegetation and exposed mud
Crystal Lake, Gardner	MA35014	U	Little turbidity, low water level rock rip rap around shore, silt covered rocks on bottom, sparse vegetation
Davenport Pond, Athol/Petersham	MA35015	E	Observed from a distance, 100% covered with floating leaf plants
Depot Pond (Railroad Pond), Templeton	MA35018	E	Slightly turbid, little water visible through vegetation, vegetation and undecomposed matter on bottom, very dense floating, emergent and submergent vegetation around perimeter of pond, some patches in center, approximately 1/3 of pond covered
Dunn Pond, Gardner	MA35021	M	Tea-stain, slight turbidity, sandy bottom with greenish brown silt and undecomposed debris, sparse aquatic plant cover, a few patches spread along the shore
East Templeton Pond, Templeton	MA35022	E	South basin 100% emergent plants, north basin filled in to form a wet meadow
Ellis Pond (Lake Ellis), Athol	MA35023	E	Slightly turbid, slight stain, sand/gravel bottom at shore, silt and organic matter further out, non-natives present (Cc, Ec), very dense submerged plants near outlet and access, but mostly open in main basin, coves generally covered with floating leaf plants
Gales Pond, Warwick	MA35024	M	Turbid (brown), tea-stained, secchi disk 1.0m, brown silt over rock bottom, water level low, sparse patches of floating leaf plants scattered around pond, mostly open
Greenwood Pond, Westminster	MA35025	M	Slight turbidity, bottom muck and undecomposed leaf debris, north end and west side with very dense perimeter of floating, submergent, and emergent vegetation, patches of floating plants in center, less than 50% cover total
Greenwood Pond, Templeton	MA35026	E	Little open water, 100% emergent plants
Hastings Pond, Warwick	MA35028	U	Observed at a distance, dense plant cover at downstream end and along the left shore out to approximately 100', remainder open water
Hilchey Pond, Gardner	MA35029	U	Tea-stained, brown turbidity, sandy bottom with much undecomposed matter, sparse floating stands of emergents at upper end, encroaching patches of dense submergents along west shore
Kendall Pond, Gardner	MA35034	U	Clear, slight turbidity, slight silt cover over sand bottom, some partially decomposed debris further out, perimeter of very dense floating leaf vegetation
Lake Denison, Winchendon	MA35017	M	Slight turbidity, sand/gravel bottom with some silt and partially decomposed matter, sparse aquatic vegetation except for occasional patches in coves, wet meadow on northeast arm

Table B1 (cont). Millers River Watershed 1995 Lake Synoptic Survey Data and Trophic Status Estimates.

Lake	Waterbody Identification Code (WBID)	Trophic Status Estimate	Survey Observations (Objectionable Conditions)
Lake Monomonac, Winchendon/Rindge, NH	MA35047	M	Slight turbidity, bottom a mix of undecomposed leaf litter and other debris, rocks with green and brown floc on them, sand, gravel and rock, moderate to dense low growing plants in east arm; very dense aquatic plants in cove out to Blueberry Island; dense to very dense plant cover along west shore, approximately, ½ way across basin; total affected area in MA about 1/3 of MA surface area
Lake Rohunta (Middle Basin), Athol/Orange/New Salem	MA35070	E	Brown turbidity, little water visible, 100% cover floating vegetation except central channel, meadows encroaching
Lake Rohunta (North Basin), Athol/Orange	MA35106	E	Slight stain, slight turbidity; very dense submerged vegetation around shore near dam; very dense floating leaf marginally along east and southeast shore, west shore open; non-native present (Cc)
Lake Rohunta (South Basin), New Salem	MA35107	E	Little water open to observe; very dense floating and emergent vegetation over entire basin, non-native present (Pa)
Lake Watatic, Ashburnham	MA35095	U	Tea-stained, very sparse vegetation
Laurel Lake, Erving/Warwick	MA35035		Clear, silty bottom over sand/gravel (near shore); silt and undecomposed matter further out; clouds of filamentous green algae (subsurface), moderate plant cover near outlet, rest of lake open
Little Pond, Royalston	MA35037	U	Tea-stained, turbid, sand/gravel bottom; organic further out; open water throughout, wooded wet land (bog) around entire pond
Lower Naukeag Lake, Ashburnham	MA35041	U	Heavy brown stain; gray/ brown algal blooms, sparse cover mostly submerged
Minott Pond, Westminster	MA35046	U	Tea-stained, slight turbidity, muck, undecomposed matter and vegetation on bottom, low water, northeast arms filled in, perimeter of pond with very dense submerged vegetation, total plant cover about 1/3 of pond
Minott Pond South, Westminster	MA35045	E	Tea-stain, little turbidity, bottom mucky brown, water level low, 100% cover of floating and submergent plants
Moore's Pond, Warwick	MA35048	U	Clear, silty bottom over sand/gravel, upper end of lake filled in as a bog (20% of the lake affected), dense patches of floating leaf vegetation around perimeter, rest of lake open
North Spectacle Pond, New Salem	MA35052	M	Clear, slight stain; sand/gravel bottom with some large stones; further out undecomposed organic matter; very dense patches of floating leaf on west shore encroaching from bog area, some floating patches in southeast corner, some encroachment in northeast corner
Packard Pond, Orange	MA35053	U	Tea-stain, very little turbidity, secchi disk 3.0 m, bottom sand/gravel with undecomposed debris, sparse aquatic vegetation
Parker Pond, Gardner	MA35056	E	Stain, very turbid, not much open water, mucky bottom; water level very low, 100% emergents and floating plants in areas where bottom not exposed, non-native present (Cc)
Partridgeville Pond, Templeton	MA35057	U	Tea stain, turbid, sand bottom with silt and undecomposed matter further out, foam on beach shore, no vegetation observed

Table B1 (cont). Millers River Watershed 1995 Lake Synoptic Survey Data and Trophic Status Estimates.

Lake	Waterbody Identification Code (WBID)	Trophic Status Estimate	Survey Observations (Objectionable Conditions)
Perley Brook Reservoir, Gardner	MA35059	U	Slight stain, slight green/brown turbidity, algae on rocky bottom, foam washed up on shore, large riprap rocks along road, sand/gravel bottom elsewhere with silt covering, sparse aquatic plant density
Phillipston Reservoir, Athol/Phillipston	MA35060	U	Brown turbidity, very little stain; bottom rocky with silt covering and some undecomposed matter; aquatic plant density sparse over most; dense patches at east end
Ramsdall Pond, Gardner	MA35062	E	Viewed at a distance, no water, wet marsh
Reservoir #1, Athol	MA35063	E	Water mostly filled with vegetation; bottom of vegetation and organic matter, approximately 75% of pond covered with very dense floating and emergent vegetation
Reservoir #2 (Secret Lake), Athol/Phillipston	MA35064	E	Slight turbidity, slight stain; bottom with brown silt and organic matter over sand; water level low; very dense floating vegetation at upper end; open from dam to extent visible except bay viewed to left shore
Riceville Pond, Athol/Petersham	MA35065	E	Stained water; slightly turbid; scum on surface with foam, patches of dense floating leaf and emergent plants near dam; 100% covered with floating plants (approximately ½ pond)
Richards Reservoir, Warwick	MA35067	E	Slightly turbid, weedy bottom with some silt; very dense floating vegetation at upper end and along left bank, encroaching bog shrubs; lower pond with patchy floating vegetation along sides and dense submergent vegetation; (approximately ¾ of pond covered with very dense weeds or filled in with shrubs)
Royalston Road Pond, Orange	MA35071	E	No water visible, 100% cover over entire pond
Ruggles Pond, Wendell	MA35072	E	Very little turbidity, tea stain; silt (brown) over sand at beach, elsewhere weedy; very dense plant cover over entire lake except beach and near dam
Sheomet Lake, Warwick	MA35074	M	Greenish brown turbidity; secchi disk 1.6m; silty brown sediment on rocks at dam; sparse aquatic plant cover; few patches of floating leaf
South Athol Pond, Athol	MA35078	E	Slight stain; very little turbidity; sand/gravel bottom, organic debris further out; cove near dam open on surface, but dense to very dense submerged vegetation; main body of lake with floating leaf vegetation encroaching well out from shores; southwest shore open; southeast shore 100% cover of floating leaf and submergent vegetation, non-native present (Cc)
South Spectacle Pond, New Salem	MA35081	D	Observed at a distance, water level low; bog has encroached approximately 50% of original area with floating leaf plants extend into the water
Sportsmans Pond, Athol	MA35082	E	Clear, little turbidity, bottom of vegetation, brown silt and undecomposed debris; very dense floating leaf plants in most of south end; band of open water between bog island and shore; north end of lake with marginal growth of floating leaf vegetation around most and patches further out; approximately 20% of pond affected by very dense vegetation

Table B1 (cont). Millers River Watershed 1995 Lake Synoptic Survey Data and Trophic Status Estimates.

Lake	Waterbody Identification Code (WBID)	Trophic Status Estimate	Survey Observations (Objectionable Conditions)
Stoddard Pond, Winchendon	MA35083	E	Tea stain, slight turbidity; rocky bottom with muck and vegetation, water level low; very dense patches of floating leaf spaced across open water in north end; very dense patches of floating leaf and submerged vegetation over approximately 1/3 of surface area
Sunset Lake, Ashburnham/Winchendon	MA35086	U	Tea stain, some green algae on rocks; sparse plant cover
Travers Pond, Gardner	MA35088	E	Poor water quality, very turbid with scum, filled in except stream
Tully Lake, Royalston	MA35111	U	Tea stain, slight turbidity; water level low; sparse plant cover
Tully Pond, Orange	MA35089	E	Stained, slightly turbid; very dense patches of floating leaf around most of border and some to the center, approximately 50% of area affected
Upper Naukeag Lake, Ashburnham	MA35090	U	Clear, slightly tea stain; sparse vegetation, mostly submerged and low growing
Upper Reservoir, Westminster	MA35091	M	Tea stain, turbid; bottom rock/gravel and vegetation; muck and undecomposed matter further out; water level low; south end with a perimeter of floating leaf vegetation encroaching; west shore less and patchy; little aquatic vegetation on east and north shores; east arm open except near outlet
Wallace Pond, Ashburnham	MA35092	E	Slightly tea-stained; approximately 75% of area with very dense floating leaf and submergent vegetation
Ward Pond, Athol	MA35093	E	Viewed at a distance, little open water; 100% covered with very dense floating leaf vegetation
Wheeler's Pond, Warwick	MA35097	E	Brown turbidity, slight tea stain; silt and undecomposed debris on bottom; very dense cover of floating leaf, emergent and submergent plants over most of upper end and left half of lower end and open near dam
White Pond, Athol	MA35098	U	Stained water; slightly turbid, bottom vegetated; 75- 100% submerged plants in small cove near outlet floating leafed plants encroaching in coves on east side of lake ; remainder open water; non-native present (Cc)
Whites Mill Pond, Winchendon	MA35099	E	Slight turbidity (brown), little open water; mucky brown bottom over sand and gravel; very dense aquatic vegetation beyond second island; second island to outlet was approximately 2/3 covered with floating leaf, emergent and submergent vegetation
Whitney Pond, Winchendon	MA35101	M	Tea stain, heavy brown turbidity; water very low; rocky bottom covered with brown silt; foam on shore; sparse aquatic vegetation over most of lake; northeast cove filling in with floating leaf plants (approximately 10-15% of total area)
Wickett Pond, Wendell	MA35102	M	Slightly turbid (silty brown); silt on bottom over gravel; most of pond open, area near launch and south end of pond with very dense floating leaf plants; some patches of very dense floating leaf vegetation elsewhere

Table B1 (cont). Millers River Watershed 1995 Lake Synoptic Survey Data and Trophic Status Estimates.

Lake	Waterbody Identification Code (WBID)	Trophic Status Estimate	Survey Observations (Objectionable Conditions)
Wrights Reservoir, Gardner/Westminster	MA35104	U	Little water visible, slightly turbid, tea stain; mucky bottom in southeast corner; very dense aquatic vegetation in southeast cove; entire southern arm with very dense floating leaf and submergent vegetation; sparse aquatic vegetation in main body and along west and north shores

* Indicates Class A (water supply) water body; all others are Class B.

WBID – Water body Identification code.

Trophic State: E= Eutrophic, H= Hypereutrophic, M= Mesotrophic, U= Undetermined.

Non-native Plants: Ls = *Lythrum salicaria*, Mh = *Myriophyllum heterophyllum*, Pa = *Phragmites australis*, Cc = Cabomba Caroliniana

Note: M. sp. – Possible *Myriophyllum heterophyllum*, requires further confirmation when flowering heads are evident.

2000

In the Millers River Watershed, baseline lake surveys were conducted in July, August, and September 2000 to coincide with maximum growth of aquatic vegetation, highest recreational use, and highest lake productivity. Two ponds, Stoddard Pond and Whitney Pond were sampled three times each (generally at monthly intervals). A technical memorandum by Dr. Mark Mattson entitled *Baseline Lakes 2000 Technical Memo* provides details of sample collection methods, results, data, and weed maps for the lakes surveyed in the Deerfield, Millers, Shawsheen, Ipswich, Islands, and Buzzards Bay watersheds in 2000 (MA DEP 2000).

In situ measurements using the Hydrolab® (measures dissolved oxygen, water temperature, pH, conductivity, and depth and calculates total dissolved solids and % oxygen saturation) were recorded. At deep hole stations measurements were recorded at various depths creating profiles. In-lake samples were also collected and analyzed for alkalinity, total phosphorus, apparent color, and chlorophyll a (an integrated sample). Procedures used for water sampling and sample handling are described in the *Grab Collection Techniques for DWM Water Quality Sampling Standard Operating Procedure* and the *Hydrolab® Series 3 Multiprobe Standard Operating Procedure* (MA DEP 1999a and MA DEP 1999b). The Wall Experiment Station (WES), the Department's analytical laboratory, supplied all sample bottles and field preservatives, which were prepared according to the *WES Laboratory Quality Assurance Plan and Standard Operating Procedures* (MA DEP 1995). Samples were preserved in the field as necessary, transported on ice to WES, and analyzed according to the WES Standard Operating Procedure (SOP). Both quality control samples (field blanks, trip blanks, and split samples) and raw water quality samples were transported on ice to WES on each sampling date; they were subsequently analyzed according to the WES SOP. Information about data quality objectives (accuracy, precision, detection limits, holding times, representativeness and comparability) is also presented in Appendix A. Apparent color and chlorophyll a were measured according to standard procedures at the MA DEP DWM office in Worcester (MA DEP 1999c and MA DEP 1999d). An aquatic macrophyte survey was conducted at each lake. The aquatic plant cover (native and non-native) and species distribution was mapped and recorded. Details on procedures used can be found in the *Baseline Lake Survey Quality Assurance Project Plan* (MA DEP DWM 1999e).

Data was excerpted from the *Baseline Lake Survey 2000 Technical Memo* and presented in Tables B2 and B3.

Table B2. 2000 MA DEP DWM Millers River Watershed Baseline Lakes *in-situ* Hydrolab® data

Date	OWMID	Time (24hr)	Depth (m)	Temp (°C)	pH (SU)	Conductivity @ 25C (µS/cm)	DO (mg/L)
Stoddard Pond (PALIS: 35083)							
Station: A Description: deep hole in northern end, Winchendon							
7/18/2000	LB-1022	13:36	**m	**m	**m	**m	**m
8/17/2000	LB-1065	11:57	**m	**m	**m	**m	**m
9/13/2000	LB-1107	10:30	0.1	21.0	5.7	39.7	7.6
		10:34	0.5	20.8	5.7	39.6	7.5
		10:39	1.0	18.9	5.3	40.7	2.3u
		10:43	1.5	17.6	5.2	41.7	0.4
		10:48	2.0	16.6	5.5	51.5u	<0.2
Millers River/Whitney Pond (SARIS: 3522150) (PALIS: 35101)							
Station: A, Mile Point: 40.2 Description: deep hole in western quadrant of pond, Winchendon							
7/18/2000	LB-1018	11:35	**m	**m	**m	**m	**m
8/17/2000	LB-1061	09:48	**m	**m	**m	**m	**m
9/13/2000	LB-1103	12:15	0.1	21.6	6.3	86.5	8.7u
		12:18	0.5	19.4	5.6	87.1	5.4
		12:25	1.0	18.7	5.5	86.1	3.8
		12:30	1.5	17.9	5.4	85.5	2.0
		12:33	2.0	17.5	5.3	85.4	1.1u
		12:38	2.5	17.3	5.3	85.0	0.2
		12:42	3.0	17.1	5.3	85.4	<0.2
		12:46	3.5	16.9	5.5	86.5	<0.2
		12:49	4.0	16.3	6.0	101	<0.2
		12:53	4.5	15.6	6.5	128	<0.2
		12:56	5.0	15.0	6.8	150	<0.2

“ ** ” = Censored or missing data (i.e., data that should have been reported)

“ m ” = method not followed; one or more protocols contained in the DWM Multi-probe SOP not followed, i.e. operator error (e.g. less than 3 readings per station (rivers) or per depth (lakes), or instrument failure not allowing method to be implemented.

“ u ” = unstable readings, due to lack of sufficient equilibration time prior to final readings, non-representative location, highly-variable water quality conditions, etc

Table B3. 2000 MA DEP DWM Millers River Watershed Baseline Lakes *physico-chemical* data.

Date	Secchi (m)	Secchi Time 24hr	Station Depth (m)	OWMID	QA/QC	Sample Depth (m)	Alkalinity (mg/L)	TP (mg/L)	Apparent Color PCU	Chl a (mg/m3)
Stoddard Pond (PALIS: 35083)										
Station: A Description: deep hole in northern end, Winchendon										
7/18/2000	>1.8	13:33	1.8							
				LB-1019	**	0.5	<2	0.028	65m	--
				LB-1020	**	1.3	2	0.024	65m	--
				LB-1021	**	0 - 1.3	--	--	--	8.6
8/17/2000	1.4	11:53	2.1							
				LB-1062	**	0.5	4	0.027	140	--
				LB-1063	**	1.6	3	0.037	170	--
				LB-1064	**	0 - 1.6	--	--	--	2.9
9/13/2000	1.5	10:27	2.7							
				LB-1104	**	0.5	5	0.020b	160b	--
				LB-1105	**	2.2	3	0.40 b	260b	--
				LB-1106	**	0 - 2.2	--	--	--	4.6 h
Millers River/Whitney Pond (SARIS: 3522150) (PALIS: 35101)										
Station: A, Mile Point: 40.2 Description: deep hole in western quadrant of pond, Winchendon										
7/18/2000	1.5	10:25	** m							
				LB-1013	LB-1014	0.5	3	0.034	120	--
				LB-1014	LB-1013	0.5	<2	0.038	130	--
				LB-1015	BLANK	--	<2	<0.005	<15	--
				LB-1016	**	0 - 4.5	--	--	--	4.3
				LB-1017	**	4.5	3	0.057	360	--
8/17/2000	1.2	10:27	5.3							
				LB-1055	LB-1056	0.5	2	0.039	160	--
				LB-1056	LB-1055	0.5	3	0.045	--	--
				LB-1057	DUP	0.5	4	0.042	--	--
				LB-1058	BLANK	--	<2	<0.005	--	--
				LB-1059	**	4.8	10	0.092	260	--
				LB-1060	**	0 - 3.6	--	--	--	<1.0
9/13/2000	1.2	12:11	5.6							
				LB-1097	LB-0198	0.5	3	0.031b	340b	--
				LB-1098	LB-0197	0.5	3	0.033b	190b	--
				LB-1099	DUP	0.5	<2	0.032b	320bd	--
				LB-1100	BLANK	--	<2	0.031b	21b	--
				LB-1101	**	5.1	12	0.88 b	580bm	--
				LB-1102	**	0 - 3.6	--	--	--	2.7

"**" = Censored or missing data (i.e., data that should have been reported)
"--" = No data (i.e., data not taken/not required)
"h" = holding time violation (usually indicating possible bias low)
"m" = method not followed; one or more protocols contained in the DWM Multi-probe SOP not followed, i.e. operator error (e.g. less than 3 readings per station (rivers) or per depth (lakes), or instrument failure not allowing method to be implemented).
"b" = blank Contamination in lab reagent blanks and/or field blank samples (indicating possible bias high and false positives).
"d" = precision of field duplicates (as RPD) did not meet project data quality objectives identified for program or in QAPP; batch samples may also be affected

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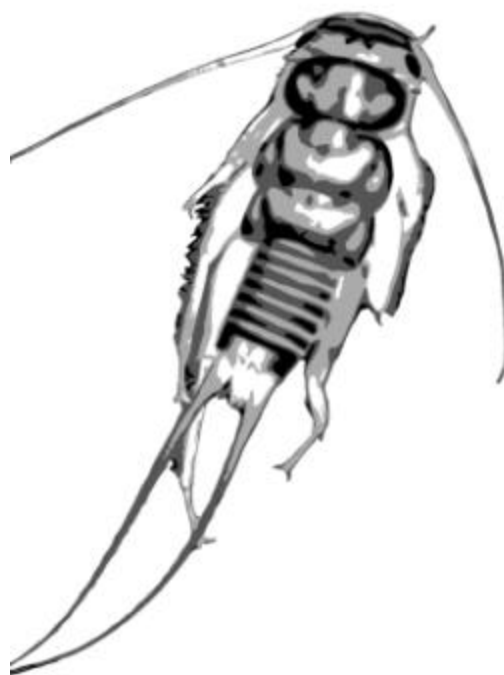
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APPENDIX C

Report # TM-35-5

Millers River Watershed

Results of the 1995 and 2000 Biomonitoring Surveys



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Introduction

As part of the watershed assessment activities of the Department of Environmental Protection's (DEP) Division of Watershed Management (DWM), benthic macroinvertebrate samples were collected from streams in the Millers River watershed. These samples were analyzed to detect indications of the status of aquatic community health. Historically, parts of the Otter and Millers Rivers have been extremely degraded by conventional pollutants, resulting in hypoxic or anoxic conditions over vast portions of these rivers. Although water quality has vastly improved since the 1970s because of upgrading all wastewater treatment to at least secondary, evidence of significant pollution impacts persisted (Austin, et al. 1990). Selection of sampling locations is typically the result of watershed planning activities communicated through the Executive Office of Environmental Affairs (EOEA) watershed team, as well as the direct needs of DWM for evaluating the efficacy of, and setting, permit limits for dischargers.

In 1995 samples of the benthic macroinvertebrate communities, or benthos (assemblages of aquatic macroinvertebrates living in association with the bottom substrates), of riffle dominated stream segments were collected from the Otter River and from several Millers River tributaries for which DWM was lacking biomonitoring data. In 2000 benthos were sampled at locations more broadly distributed throughout the watershed, including three mainstem stations, along with nine tributary stations, four of them at or near locations sampled in 1995 (Figure 1, Table 1).

Methods

As described in the Quality Assurance Project Plan (QAPP; Fiorentino 2000) and standard operating procedures (Nuzzo 1999—sample collection method was the same for both 1995 and 2000), aquatic macroinvertebrates were collected from wadeable riffle habitat sites by kicking bottom substrates to dislodge the organisms. A kick-net with a 500 μm mesh bag, pressed firmly against the stream bottom just downstream from the kicked area, was used to capture the organisms released to the current. Samples were composites of 10 kicks taken from approximate 0.46 m by 0.46 m areas (about 2 m^2 total) of riffle habitat within a 100 m reach. Samples were preserved in the field with denatured 95% ethanol, then brought to the DWM lab for processing. Before leaving the sample reach, habitat qualities were scored using a modification of the evaluation procedure in Plafkin, et al. (1989). The 1995 sampling was conducted from 29 August through 5 September, except for Lawrence Brook (B0224), which was sampled on 29 September. The 2000 sampling was conducted from 11 September through 14 September.

Processing the benthos samples entailed extracting a count-based subsample in the following manner. Samples were distributed among several sorting pans, grids were randomly selected within the pans, and specimens were sorted from the other materials in the sample until approximately 100 organisms ($\pm 10\%$) were extracted. Specimens were identified to genus or species as allowed by available keys, specimen condition, and specimen maturity. Taxonomic data were analyzed using a modification of Rapid Bioassessment Protocol III (RBP) metrics and scores (Plafkin, et al. 1989). The modifications were: substitution of "reference site affinity" (RSA) for the Community Loss Index and elimination of the shredder/total ratio (no separate leaf-pack material was collected). The reference site affinity metric is a modification of Percent Model Affinity (Novak and Bode 1992). Instead of using the model's percentages for Oligochaeta, Ephemeroptera, Plecoptera, Trichoptera, Coleoptera, Chironomidae, and other, these percentages were taken from the reference site data. The RSA score is then calculated as:

$$100 - S(d \times 0.5)$$

where d is the difference between the reference percentage and the sample percentage for each taxonomic grouping. RSA percentages convert to RBP III scores as follows: <35% receives 0 points; 2 points in the range from 35 to 49%; 4 points for 50 to 64%; and 6 points if =65%. The whole suite of metrics used for the analysis were:

- Richness (the total number of different species present),
- HBI (Hilsenhoff Biotic Index, as modified in Nuzzo 1999; HBI is the sum of the products of the pollution tolerance values and the abundance of each of the taxa present divided by the total count in the subsample)
- EPT (sum of richness among the orders Ephemeroptera, Plecoptera, and Trichoptera),
- EPT/Chironomidae (ratio of total abundance among EPT taxa to total abundance among chironomid taxa),
- SC/FC (ratio of the proportion of sample that is represented by individuals that predominantly feed by scraping to those that feed primarily by filter-feeding),
- % Dominant (most abundant taxon as a percent of the assemblage),
- RSA (described above).

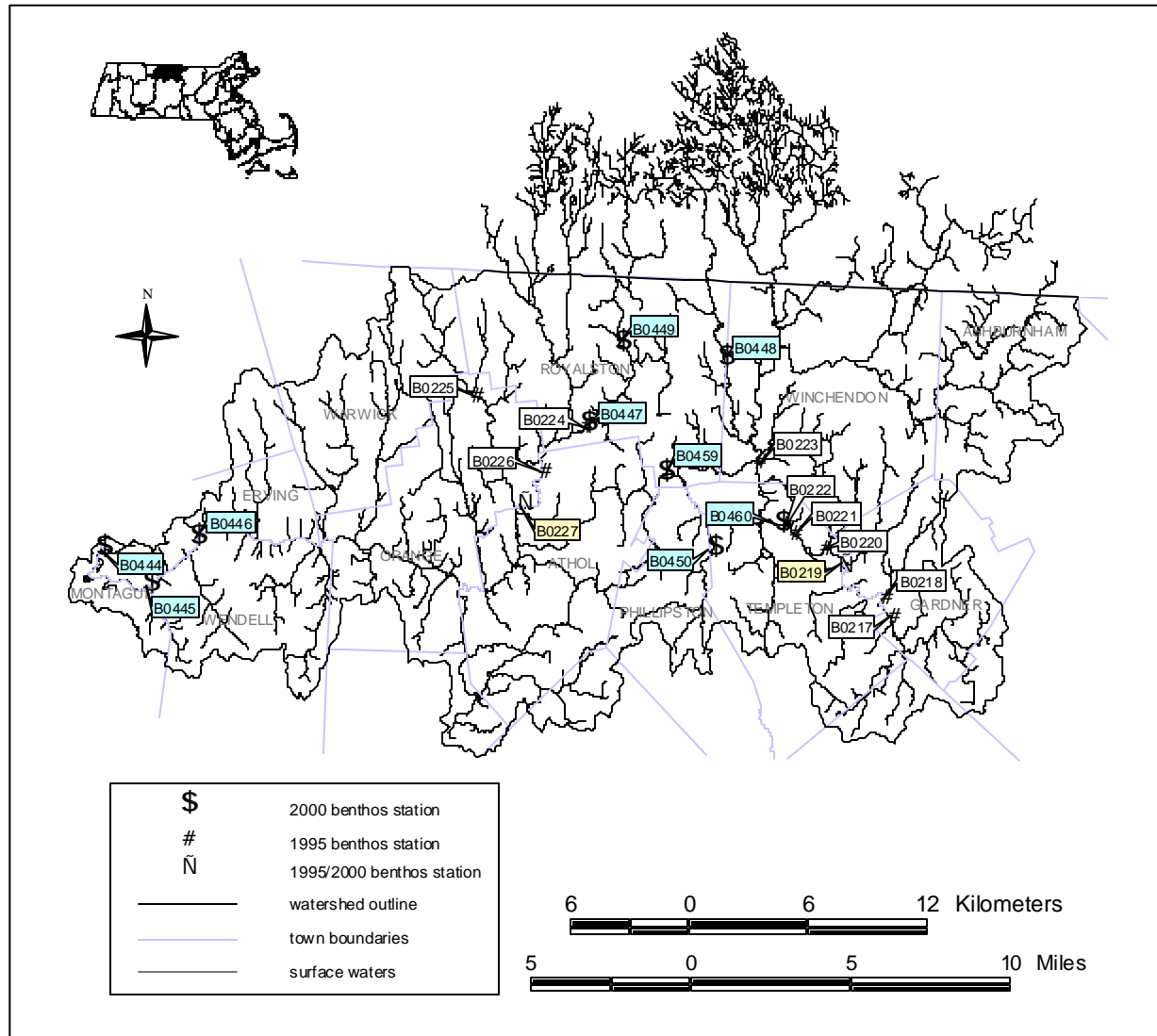


Figure 1. Location of benthic macroinvertebrate biomonitoring stations within the Millers River watershed. Inset shows watershed location within Massachusetts.

Table 1. Millers River watershed benthic macroinvertebrate sampling locations for the 1995 and 2000 surveys. Sites are listed starting with the most upstream station on the most upstream tributary in the watershed.

Stream	Station	Date Sampled	Descriptor
Priest Brook	B0448	12 Sept. 2000	approximately 125 meters downstream/south from Winchendon Road, Royalston
Otter River	B0217	29 Aug. 1995	downstream/north from Route 2A, Gardner
Otter River	B0218	29 Aug. 1995	upstream/south from Route 101, Gardner/Templeton (downstream/northeast of Gardner WWTP discharge)
Otter River	B0219	29 Aug. 1995 & 14 Sept. 2000	upstream/southeast from Bridge/Turner Street, Gardner/Templeton
Otter River	B0220	30 Aug. 1995	approximately 50 meters downstream/southwest from Main Street, Templeton (upstream from Seaman Paper wastewater discharge)
Otter River	B0221	30 Aug. 1995	approximately 570 meters upstream/southeast from Route 202, Templeton (upstream/southeast of Templeton WWTP discharge)
Otter River	B0222	30 Aug. 1995	approximately 200 m downstream/west from Route 202, Templeton
Otter River	B0460	13 Sept. 2000	approximately 400 meters downstream/west from Route 202, Templeton
Otter River	B0223	31 Aug. 1995	approximately 320 meters upstream/south from confluence with Millers River at remnant abutments from old railroad bridge, Winchendon
Beaver Brook	B0450	14 Sept. 2000	downstream from Templeton Development Center WWTP discharge, Templeton
Millers River	B0459	12 Sept. 2000	approximately 100 meters upstream from Royalston WWTP discharge, village of South Royalston, Royalston
Lawrence Brook	B0449	13 Sept. 2000	approximately 250 meters upstream/northwest from Northeast Fitzwilliam Road, Royalston (2000 reference station)
Lawrence Brook	B0447	12 Sept. 2000	approximately 250 meters upstream/northeast from Athol Road and Doane Falls, Royalston
Lawrence Brook	B0224	29 Sept. 1995	approximately 65 meters upstream/northeast from Athol Road and Doane Falls, Royalston
East Branch Tully River	B0226	5 Sept. 1995	upstream/northeast from Logan/Fryeville Road, Athol/Orange
East Branch Tully River	B0227	5 Sept. 1995 & 12 Sept. 2000	immediately upstream/east from Pinedale Avenue/Tully Road, Athol/Orange
West Branch Tully River	B0225	5 Sept. 1995	upstream/west from Tully Road (adjacent to Butterworth Road), Orange (1995 reference station)
Millers River	B0446	11 Sept. 2000	approximately 50 meters upstream/north from Farley Road, Wendell/Erving
Lyons Brook	B0445	11 Sept. 2000	immediately upstream from confluence with Millers River, Wendell/Montague
Millers River	B0444	11 Sept. 2000	approximately 520 meters upstream/south from mouth, Erving/Montague

1995 Biomonitoring Survey Results and Discussion

The results from the 1995 biomonitoring survey of the Millers River watershed are arranged starting with the most upstream station on the Otter River, the main focus of the 1995 survey (seven stations sampled). The remaining results (four stations) are similarly arranged, starting from the most upstream station on the more upstream tributary and proceeding downstream. The habitat data referred to can be found in Appendix A, Table A1. The benthic macroinvertebrate data and RBP scoring summaries are presented in Tables B1 and B2 of Appendix B.

Otter River (B0217)—downstream from Route 2A, Gardner, MA

Habitat

Intended as an upstream bracket for the Gardner wastewater treatment plant (WWTP) this site was downstream from the city of Gardner, an extensive wetland area, and at least one sand and gravel facility. Within the sample reach riffle habitat was restricted to a single riffle, which proved to cover an area sufficient for obtaining the required 2 m² composite sample. The substrates contained within the riffle were 90% cobble and gravel. Surrounding land uses included light industrial, forest, and wetlands. The water was tea-colored and slightly turbid. The riparian zone was vegetated mostly with shrubs on the west bank and grasses along the east bank. The tree canopy extended to cover less than 25% of the stream channel. The dominant tree in the riparian zone was *Acer rubrum* (red maple). The dominant emergent aquatic macrophyte was *Sparganium* sp. (bur-reed). The overall habitat score was 135.

Benthos

The assemblage of aquatic macroinvertebrates was dominated by the filter-feeding hydropsychid caddisflies, *Hydropsyche betteni* (36%) and *Cheumatopsyche* sp. (12%) in particular. Another 20% of the assemblage was the blackfly *Simulium fibrinflatum*, also a filter feeder. All the metrics used except the ratio of EPT to chironomid abundances indicated impairment when compared to the reference station (West Branch Tully River, B0225). The most severely affected were the EPT index (4, resulting in 0 points) and the SC/FC ratio (0.29, receiving 0 points). The low scores on the remaining metrics resulted in a total of 16, only 40% of the reference station, and therefore in the range for *moderately impacted*.

Otter River (B0218)—downstream from Gardner WWTP, Templeton, MA

Habitat

This station was located downstream from the Gardner WWTP, just upstream from Route 101. Land uses immediately surrounding the sample reach included forest, field, and wetland. Upstream from the reach water was slow and the fine sediments have settled out making large areas of mudflats. The water was turbid passing through this sample reach, as well. Gradient, however, increased, and concomitantly, current velocity. About 95% of the sampled streambottom was coarse substrates (cobble and gravel, 80%; boulder, about 15%).

This stretch of the river was obviously very productive, as indicated by the abundant plant growth. At least 75% of the reach was covered with rooted emergent vegetation such as *Pontederia* sp. (pickerel weed), *Sparganium* sp. and *Polygonum* sp. (smartweed). The exposed muddy areas were covered predominantly with *Eleocharis* (spike rush) and *Scirpus* (bulrush) spp. *Lemna* sp. (duckweed) floated on the surface and filamentous green algae could be seen attached to rocks and streaming from vegetation. Moss covering on the rocks was common. The overall habitat score was 143.

Benthos

The results of the benthic analysis at this site were nearly the same as at the site (B0217) bracketing the treatment plant on the upstream side. The notable differences were that two fewer EPT taxa were encountered, and total richness was lower by two, also. The RSA, too, was lower, resulting in a lower

score for that metric than at the upstream bracket. The total score of 12 (30% of reference) placed it in the category for *moderately impacted*.

Otter River (B0219)—upstream from Turner/Bridge Street, Templeton/Gardner, MA

Habitat

Most of the sample reach was fast-flowing water between the outlet of a small impoundment and the Turner/Bridge Street bridge, with quiet-water largely restricted to the stream margins. Roughly 95% of the bottom substrates were gravel, cobble, and boulder. The reach was partially channelized.

The riparian zone on the northeast side of the stream was mostly wooded. Trees lined the southwest bank of the stream, but a maintained lawn lay beyond. The canopy extended over about 70% of the stream channel. The dominant tree was *Acer rubrum*. Shrubs were mostly along the east bank, and were predominantly represented by *Sambucus* sp. (elderberry) and *Ilex* sp. (holly). A mix of hydrophilic monocots (e.g., *Carex* sp.—sedge), and ferns (e.g., *Onoclea* sp.—sensitive fern) could be found on both banks. Instream, less than 1% of the bottom was covered by vegetation, essentially all of it *Sparganium* sp. Mosses and filamentous algae were present on some rocks in the reach.

The water was turbid, which was especially noticeable where the water slowed as it passed under the bridge. Local residents have alleged that the turbidity is associated with operations at the sand and gravel plant a short distance upstream, and that the water clears at times and on days when the plant is not operating. The total habitat score was 131.

Benthos

All the metrics indicated a healthier benthic community compared to the two preceding stations. This was reflected in a slightly higher total score (18, or 45% of reference), though not sufficient to result in an appraisal better than *moderately impacted*.

Otter River (B0220)—downstream from Main Street, Templeton, MA

Habitat

This station was downstream from an impoundment and Main Street, and upstream from the discharge of the treated effluent from Seaman Paper. The riparian zone along the north side had grasses and other herbaceous cover in bar areas, with trees a little farther back—including *Betula* spp. (birches), *Populus* sp. (poplar), *Pinus strobus* (white pine), *Prunus* sp. (cherry), and *Acer* sp. (maple). The overall habitat score was 111.

Benthos

Richness (both total and EPT—25 and 9, respectively) here was the highest of any of the Otter River sites. The HBI value for this site was the lowest (lower HBI values indicate better water quality) among the Otter River sites. These metrics, and others, indicated that this stretch had the best water quality in the Otter River. In spite of having the lowest habitat score (mainly due to sediment deposition) of sites sampled, the overall RBP score (36) was in the range for *non-impacted*.

Otter River (B0221)—upstream from Route 202, Templeton, MA

Habitat

This station was upstream from the Templeton wastewater treatment plant (WWTP) and downstream from a water diversion dam behind American Tissue Mills. Water spilled over the dam, creating fast-flowing riffle habitat for about 15 m downstream, before the channel deepened and the wastewater effluent entered. Overall habitat score was 124.

Benthos

Despite slightly better habitat quality compared to the previous site, nearly all metrics indicated a deterioration in water quality. The proportion of the filter-feeding hydropsychid caddisflies (65%) more

than doubled over that of the previous site (24%), suggesting an increase in the loading of suspended particulates. The total RBP score was 40% of the reference score, which is in the range for *moderately impacted*.

Otter River (B0222)—downstream from Route 202, Templeton, MA

Habitat

Serving as the downstream bracket for the Templeton WWTP effluent, the sample reach was roughly 200 m downstream from Route 202. About 80% of the stream bottom area was a mix of cobble and gravel, with a few large boulders. The riparian zone was mostly wooded, with *Acer rubrum* the dominant. *Alnus* sp. (alder) was prominent in the understory. Among the herbaceous layer in the riparian zone were *Onoclea* sp., *Carex* sp., *Glyceria* sp. (manna grass), *Solidago* sp. (goldenrod), and *Impatiens* sp. (jewel weed). Instream rooted vegetation was lacking. Many of the rocks were covered with moss, which itself served as substrate for some sort of brown filamentous periphyton. Also observed instream were remnants of an industrial site (bricks, old pipe, cement blocks), as well as trash (scrap metal and plastic). The overall habitat score was 145.

Benthos

This station had the lowest total richness, and one of the lowest EPT values, of the sites sampled in this watershed in 1995. Richness here dropped to half of what it was at the site upstream from the WWTP discharge (B0221), and little more than one third of what it was a bit farther upstream at the Main Street location (B0220, which qualified as *non-impacted*). The HBI also increased, indicating a greater dominance by pollution tolerant groups. The total RBP score (12) rated this site *moderately impacted*.

Otter River (B0223)—approximately 320 meters upstream from confluence with Millers River, Winchendon, MA

Habitat

This was the last riffle stretch on the Otter River before it joined the mainstem Millers River. Remnant footings from an old railroad bridge (long since collapsed or removed) constricted the river and accelerated flow sufficiently to create a short riffle stretch. This portion of the river was otherwise wide and moving slowly through floodplain wetlands. Nevertheless, substrates within the riffle stretch were mostly cobble and boulders. The water was brown and somewhat turbid.

The wooded riparian zone was dominated by *Acer rubrum* and *Pinus strobus*, while *Cornus* sp. (dogwood) and *Alnus* sp. were the dominant shrubs. Conspicuous amid the herbaceous cover were *Carex* sp., *Eleocharis* sp., *Juncus* sp. (rush), *Onoclea* sp., and *Osmunda* sp. (royal fern). There was no rooted vegetation in the riffle stretch, but at the margins upstream (especially) and downstream were *Pontederia* sp., *Sagittaria* sp. (arrowhead), and *Nymphaea* sp. ("white" water lily). *Lemna* sp. was observed on the water surface. The overall habitat score was 130.

Benthos

Despite an increase in total richness, the EPT richness remained the same, and the HBI increased—suggestive of continued stress from low dissolved oxygen concentrations. This is probably a result of a flattening of the gradient and the predominantly wetland nature of the river corridor between B0222 and this sampling station, limiting the potential reaeration in this stretch. The RBP score for this site was the same as for the preceding, indicating that this site is *moderately impacted*, as well.

Lawrence Brook (B0224)—upstream from Athol Road, Royalston, MA

Habitat

The sample reach was a short distance upstream from Athol Road and Doane Falls. Bottom substrates were dominated by boulders and bedrock (often fractured into large slabs). Most of these rock surfaces were covered with mosses and liverworts. Rooted aquatic vegetation within the sample reach included *Sparganium* sp., *Nasturtium officinale* (water cress) and various fine grasses. The riparian zone was

mostly forested with a couple of residences at the top of the slope that ran along the north bank. The overall habitat score for this site was 154.

Benthos

With the highest habitat score for any of the sites evaluated in this survey, this site would be expected to produce a healthy benthic community if pollution stressors were lacking or minimal. In fact, the scores for most of the RBP metrics were comparable to the reference site. Thus, the determination for this site was: *non-impacted*.

East Branch Tully River (B0226)—upstream from Fryeville Road, Athol/Orange, MA

Habitat

This site was chosen as an upstream bracket for a landfill, which had generated some concern (communicated via the watershed team) regarding possible impacts to the watershed. The sample reach was nearly all bedrock, with only small deposits of gravel, cobbles, and/or coarse organic debris (twigs, leaves). There was little material that could be churned by foot, so the sampling effort consisted mainly of rubbing the rock surfaces by hand or by foot to dislodge benthic invertebrates. Because of the nature of the streambed, there were no rooted plants instream, but there were no growths of periphyton detected either. The riparian zone was forested, mainly with *Acer rubrum*, *Ulmus* sp. (elm), and *Fraxinus* sp. (ash). The overall habitat score was 149.

Benthos

Although the richness and EPT metrics were better than most of the Otter River sites, the performance of the metrics overall was not good enough to register better than *moderately impacted* from the total RBP score. In spite of a relatively high habitat score, the nature of the stream bed may have contributed to poor sampling efficiency—making it more difficult to distinguish between habitat effects and possible water quality effects.

East Branch Tully River (B0227)—upstream from Tully Road/Pinedale Avenue, Athol/Orange, MA

Habitat

This site was selected to serve as the downstream bracket for the landfill. The bottom substrates through this sample reach were dominated by large boulders, with a substantial amount of cobble also present. The stream bottom appeared very black, though when examined closely, rocks lifted from the bottom did not appear to be coated with oil or tarry substances. There were areas of rust-red deposits, as well as silt. Much of the moss on the rocks had black mucky sediments entrained.

Aquatic vegetation in this reach was limited and was nearly all *Sparganium* sp. Mats of algae could be seen attached to moss in some places and filamentous algae were also recorded in the reach. The riparian zone was wooded on both banks, primarily with *Acer rubrum*, *Pinus strobus*, and *Quercus rubra* (Red Oak). The overall habitat score was 147.

Benthos

The metric scores for this site were mostly comparable to the upstream bracket (B0226). The EPT/Chironomidae abundance ratio and compositional similarity to the reference station contributed to a total RBP score that was high enough to qualify as *slightly impacted*.

West Branch Tully River (B0225)—upstream from Tully Road, Orange, MA (1995 biomonitoring reference station)

Habitat

This site on the West Branch Tully River was chosen to represent “least impacted” conditions for the Millers River watershed in 1995. With headwaters in the Warwick State Forest, this stream flows south

easterly (as Tully Brook) through Sheomet Lake and (as West Branch Tully River) into Orange through a landscape that appeared to be mostly forested and with a low human population density. The water level was very low, exposing many otherwise useful fish cover or epifaunal substrate features (undercut banks, overhanging vegetation, fallen logs), effectively making them unavailable. This was reflected in the low scores for instream cover and frequency of riffles, in particular. (Note: Channel flow status was not rated in 1995 because it was not part of the habitat scoring scheme at that time.) Overall the habitat received a score of 135.

Benthos

Though the habitat observations and score might have indicated some habitat limitation, the performance of all metrics used in calculating the RBP scores was consistent with high quality water. In particular, the relatively high richness (total and EPT) and low HBI are characteristic of unpolluted sites. There was slight hyperdominance, however, by the pollution intolerant riffle beetle larvae of *Promoesia* sp. Overall, though, RBP metrics indicate that this was a good choice to serve as a reference for “least impacted” conditions for this watershed.

2000 Biomonitoring Survey Results and Discussion

Eight locations on tributary streams within the Millers River watershed were sampled in 2000, along with three stations on the mainstem Millers River. Results from the 2000 biomonitoring survey are arranged below starting with the most upstream station on the most upstream tributary, proceeding downstream toward the mouth of the Millers River. The habitat data discussed for each location are presented in Appendix A, Table A2. The benthos data and RBP scoring summaries are in Tables B3 and B4, respectively, of Appendix B.

Priest Brook (B0448)—downstream from Winchendon Road, Royalston, MA

Habitat

This tributary empties into the Millers River in Winchendon, upstream from the Millers River/Otter River confluence. A lot of beaver activity was observed along Priest Brook in 2000, making it difficult to find a riffle reach to sample. A short distance downstream from Winchendon Road, however, a weir caused enough velocity for riffle habitat to develop (though somewhat limited). Considering the substrates over the whole 100 m sample reach, composition was approximately 10% boulder, 40% cobble, 20% pebble and gravel, and 30% sand; yet in characterizing only the discrete riffle areas where each of the 10 kicks were performed, somewhat more coarse material—and less sand—was represented (10% boulder, 50% cobble, 30% pebble and gravel, and 10% sand). The stream was about 3 m wide through the sample reach. The riffles tended to be shallow (about 15 cm) but some run and pool areas were approximately a half meter deep. The water was tea-colored but clear.

The surrounding land was characterized as forested, with mostly *Pinus strobus* (white pine), *Acer rubrum* (red maple), and *Betula* sp. (birch). *Sambucus* sp. (elderberry) was the only shrub recorded. Ferns, mosses, and *Solidago* sp. (goldenrod) were present in the herbaceous layer. Instream the reach was about 80% covered with vegetation; mosses accounted for about half of the coverage and *Sparganium* sp. (bur-reed) the other half. The total habitat score was 163.

Benthos

Though total and EPT richness were lower, and HBI was higher, than at the 2000 Millers River watershed reference station (B0449) these differences did not result in a total RBP score low enough to indicate a significant stressor impact (overall rating: *non-impacted*). This was in spite of inferior habitat quality.

Otter River (B0219)—upstream from Turner/Bridge Street, Templeton/Gardner, MA

Habitat

This was the most upstream sampling location on the Otter River in 2000. The riparian features appeared relatively unchanged since the 1995 biomonitoring survey. The record of riparian zone vegetation was similar, listing *Acer rubrum* as the dominant tree, and *Sambucus* sp. as the eminent shrub. Herbaceous cover included grasses, ferns, goldenrod, *Eupatorium* sp. (Joe-Pye weed), and *Peltandra virginica* (arrow-arum). One difference, however, was the estimate of tree canopy over the stream (40% vs. 70% reported in 1995). There was no noticeable evidence of tree removal so this difference could indicate die-back or removal of tree branches overhanging the stream channel.

A more notable difference in the habitat observations was that the instream vegetative cover in the reach was estimated at less than 1% in 1995, but 60% in 2000. A little more than a third of that coverage was *Sparganium* sp., the remainder was moss(es). *Lemna* sp. (duck weed) was present at the surface. About 5% of the reach had filamentous green algae streaming from rocks and moss. The overall habitat score was 155.

Benthos

Richness and EPT values less than half that of the reference, an HBI that was somewhat higher, and percent dominance of 58%, all indicate that aquatic life in the Otter River at Turner/Bridge Street are still subject to environmental stressors. The difference between the total RBP score for this site and the reference was less than in past years, resulting in an overall assessment determination of *slightly impacted*.

Otter River (B0460)—downstream from Route 202, Templeton, MA

Habitat

This sampling site was intended to detect possible impacts from the Templeton WWTP, but was a couple hundred meters farther downstream than the site used for benthos in 1995. The stream was about 15 m wide, with riffles and runs between 0.5 and 0.75 m deep, and about 0.50 m deep in the pool(s). The inorganic substrates were mostly cobble and boulder, with sand and smaller particles accounting for only about 5% of the bottom materials. This section of the river was channelized and had a series of dams (or their remnants, one just upstream from the top of the sample reach). Slight erosion of the banks within the reach was evident. The water flowing into the reach carried a heavy load of particulates, giving the water a murky brown appearance. This, along with sewage odors and an accumulation of trash along the banks and in the water, made for poor aesthetics.

Though only a few hundred meters downstream from Baldwinville center, the riparian zone was wooded on both banks; but the south bank graded steeply up to a road only about 12 m away. The canopy cover above the sample reach was about 40%. Trees present in the riparian zone included *Acer rubrum*, *Fraxinus* sp. (ash), and *Pinus strobus*. *Viburnum* sp. (viburnum) was the only shrub recorded, while ground cover included mosses, grasses, ferns, *Solidago* sp., and *Eupatorium* sp. Rooted vegetation was lacking instream but mosses covered about 40% of the reach. Algal coverage was about 30% and was in both mat and filamentous forms. The overall habitat score was 186.

Benthos

Total richness and EPT were slightly better, but HBI was slightly worse, than at Turner/Bridge Street (B0219). The abundance was more evenly distributed among the species present, as evident from percent dominance—another sign of a healthier benthic community as compared to the Turner/Bridge Street site. The total RBP score resulting from comparison to the reference station (B0449) rated this site *slightly impacted*.

Beaver Brook (B0450)—downstream from Templeton Development Center Wastewater Treatment Facility, Templeton, MA

Habitat

Wastewater effluent enters Beaver Brook in an open wetland before the brook flows through a small impoundment and then enters woodlands. The brook was sampled in this forested reach, with the top of the reach 30 m or so from the outlet of the impoundment. There were remnants of an old stone dam in the reach, but no evidence of channelization, and no indications of erosion or nonpoint source (NPS) pollution from the immediate watershed area. Water depth ranged from a quarter of a meter in riffles up to three quarters of a meter in one or more of the pools. The sample reach was dominated by boulder and cobble substrates (about 80%), with lesser amounts of pebble and gravel (about 20%). There was a small amount of fine particulate organic matter (FPOM) visible settled-out in limited areas of the reach. The water was tea-colored and very slightly turbid.

The canopy over the stream was about 95% closed. The dominant trees observed were *Tsuga canadensis* (hemlock), *Fraxinus* sp., and *Betula papyrifera* (paper birch). The understory was mostly ferns and mosses. Instream vegetative coverage was about 90% of the reach. More than half of the coverage was moss, and little more than a third was rooted submergent forms, namely *Nasturtium officinale* (water cress) and *Callitriche* sp. (water starwort). The emergent vascular plants *Sparganium* sp. and *Polygonum* sp. were only about 5% of the vegetative cover instream. Thin-film green algae were found on some rocks instream but they covered less than 2% of the reach. The overall habitat score was 190.

Benthos

Though the HBI was comparable to the reference, total richness and EPT were not sufficient to count for more than two points between the two of them (EPT received 0 points). Hyperdominance and excessive difference in community structure relative to the reference also reduced the total score. The overall RBP score indicated this site was *slightly impacted*.

Millers River (B0459)—upstream from the Royalston WWTP, Royalston, MA

Habitat

This site was quite treacherous during September of 2000. Although the original intent of sampling this stretch of the river was to gather data on possible impacts of the Royalston WWTP on aquatic life, there was no safe place to collect samples where the effluent would have been mixed-in (the only safe place to wade downstream from the discharge was in the plume itself). Sampling upstream from the WWTP discharge was manageable and was judged still to be of some value because it would reflect mainstem conditions downstream from both the Priest Brook confluence and the Otter River confluence.

The river was about 40 m wide here with riffle/run depths generally running 30-50 cm, but some “pool” areas were 1 m or more deep. The river bottom was dominated by large boulders (70%); cobble, pebble, and sand each were only about 10% of the bottom materials. The riparian zone was roughly 70% forested and 30% residential. Indications of erosion were not detected, but the proximity of residences and lawns presented possible routes of NPS inputs. The water was detectably colored but did have slight turbidity.

Canopy cover was only about 5%. Trees were mostly *Acer rubrum*, *Betula* sp., *Salix* sp. (willow), *Ulmus rubra* (slippery elm), and *Quercus rubra* (red oak). Shrubs and woody vines in the riparian zone included *Vitis* sp. (grapes), *Sambucus* sp., and *Rhus* sp. (sumac). Among the herbaceous cover were grasses, *Solidago* sp., *Eupatorium* sp., and *Lobelia cardinalis* (cardinal flower). Around 25% of the reach had aquatic vegetation. Most of it was moss, but *Sparganium* sp., *Nasturtium officinale*, and *Callitriche* sp. were present. There was also light surface coverage by *Lemna* sp. Algae of different forms—streaming filaments, mats of filaments, and thin film—were attached to rocks in about 75% of the reach. The total habitat score was 181.

Benthos

Total richness was the second highest encountered during this survey, and EPT was higher than it was in the upstream tributaries (Priest Brook and Otter River). Evenness of the abundance distribution among taxa present (% dominance) and structural similarity to the reference station were also very good. The results from this station led to a determination of *non-impacted*.

Lawrence Brook (B0449)—upstream from Northeast Fitzwilliam Road, Royalston, MA (2000 biomonitoring reference station)

Habitat

Water draining from parts of western and southern Fitzwilliam, New Hampshire via Kemp Brook, Laurel Lake, and Sportsman Pond becomes Lawrence Brook once it crosses into Massachusetts. The Laurel Lake watershed appears to be the most heavily developed part of the New Hampshire portion of the Lawrence Brook drainage. The remainder of the watershed upstream from this sampling location appears only to be lightly developed. This site was sampled to represent “least impacted” stream conditions in the Millers River watershed for the 2000 biomonitoring survey.

Within the first 200 m upstream from the road was a series of beaver dams. Beyond that the gradient was steeper and presented nearly ideal riffle habitat as indicated by the habitat assessment score (195 out of 200 points possible). The stream was roughly 5 m wide, with depths ranging from 0.3 m to 0.5 m. There was no evidence of past channelization or man-made dams (there was a beaver dam at the downstream end of the reach across the upper end of a small side branch off the main channel). Also lacking was any indication of erosion or NPS pollution. The water was tea-colored but was clear (turbidity was not evident).

The substrate composition in the riffles was about 50% boulder and 40% cobble. The forested riparian zones produced a canopy over about 60% of the stream channel. The tree composition included *Tsuga canadensis*, *Quercus rubra*, *Acer rubrum*, *Betula papyrifera*, *Ulmus rubra*, and *Pinus strobus*. No shrubs were observed, but mosses, ferns, grasses, *Lobelia cardinalis*, and *Solidago* sp. were recorded as being present in the understory. Small patches of *Sparganium* sp. were the only rooted plants detected instream, but mosses covered nearly 60% of the bottom of the reach.

Benthos

The results for this station were mostly as expected. Richness (33 total, 14 EPT) was higher here than at any other site from this survey, and the HBI was one of the two lowest. There was, however, slight hyperdominance (% Dominance > 20) by the filter-feeding midge *Rheotanytarsus distinctissimus* gr. The preponderance of this midge also affected the EPT/Chironomidae and Scraper/Filtering Collector ratios, making them a bit lower than might be expected from a reference station. While this genus is commonly encountered in running waters, members of the *R. distinctissimus* species group are most often encountered in unpolluted stream reaches, where it may be the most abundant organism present (Simpson and Bode 1980).

Lawrence Brook (B0447)—upstream from Athol Road, Royalston, MA

Habitat

The sample reach used in 2000 was farther upstream from Athol Road and Doane Falls than the reach used in 1995. Here, too, the bottom substrates were primarily boulder (ca. 60%). The sample reach had bedrock, cobble, pebble, and gravel, but in the specific locations where the kicks were actually performed, bedrock was lacking and cobble accounted for about 30% of the available substrate. The brook was about 5 m wide; riffle/run depths ran about 30-40 cm and pools about 60 cm. Of the organic components, about 30% was in the form of FPOM. Even so, the water appeared clear, though deeply tea-colored. Although there were no indications of a dam within the sample reach, there was a beaver dam just below the bottom of the reach (in fact, there was a lot of beaver activity downstream from the sample reach); and there were remnants of a rather substantial mill dam a bit upstream from the reach. At one time this dam must have flooded the wetlands back up to Route 68.

The riparian zone was all forested, creating canopy cover of about 75%. Dominant trees were *Quercus rubra*, *Acer* sp., *Betula* sp., *Tsuga canadensis*, and *Pinus strobus*. *Kalmia latifolia* (mountain-laurel) was present in the understory as were herbaceous plants such as moss, *Osmunda* sp., *Onoclea* sp., and some liverworts along the stream margin. Aquatic vegetation was 85% moss and 15% rooted submergent vascular plants (*Sparganium* sp., *Nasturtium officinale*) covering close to 98% of the reach. No algal coverage was detected but sponges were observed. The overall habitat score was 180.

Benthos

This site had the highest HBI and lowest EPT index of the sites included in this survey. This is surprising because of the relatively high habitat score and the apparent lack of human activities within the watershed along the 7 km (approximately 4 mi.) between the reference site (B0449, Lawrence Brook upstream from Northeast Fitzwilliam Road) and this reach. The combination of the high HBI and low total and EPT richness measures is suggestive of low DO stress. It is not clear whether this could be due to: 1.) poor reaeration after flowing through an extensive low-gradient wetland section; 2.) past contamination in the formerly impounded reach; or 3.) other nonpoint source influences. The resulting total RBP score ranked this site *slightly impacted*.

East Branch Tully River (B0227)—upstream from Tully Road/Pinedale Avenue, Orange/Athol, MA

Habitat

Bottom substrates in this reach were dominated by cobble and boulder, with pebble and gravel making up about a third of the inorganic substrate materials; in locations where the actual samples were taken cobble and boulder accounted for about 80% of the bottom substrates. The stream was approximately 15 m wide through the sample reach. Depths in the riffles and runs ran about 15 to 40 cm, while some of the deeper pools were about 0.5 m. There was evidence of past channelization and that there once had been a dam at about mid-reach. There were two indicators of potential problems at this site that were not seen elsewhere. There was a substantial accumulation of FPOM on much of the substrates, and on areas of exposed substrates an oily, tarry coating was evident. The water appeared slightly turbid as well as having a slight tea color.

The surrounding land use was about 5% residential and 95% forested. The canopy spread over about 50% of the channel. The predominant trees were *Pinus strobus*, *Quercus rubra*, *Acer rubrum*, and *Fraxinus* sp. No shrubs were recorded, and the ground cover consisted mostly of mosses, grasses, and ferns. Aquatic vegetation covered about 60% of the reach, most of it moss and only about 3% attributable to *Sparganium* sp. Mats of green algae were found attached to rocks, wood, and sediment in about 20% of the reach. The total habitat score was 179.

Benthos

While the EPT index and total richness were lower than for the reference site (B0449), the total RBP score for this site placed it in the *non-impacted* category.

Millers River (B0446)—upstream from Farley Road, Wendell/Erving, MA

Habitat

This stretch of the river was about 30 m wide but more easily wadeable than at South Royalston. Riffles generally were around 25 cm deep, and the runs and pools 40 cm deep. Substrate composition in the sample areas was about 80% boulder and cobble, 10% pebble and gravel, and 10% sand. The water was slightly turbid but had no noticeable color.

The riparian zone was 100% forested, but the canopy cover over the channel was no more than 5%. *Betula* spp. dominated but *Fraxinus* sp. and *Pinus strobus* were also recorded. *Sambucus* sp. was present and herbaceous cover included ferns, grasses, *Solidago* sp., *Impatiens* sp. (jewel weed), *Lythrum salicaria* (loosestrife), and *Eupatorium* sp. About 75% of the stream bottom within the reach was blanketed with *Podostemum ceratophyllum* (river weed), which attached tightly to the rocky substrates giving the impression of a moss covering. Small amounts of *Elodea* sp. (elodea) were also present in the

reach. Green algae were observed as thin films on rocks, but coverage was less than 5% of the stream bottom within the reach. The overall habitat score was 182.

Benthos

Though total richness was low enough to reduce the total RBP score, both HBI and EPT index were very comparable to the reference station. The low ratio of scrapers to filtering collectors might seem unexpected for a wide rocky reach with virtually no canopy, suggesting a possible pollution impact. The clear explanation in this case, however, is the dense coverage of the *Podostemum ceratophyllum*—which would not favor scrapers. The overall assessment of the site was *non-impacted*.

Lyons Brook (B0445)—at mouth, Wendell/Montague, MA

Habitat

Sampling this brook was requested by the EOEA Millers River Watershed Team because of citizens' concerns of possible impacts from an adjacent landfill. Attempts were made to identify a suitable sampling reach along the area where the landfill abutted the riparian zone, but for much of the first 500 m downstream from Mormon Hollow Road the brook cut through a high-sided rocky gorge under a closed canopy of hemlock. The water flowed over solid rock, alternately spreading to become shallow, fast-flowing sections, and then plunging to deep pools. It was only in the last 100 m or so above the confluence with the Millers River that the gradient decreased and substrate materials became sufficiently heterogeneous to provide riffle habitat suitable for applying RBP III protocols. Sampling was conducted in this reach, between the railroad bridge and the confluence, where substrate composition was about 60% cobble, 20% boulder, and pebble and sand were about 10% each. The width of the stream was about 3 m, with depths running approximately 10 to 15 cm in the riffles and runs and 20 cm in the pool. The water appeared clear and colorless. Evidence (a blue tarp, a length of 2" X 6" lumber, a piece of copper wire), though sparse, of the landfill's potential as a nonpoint source contributor of contaminants was found in the gorge leading down to the sample reach. The railroad also has to be recognized as a potential source of NPS pollution, though there was no visible evidence of it at the time of sampling.

The surrounding land just upstream of the sample reach was predominantly forested but the canopy along the sample reach was only about 5%. Trees in the riparian zone included hemlock, *Quercus* sp., *Ulmus rubra*, *Betula* sp., and *Fraxinus* sp. Among the shrubs and woody vines were *Kalmia latifolia* and *Vitis* sp. Herbaceous plants included ferns, grasses, *Solidago* sp., *Eupatorium* sp., *Impatiens* sp., and *Lythrum salicaria*. No rooted vegetation was found instream, but filamentous green algae were attached to rocks in about 5% of the area. The habitat score total was 159.

Benthos

Despite having one of the two lowest habitat scores, the RBP score lost only a few points for total richness, slight hyperdominance, and compositional similarity to the reference. The total score still placed this site in the *non-impacted* category.

Millers River (B0444)—near mouth, Erving/Montague, MA

Habitat

Although this station was only a little more than 500 m upstream from the confluence with the Connecticut River, it was wadeable. The depths in the sample area were about 25 cm in the riffles and runs and 10 cm in the pools (which were restricted to the margins). Bottom substrates were 75-80% cobble and 10% pebble, with smaller amounts of gravel and sand. The water appeared colorless, though slightly turbid, and seemed to have a sewage odor.

The land on both sides of the river was forested, but because of the river's width the canopy cover was less than 5%. Prominent trees in the riparian zone were *Acer rubrum*, *Fraxinus* sp., *Pinus strobus*, and *Betula* sp. No shrubs were seen, but the woody vine, *Celastrus scandens* (bittersweet), was present. Mosses, ferns, *Solidago* sp., *Eupatorium* sp., and *Impatiens* sp. were also present. Instream vegetation—most of it *Elodea* sp. and small amounts of moss—covered less than 5% of the area. Green

algae, however, coated the rocks in thin films through probably 80% of the reach. The overall habitat score was 170.

Benthos

Although the benthic assemblage at this site lost points for richness, EPT, percent dominance, and similarity to the reference, these differences were small. The overall RBP determination for this site was still in the *non-impacted* category.

Summary and Conclusions

Otter River

The 1995 biomonitoring survey data indicated that all except B0220 (near Main Street, Templeton) of the Otter River sites, from the most upstream to the mouth, were *moderately impacted* by environmental stressors. In 2000 only two sites on the Otter River were sampled. Though the data from these two sites indicated the river was still impacted by pollution, it appeared to be less severe (i.e., *slightly impacted*) than in 1995. A partial explanation for this may be related to hydrologic differences between the two years. As can be seen in Table 2, in 2000 the streams in this watershed were carrying much more water leading up to the biomonitoring survey than they were in 1995. The difference is even more striking when only summer months are compared. Of particular significance was that the September mean monthly discharges for each gage, while never dropping below 7Q10, were very near it (see Appendix C, Table C1). Investigating the daily means (Table 3) showed that each of the gages recorded flows with daily means falling at or below 7Q10 for 10 to 27 consecutive days from mid-August through mid-September.

Table 2. Mean discharge for January through August (in m³/s). (Based on USGS data obtained over the internet at: <http://waterdata.usgs.gov/nwis/discharge>; cf. Appendix C, Table C1.)

Year	Priest Brook near Winchendon, MA (Gage 01162500)	Millers River Winchendon, MA (Gage 01162000)	Otter River at Otter River, MA (Gage 1163200)	Millers River Erving, MA (Gage 01166500)
7Q10	0.011	0.20	0.13	1.33
1995	0.7	3.3	1.35	15.1
2000	1.2	5.6	2.29	24.3

7Q10 values are from Wandle 1984.

The most upstream reach on the Otter River sampled in 1995 (**B0217**, near Route 2A, Gardner) was overwhelmingly dominated by filter-feeding macroinvertebrates (72%) suggesting a high loading of suspended solids. The low scores for EPT and HBI were suggestive of DO reductions as might be expected from nutrient enrichment or excessive organic matter loadings. These results were comparable to the findings of the August 1987 biomonitoring survey (Austin, et al. 1990). Possible sources of the problem could have been one or more of the following:

1. NPS pollution from highway run-off, urban run-off (city of Gardner), or stream-side industrial activities;
2. extensive low-gradient, wetland reaches upstream that may be organically rich, with little turbulent flow to reaerate the water;
3. habitat limitations.

Despite the fact that riffle habitat at this site was limited, it scored the same as the reference site habitat. Habitat alone, then, cannot explain the health status of the aquatic community as determined by the RBP analysis. The status of the benthic community appeared to be comparable at **B0218** (downstream from the Gardner WWTP), with little indication of additional stress caused by the introduction of treated wastewater effluent. Neither site was sampled in 2000.

At the Turner/Bridge Street, Templeton/Gardner reach (**B0219**) the 1995 data showed signs of improvement in the health of the benthic community compared to the upstream sites, but still *moderately impacted* compared to the reference station. Our field observations, and anecdotal observations from local residents, suggested that management practices at the sand and gravel operation upstream from this site should be investigated and improved for the benefit of reducing or eliminating its contribution to turbidity and sedimentation. Stressor impacts were still seen from the 2000 data, but at a less severe level (*slightly impacted*).

Table 3. Mean daily discharges for August and September 1995 (in m³/s). Values in bold type are at or below 7Q10 . (Based on USGS data obtained over the internet at: <http://waterdata.usgs.gov/nwis/discharge>.)

USGS Gage	Priest Brook near Winchendon, MA (Gage 01162500)	Millers River Winchendon, MA (Gage 01162000)	Otter River at Otter River, MA (Gage 1163200)	Millers River Erving, MA (Gage 01166500)
7Q10*	0.011	0.20	0.13	1.33
8/1/1995	0.062	0.340	0.187	2.690
8/2/1995	0.059	0.368	0.173	2.775
8/3/1995	0.059	0.396	0.170	2.888
8/4/1995	0.068	0.368	0.187	2.747
8/5/1995	0.085	0.425	0.252	2.775
8/6/1995	0.340	1.104	0.538	6.541
8/7/1995	0.368	1.444	0.680	7.023
8/8/1995	0.227	1.161	0.453	5.975
8/9/1995	0.159	0.850	0.368	4.701
8/10/1995	0.113	0.680	0.340	3.710
8/11/1995	0.091	0.566	0.340	3.285
8/12/1995	0.076	0.481	0.283	3.030
8/13/1995	0.062	0.425	0.255	2.973
8/14/1995	0.051	0.396	0.198	3.171
8/15/1995	0.048	0.368	0.167	3.002
8/16/1995	0.045	0.340	0.176	2.803
8/17/1995	0.040	0.311	0.170	2.633
8/18/1995	0.031	0.283	0.161	2.435
8/19/1995	0.028	0.252	0.147	2.294
8/20/1995	0.025	0.246	0.153	1.982
8/21/1995	0.022	0.258	0.113	1.841
8/22/1995	0.020	0.255	0.122	1.784
8/23/1995	0.022	0.252	0.119	1.727
8/24/1995	0.017	0.249	0.119	1.614
8/25/1995	0.012	0.244	0.113	0.821
8/26/1995	0.011	0.241	0.116	0.708
8/27/1995	0.011	0.246	0.122	0.821
8/28/1995	0.011	0.241	0.105	0.878
8/29/1995	0.010	0.232	0.105	0.934
8/30/1995	0.009	0.229	0.102	0.991
8/31/1995	0.009	0.221	0.096	0.991
9/1/1995	0.009	0.221	0.096	1.076
9/2/1995	0.009	0.218	0.093	1.019

USGS Gage	Priest Brook near Winchendon, MA (Gage 01162500)	Millers River Winchendon, MA (Gage 01162000)	Otter River at Otter River, MA (Gage 1163200)	Millers River Erving, MA (Gage 01166500)
7Q10*	0.011	0.20	0.13	1.33
9/3/1995	0.008	0.210	0.093	1.189
9/4/1995	0.007	0.210	0.091	1.019
9/5/1995	0.007	0.221	0.079	1.048
9/6/1995	0.007	0.210	0.076	1.048
9/7/1995	0.007	0.204	0.076	1.048
9/8/1995	0.007	0.193	0.076	1.048
9/9/1995	0.007	0.187	0.074	1.048
9/10/1995	0.007	0.176	0.082	0.991
9/11/1995	0.007	0.176	0.074	0.934
9/12/1995	0.007	0.170	0.068	0.934
9/13/1995	0.007	0.170	0.074	0.963
9/14/1995	0.008	0.181	0.091	0.963
9/15/1995	0.007	0.159	0.113	0.934
9/16/1995	0.006	0.170	0.125	0.906
9/17/1995	0.018	0.425	0.150	1.189
9/18/1995	0.037	0.566	0.311	1.246
9/19/1995	0.034	0.453	0.227	1.189
9/20/1995	0.027	0.396	0.156	1.472
9/21/1995	0.025	0.396	0.147	1.472
9/22/1995	0.040	0.481	0.147	1.784
9/23/1995	0.062	0.708	0.340	3.398
9/24/1995	0.045	0.566	0.340	2.435
9/25/1995	0.037	0.623	0.235	2.322
9/26/1995	0.130	0.708	0.249	2.464
9/27/1995	0.127	0.623	0.283	2.067
9/28/1995	0.125	0.538	0.249	2.180
9/29/1995	0.088	0.481	0.221	1.812
9/30/1995	0.051	0.453	0.221	1.812

*7Q10 values are from Wandle 1984.

The reach just downstream from Main Street, Templeton (**B0220**) was the only Otter River site that the 1995 data indicated was *non-impacted*. An impoundment about 170 m upstream from the sample reach may have played a beneficial role, perhaps by reducing the sediment load apparent upstream at Turner/Bridge Street. By contrast, the addition of paper mill wastewater effluent and another impoundment were no doubt contributing factors to the poor quality seen downstream at **B0221** (upstream from the Baldwinville WWTP). Downstream from the Baldwinville WWTP effluent discharge (at **B0222**) the benthic community health indicators plummeted to their lowest level on the Otter River in 1995. The data from the most downstream site sampled (**B0223**) showed no signs of improvement in the indicators. The low gradient, wetland nature of this latter stretch undoubtedly did not provide sufficient opportunities for the reaeration that might have aided in assimilation of any oxygen demand that had built up.

As with the Turner/Bridge Street site, the 2000 data from the site downstream from the Baldwinville WWTP (in 2000 the sample site was a couple hundred meters farther downstream and was identified as **B0460**) was ranked by the RBP analysis as only *slightly impacted*. Since this reach (B0460) and the Turner/Bridge Street (B0219) site had comparable RBP scores in 1995, and B0460 had a higher score based on the 2000 results, it is evident that the health of the reach downstream from the Baldwinville

WWTP had improved. The American Tissue Mills of Massachusetts facility in Templeton, which was a major contributor of influent to the Baldwinville WWTP, ceased operations in September 1995. While higher flows in 2000 (see Table 2) may have been beneficial in diluting effluent effects, it is suspected that cessation of wastes to the WWTP from American Tissue Mills likely reduced both loading of wastes for treatment and the final effluent volume from the treatment plant. Together these factors may explain the apparent improvement in the health of this reach of the river.

Tully Rivers

In 1995 the sample from the West Branch Tully River site (**B0225**) was used as a reference for benthic macroinvertebrate communities in the Millers River watershed. The indicators of community health in this sample were typical of what might be expected from “least impacted” stream sites in Massachusetts. The East Branch Tully River sites had been selected to bracket an abutting landfill as a way of screening for possible nonpoint source influences on the river. Surprisingly, however, the upstream site (**B0226**) was *moderately impacted*, while the downstream site (**B0227**) was only *slightly impacted*. Due to the mostly bedrock nature of the stream channel at the upstream site it is possible that poor sampling efficiency—not water quality—had the greatest influence on the outcome of the analysis. The downstream site (**B0227**) was resampled in 2000 and scored as *non-impacted*.

Lawrence Brook

In 2000 Lawrence Brook was sampled upstream (**B0449**) from Northeast Fitzwilliam Road in Royalston, MA to serve as the watershed reference. While not all of the community health indicators were as good as might have been expected, they were for the most part consistent with communities from “least impacted” riffle-dominated streams in Massachusetts. Farther downstream, near Athol Road and Doane Falls (**B0447**), the RBP score indicated *slightly impacted* community health. It is not clear what nonpoint source influences might be involved. In 1995 this stretch was sampled a little closer to Athol Road (**B0224**) but its RBP score from that data set rated it *non-impacted*.

Other tributaries

Priest Brook was not sampled in 1995 but the sampling near Winchendon Road, Royalston (**B0448**) in 2000 indicated a healthy aquatic community. Evidence of beaver activity was abundant in this drainage, so a lot of changes in habitat character can be expected over the coming years. Despite excellent habitat, analysis of the sample from Beaver Brook (**B0450**) detected slight stressor impacts. Upstream from the sample site the brook is a low gradient wetland stream; it receives wastewater effluent, and then flows through a small impoundment before entering woodlands and becoming more turbulent as the slope increases. Lyons Brook (**B0445**) was found to support a healthy aquatic macroinvertebrate community.

Millers River

Mainstem benthos were not sampled in 1995, but Austin, et al. (1990) interpreted data from August 1987 as showing signs of slight pollution impacts at three of the four stations sampled; with the fourth, and most downstream station (in Erving’s village of Millers Falls), appearing to be the least impacted (*non-impacted* to *slightly impacted*). When the 1987 mainstem results were analyzed in a manner consistent with the analysis in this report (Table 4), using the most downstream station from 1987 as the reference, the stations in Winchendon and Royalston are ranked as *moderately impacted*, and the station in Wendell/Orange only *slightly impacted*. All three of the stations sampled in 2000 (Royalston—**B0459**, Wendell/Erving—**B0446**, and near the mouth—**B0444**) were rated *non-impacted* by their RBP scores. This is an encouraging sign of improved water quality in the mainstem Millers River.

Table 4. RBP analysis of benthic invertebrate data collected in August 1987 from the Millers River at: Rte. 202, Winchendon (MI12); Rte. 68, South Royalston (MI10); Wendell Depot Rd., Wendell/Orange (MI05); and Rte. 63, Millers Falls (Montague/Erving, MI02—used as reference station). Impact categories are abbreviated in the table as: Ref. = reference; SI = *slightly impacted*; MI = *moderately impacted*.

STATION:	MI12	MI10	MI05	MI02
Richness	21	23	18	22
HBI	5.56	5.33	4.79	3.48
EPT	5	6	10	11
EPT/Chiro	2.76	0.24	5.56	10.20
SC/FC	0.11	0.19	0.07	1.21
% Dom.	38%	17%	26%	29%
Sim. (% Ref. Aff.)	33%	35%	45%	100%
STATION:	MI12	MI10	MI05	MI02
Richness	95%	105%	82%	100%
HBI	63%	65%	73%	100%
EPT	45%	55%	91%	100%
EPT/Chiro	27%	2%	54%	100%
SC/FC	9%	16%	6%	100%
% Dom.	38%	17%	26%	29%
Sim. (% Ref. Aff.)	33%	35%	45%	100%
STATION:	MI12	MI10	MI05	MI02
Richness	6	6	6	6
HBI	2	2	4	6
EPT	0	0	6	6
EPT/Chiro	2	0	4	6
SC/FC	0	0	0	6
% Dom.	2	6	4	4
Sim. (% Ref. Aff.)	0	2	2	6
Total Score	12	16	26	40
Impact Category	MI	MI	SI	Ref.

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Appendix A

Habitat Assessment Data

Table A1. Millers River Watershed Habitat Scores from the 1995 biomonitoring survey. Table shows habitat character and points possible, along with the scores for each biomonitoring station. Stations were located on the Otter River at Rte. 2A, Gardner (B0217), Rte. 101, Templeton/Gardner (B0218), Turner/Bridge St., Templeton/Gardner (B0219), Main St., Templeton (B0220), Rte. 202 (upstream), Templeton (B0221), Rte. 202 (downstream), Templeton (B0222), and in Winchendon near the mouth (B0223), and on Lawrence Brook near Doane Falls, Royalston (B0224), East Branch Tully River at Fryeville Rd., Orange/Athol (B0226), East Branch Tully River at Tully Rd./Pinedale Ave., Orange/Athol (B0227), and on West Branch Tully River at Tully Rd., Orange (B0225). For more complete station descriptions see Table 1.

Description	B0217	B0218	B0219	B0220	B0221	B0222	B0223	B0224	B0226	B0227	B0225
Instream Cover (fish)—20 pts.	5	17	5	8	7	10	6	16	18	12	6
Epifaunal Substrate—20 pts.	20	20	19	18	18	20	20	15	16	20	18
Embeddedness—20 pts.	17	19	15	13	14	16	19	20	20	18	19
Channel Alteration—20 pts.	15	15	15	12	15	15	15	15	15	15	15
Sediment Deposition—20 pts.	15	15	12	10	10	11	10	15	15	14	15
Frequency of Riffles—20 pts.	11	11	15	6	12	17	6	17	11	16	12
Channel Flow Status—20 pts.	NR*	NR*	NR*	NR*	NR*	NR*	NR*	NR*	NR*	NR*	NR*
Bank Vegetative Protection-Left Bank—10 pts.	10	10	10	9	9	10	10	10	10	10	10
Bank Vegetative Protection-Right Bank—10 pts.	10	10	10	9	9	10	10	10	10	10	10
Bank Stability-Left Bank—10 pts.	9	8	7	7	9	10	10	10	9	8	7
Bank Stability-Right Bank—10 pts.	9	8	7	7	9	10	10	10	9	8	7
Riparian Vegetative Zone Width-Left Bank—10 pts.	7	5	8	6	6	8	7	8	8	8	8
Riparian Vegetative Zone Width-Right Bank—10 pts.	7	5	8	6	6	8	7	8	8	8	8
Total habitat points (out of 200 possible)	135	143	131	111	124	145	130	154	149	147	135

*NR—Channel flow status was not rated in 1995 because it was not part of the habitat scoring scheme at that time.

Table A2. Millers River Watershed Habitat Scores from the 2000 biomonitoring survey. Table shows habitat character and points possible, along with the scores for each biomonitoring station. Stations were located on Priest Brook, Royalston (B0448), Otter River, Templeton/Gardner (B0219), Otter River, Templeton (B0460), Beaver Brook, Templeton (B0450), Millers River, Royalston (B0459), Lawrence Brook upstream from Northeast Fitzwilliam Road, Royalston (B0449), Lawrence Brook upstream from Doane Falls, Royalston (B0447), East Branch Tully River, Orange/Athol (B0227), Millers River at Farley Road, Wendell/Erving (B0446), Lyons Brook, Wendell/Montague (B0445), Millers River near mouth, Montague/Erving (B0444). For more complete station descriptions see Table 1.

Description	B0448	B0219	B0460	B0450	B0459	B0449	B0447	B0227	B0446	B0445	B0444
Instream Cover (fish)—20 pts.	17	13	20	20	20	20	20	19	16	6	15
Epifaunal Substrate—20 pts.	16	17	19	18	20	19	18	20	19	19	19
Embeddedness—20 pts.	15	16	19	19	19	19	17	17	18	20	17
Channel Alteration—20 pts.	14	13	14	16	15	20	16	15	20	17	20
Sediment Deposition—20 pts.	13	15	20	18	19	18	18	15	19	19	16
Velocity/depth combinations—20 pts.	16	15	18	19	17	19	15	17	15	9	16
Channel Flow Status—20 pts.	15	20	20	20	20	20	16	17	15	13	11
Bank Vegetative Protection-Left Bank—10 pts.	10	10	10	10	10	10	10	10	10	10	10
Bank Vegetative Protection-Right Bank—10 pts.	10	10	10	10	9	10	10	10	10	10	10
Bank Stability-Left Bank—10 pts.	9	10	10	10	10	10	10	9	10	8	9
Bank Stability-Right Bank—10 pts.	9	5	10	10	10	10	10	10	10	8	7
Riparian Vegetative Zone Width-Left Bank—10 pts.	10	2	6	10	10	10	10	10	10	10	10
Riparian Vegetative Zone Width-Right Bank—10 pts.	9	9	10	10	2	10	10	10	10	10	10
Total habitat points (out of 200 possible)	163	155	186	190	181	195	180	179	182	159	170

"Velocity/depth combinations" replaced "Frequency of riffles," as used in 1995.

Appendix B

Benthic Macroinvertebrate Data

Table B1. Benthic macroinvertebrate taxa list and data from the 1995 Millers River watershed biomonitoring survey. Stations were located on the Otter River at Rte. 2A, Gardner (B0217), Rte. 101, Templeton/Gardner (B0218), Turner/Bridge St., Templeton/Gardner (B0219), Main St., Templeton (B0220), Rte. 202 (upstream), Templeton (B0221), Rte. 202 (downstream), Templeton (B0222), and in Winchendon near the mouth (B0223), and on Lawrence Brook near Doane Falls, Royalston (B0224), East Branch Tully River at Fryeville Rd., Orange/Athol (B0226), East Branch Tully River at Tully Rd./Pinedale Ave., Orange/Athol (B0227), and on West Branch Tully River at Tully Rd., Orange (B0225). For more complete station descriptions see Table 1. The FFG column shows the feeding group category (FC = filtering collector, GC = gathering collector, PR = predator, SC = scraper, SH = shredder) and the TV column shows the tolerance value used for each taxon in calculating the Hilsenhoff Biotic Index (HBI).

Final Id	FFG	TV	B0217	B0218	B0219	B0220	B0221	B0222	B0223	B0224	B0226	B0227	B0225
Pisidiidae	FC	6			5		1			1	30	18	
Lumbriculus sp.	GC	8					1						
Hydrachnidia	PR	6	1						2	2		1	1
Limnocaridae	PR	6											3
Baetidae	GC	4			2	3				4		1	
<i>Acentrella</i> sp.	SC	4					1						1
<i>Baetis</i> sp.	GC	6			3		1						
Ephemerellidae	GC	1				4				1			
<i>Dannella</i> sp.	GC	2					1						
<i>Ephemerella</i> sp.	GC	1											9
<i>Eurylophella temporalis</i>	GC	5											1
Heptageniidae	SC	4			4		1		1		2	1	8
<i>Stenonema</i> sp.	SC	3	14			6	1			3	1		
Leptophlebiidae	GC	2								4			
<i>Habrophlebia</i> sp.	GC	4								2			
<i>Leptophlebia</i> sp.	GC	4								1			
<i>Paraleptophlebia</i> sp.	GC	1											7
<i>Chromagrion conditum</i>	PR	8											1
<i>Gomphus</i> sp.	PR	5								2			
<i>Lanthus parvulus</i>	PR	5										1	
<i>Sweltsa</i> sp.	PR	0											2
<i>Utaperla</i> sp.	PR	0											2
Perlidae	PR	1											1
<i>Acroneuria</i> sp.	PR	0								3		1	3
<i>Agnetina capitata</i>	PR	2				1							
<i>Paragnetina</i> sp.	PR	1									6		
<i>Taeniopteryx</i> sp.	SH	2								1			
Corydalidae	PR	5											
<i>Nigronia</i> sp.	PR	0		1	2	1	1	1		2			1
Brachycentridae	FC	1								3			
<i>Adicropheps hitchcocki</i>	SH	2								1			
<i>Micrasema</i> sp.	SH	2								5			
<i>Glossosoma</i> sp.	SC	0									1		
Hydropsychidae	FC	4	3	7					3				
<i>Cheumatopsyche</i> sp.	FC	5	13	41	5	19	34	16	14	1	1	4	7

Table B1. (Continued.)

Final Id	FFG	TV	B0217	B0218	B0219	B0220	B0221	B0222	B0223	B0224	B0226	B0227	B0225
<i>Hydropsyche betteni</i>	FC	6	40	26	33	5		45	60			7	7
<i>Hydropsyche morosa gr.</i>	FC	6					30				5		
<i>Macrostemum zebratum</i>	FC	3									1		
Hydroptilidae	GC	4								1			
<i>Agraylea sp.</i>	GC	8								1			
<i>Leucotrichia sp.</i>	SC	6				3							
<i>Oecetis sp.</i>	PR	5								1			
<i>Psilotreta sp.</i>	SC	0											1
Philopotamidae	FC	3											
<i>Chimarra sp.</i>	FC	4	1		21	6	6	3		4	3	14	
<i>Dolophilodes sp.</i>	FC	0											3
<i>Neureclipsis sp.</i>	FC	7								1			
<i>Psychomyia sp.</i>	GC	2				1							
<i>Rhyacophila sp.</i>	PR	1									2		2
Pyalidae	SH	5		2									
Elmidae	SC	4		1								4	1
<i>Optioservus sp.</i>	SC	4	1		2		1					1	
<i>Optioservus trivittatus</i>	SC	4					1						
<i>Oulimnius latiusculus</i>	SC	4				6							1
<i>Promoresia sp.</i>	SC	2								18	15	9	20
<i>Promoresia tardella</i>	SC	2				1					2		
<i>Stenelmis sp.</i>	SC	5	8	9	14	15	10	15	4	2		4	
<i>Stenelmis mirabilis</i>	SC	5									1		
<i>Gyrinus sp.</i>	PR	4							1				
<i>Psephenus herricki</i>	SC	4			2	8							
Chironomini	GC	6								1			
<i>Cryptochironomus sp.</i>	PR	8	1										
<i>Glyptotendipes sp.</i>	SH	10		1									
<i>Lauterborniella sp.</i>	GC	5								1			
<i>Microtendipes sp.</i>	FC	5				2							
<i>Polypedilum sp.</i>	SH	6				1							
<i>Polypedilum aviceps</i>	SH	4									1	1	1
<i>Polypedilum flavum</i>	SH	6					1		1				
<i>Polypedilum illinoense</i>	SH	6							1				
Tanytarsini	FC	6				1							
<i>Micropsectra sp.</i>	GC	7											5
<i>Micropsectra/Tanytarsus sp.</i>	FC	7										1	1
<i>Paratanytarsus sp.</i>	FC	6				2							
<i>Rheotanytarsus distinctissimus gr.</i>	FC	6							2	4	2		
<i>Rheotanytarsus exiguus gr.</i>	FC	6									1		1
<i>Tanytarsus sp.</i>	FC	6					1	2	1	8	5		
<i>Pagastia sp.</i>	GC	1				6							
<i>Potthastia longimana gr.</i>	GC	2								3			
Orthoclaadiinae	GC	5				1		1					
<i>Cardiocladius sp.</i>	PR	5				1	1		1				

Table B1. (Continued.)

Final Id	FFG	TV	B0217	B0218	B0219	B0220	B0221	B0222	B0223	B0224	B0226	B0227	B0225
<i>Cardiocladius albiplumus</i>	PR	5			1		2						
<i>Corynoneura</i> sp.	GC	4								1			1
<i>Cricotopus</i> sp.	SH	7					1						
<i>Cricotopus tremulus</i> gr.	SH	7				1		4					
<i>Cricotopus vierriensis</i>	SH	7				1							
<i>Cricotopus/Orthocladius</i> sp.	GC	7				1							
<i>Eukiefferiella</i> sp.	GC	6											1
<i>Eukiefferiella brehmi</i> gr.	GC	4											1
<i>Eukiefferiella devonica</i> gr.	GC	4								4	1	1	
<i>Nanocladius</i> sp.	GC	7								1			
<i>Parachaetocladius</i> sp.	GC	2										7	
<i>Parametrioctenus</i> sp.	GC	5								1	7		1
<i>Rheocricotopus</i> sp.	GC	6									5	4	1
<i>Tvetenia bavarica</i> gr.	GC	5									3		3
<i>Tvetenia vitracies</i> gr.	GC	5				1			1	1		4	
Tanypodinae	PR	7				1				1			
<i>Conchapelopia</i> sp.	PR	6	3	1				2		2	5		
<i>Meropelopia</i> sp.	PR	6										2	
<i>Nilotanypus</i> sp.	PR	6								3		1	
<i>Thienemannimyia</i> gr.	PR	6	2	1		1					1		1
Empididae	PR	6							1				
<i>Hemerodromia</i> sp.	PR	6	1	1		1				3			
Simuliidae	FC	6									1		
<i>Prosimulium</i> sp.	FC	2	1										
<i>Simulium</i> sp.	FC	5					1			1		2	
<i>Simulium fibrinflatum</i>	FC	6	22	10	5								
<i>Simulium jenningsi</i>	FC	4			2								
<i>Simulium vittatum</i>	FC	7		3									1
Tipulidae	SH	5			1								
<i>Antocha</i> sp.	GC	3				1	2	2					
Total Individuals			111	104	102	101	99	91	93	99	102	89	100

Table B2. RBP scoring summary from the 1995 Millers River watershed biomonitoring survey. Stations were located on the Otter River at Rte. 2A, Gardner (B0217), Rte. 101, Templeton/Gardner (B0218), Turner/Bridge St., Templeton/Gardner (B0219), Main St., Templeton (B0220), Rte. 202 (upstream), Templeton (B0221), Rte. 202 (downstream), Templeton (B0222), and in Winchendon near the mouth (B0223), and on Lawrence Brook near Doane Falls, Royalston (B0224), East Branch Tully River at Fryeville Rd., Orange/Athol (B0226), East Branch Tully River at Tully Rd./Pinedale Ave., Orange/Athol (B0227), and on West Branch Tully River at Tully Rd., Orange (B0225). For more complete station descriptions see Table 1. Abbreviations used for impact categories are: NI = *non-impacted*; SI = *slightly impacted*; MI = *moderately impacted*; Ref. = reference station. Abbreviations used for habitat comparability: Comp. = comparable (≈ 90% of reference habitat score) and Supp. = supporting (between about 75% and 90% of reference habitat score).

STATION:	B0217	B0218	B0219	B0220	B0221	B0222	B0223	B0224	B0226	B0227	B0225
Richness	12	10	14	25	18	9	13	33	22	21	30
HBI	5.32	5.36	5.03	4.32	5.15	5.49	5.68	3.72	4.57	4.54	3.22
EPT	4	2	5	9	7	3	3	14	8	6	13
EPT/Chiro	11.83	24.67	68.00	2.40	12.50	7.11	11.14	1.19	0.71	1.33	3.18
SC/FC	0.29	0.11	0.31	1.11	0.21	0.23	0.06	1.00	0.45	0.41	1.6
% Dom.	36%	39%	32%	19%	34%	49%	65%	18%	29%	20%	20%
Sim. (% Ref. Aff.)	53%	40%	54%	76%	48%	50%	37%	82%	63%	68%	100%
STATION:	B0217	B0218	B0219	B0220	B0221	B0222	B0223	B0224	B0226	B0227	B0225
Richness	40%	33%	47%	83%	60%	30%	43%	110%	73%	70%	100%
HBI	60%	60%	64%	75%	63%	59%	57%	87%	70%	71%	100%
EPT	31%	15%	38%	69%	54%	23%	23%	108%	62%	46%	100%
EPT/Chiro	373%	777%	2141%	76%	394%	224%	351%	38%	22%	42%	100%
SC/FC	18%	7%	19%	69%	13%	14%	4%	63%	28%	26%	100%
% Dom.	36%	39%	32%	19%	34%	49%	65%	18%	29%	20%	20%
Sim. (% Ref. Aff.)	53%	40%	54%	76%	48%	50%	37%	82%	63%	68%	100%
STATION:	B0217	B0218	B0219	B0220	B0221	B0222	B0223	B0224	B0226	B0227	B0225
Richness	2	0	2	6	4	0	2	6	4	4	6
HBI	2	2	2	4	2	2	2	6	4	4	6
EPT	0	0	0	2	0	0	0	6	0	0	6
EPT/Chiro	6	6	6	6	6	6	6	2	0	2	6
SC/FC	0	0	2	6	0	0	0	6	2	2	6
% Dom.	2	2	2	6	2	0	0	6	4	4	4
Sim. (% Ref. Aff.)	4	2	4	6	2	4	2	6	4	6	6
Total Score	16	12	18	36	16	12	12	38	18	22	40
Impact Category	MI	MI	MI	NI	MI	MI	MI	NI	MI	SI	Ref.
Habitat Score	135	143	131	111	124	145	130	154	149	147	135
Habitat Comparability	Comp.	Comp.	Comp.	Supp.	Comp.	Comp.	Comp.	Comp.	Comp.	Comp.	Ref.

Table B3. Benthic macroinvertebrate taxa list and data from the 2000 Millers River watershed biomonitoring survey. Stations were located on Priest Brook, Winchendon (B0448), Otter River near Turner/Bridge St., Templeton/Gardner (B0219), Otter River downstream from Rte. 202, Templeton (B0460), Beaver Brook, Templeton (B0450), Millers River, South Royalston (B0459), Lawrence Brook near Northeast Fitzwilliam Rd., Royalston (B0449), Lawrence Brook near Doane Falls, Royalston (B0447), East Branch Tully River at Tully Rd./Pinedale Ave., Orange/Athol (B0227), Millers River near Farley Road, Erving/Wendell (B0446), Lyons Brook, Wendell/Montague (B0445), and Millers River near the mouth, Erving/Montague (B0444). For more complete station descriptions see Table 1. The *FFG* column shows the feeding group category (FC = filtering collector, GC = gathering collector, PR = predator, SC = scraper, SH = shredder) and the *TV* column shows the tolerance value used for each taxon in calculating the Hilsenhoff Biotic Index (HBI).

Final Id	FFG	TV	B0448	B0219	B0460	B0450	B0459	B0449	B0447	B0227	B0446	B0445	B0444
<i>Ferrissia rivularis</i>	SC	10											1
Pisidiidae	FC	6		1		6	3		6	17	1		
Lumbricina	GC	8					3						
Enchytraeidae	GC	10										1	
<i>Pristina leidy</i>	GC	8						1					
Tubificidae IWB	GC	10	5										
<i>Lumbriculus variegatus</i>	GC	5		2							2	2	1
Hydrachnidia	PR	6			1	1							
<i>Heterocloeon</i> sp.	GC	2									6		
Baetidae (cerci only)	GC	6										6	
Baetidae (short term. fil.)	GC	6					1				1	26	
Baetidae (subeq. term.)	GC	6		6	1		1			1			2
EphemereIIDae	GC	1	1				1				8		
<i>Attenella</i> sp.	GC	1						3					3
<i>Serratella</i> sp.	GC	2											5
Heptageniidae	SC	4											2
<i>Epeorus (Iron)</i> sp.	SC	0										5	2
<i>Leucrocuta</i> sp.	SC	1									3		
<i>Stenonema</i> sp.	SC	3	13		2	12		10	5	7		3	
<i>Isonychia</i> sp.	GC	2					1				1		
Leptophlebiidae	GC	2								2			
<i>Habrophlebia vibrans</i>	GC	4						2					
<i>Hetaerina</i> sp.	PR	6						1					
<i>Sweltsa</i> sp.	PR	0										5	
Leuctridae	SH	0	1										
Nemouridae	SH	2										1	
<i>Tallaperla</i> sp.	SH	0										2	
<i>Acroneuria</i> sp.	PR	0	1			2							
<i>Agnetina</i> sp.	PR	2											1
<i>Paragnetina</i> sp.	PR	1										1	
<i>Nigronia</i> sp.	PR	0	1	1		5			2	2		1	
<i>Brachycentrus</i> sp.	FC	1	5						5	1	1	1	
<i>Micrasema</i> sp.	SH	2		2			7	2					
<i>Culoptila</i> sp.	SC	1											7
<i>Glossosoma</i> sp.	SC	0			1							13	1

Table B3. (Continued.)

Final Id	FFG	TV	B0448	B0219	B0460	B0450	B0459	B0449	B0447	B0227	B0446	B0445	B0444
<i>Helicopsyche borealis</i>	SC	3						2			1		1
<i>Cheumatopsyche</i> sp.	FC	5	8	5	18	11	6	1	8	2	1		3
<i>Hydropsyche betteni</i>	FC	6	10	7	5	7		3	2	11			
<i>Hydropsyche dicantha</i>	FC	2										1	
<i>Hydropsyche morosa</i> gr.	FC	6		1	9		19				4	13	16
<i>Macrostemum zebratum</i>	FC	3					9			4	1		
<i>Leucotrichia</i> sp.	SC	6			2		2						
<i>Lepidostoma</i> sp.	SH	1						1			1	1	
<i>Oecetis</i> sp.	PR	5				2	1	1		1			
<i>Psilotreta</i> sp.	SC	0	1										
<i>Chimarra</i> sp.	FC	4	2	1	2	5		1		9	12	1	16
<i>Neureclipsis</i> sp.	FC	7						1					
<i>Psychomyia</i> sp.	GC	2					1						
<i>Rhyacophila</i> sp.	PR	1						1		1	1		
<i>Agarodes</i> sp.	GC	3						1					
<i>Petrophila</i> sp.	SC	5					1						
<i>Dubiraphia vittata</i>	GC	6					1						
<i>Microcyloopus pusillus</i>	GC	3		2					2	2			
<i>Optioservus</i> sp.	SC	4		1	1						1		2
<i>Optioservus fastiditus</i>	SC	4										1	
<i>Oulimnius latiusculus</i>	SC	4					2	1		3			
<i>Promoresia tardella</i>	SC	2	7	1		10		18	4	14			
<i>Stenelmis</i> sp.	SC	5	9	56	22	25	13	1	2	8	12		24
<i>Stenelmis crenata</i>	SC	5			1		1						1
<i>Stenelmis mirabilis</i>	SC	5							2		1		1
<i>Stenelmis sandersoni</i>	SC	5									1		
<i>Ectopria nervosa</i>	SC	5				1							
<i>Psephenus herricki</i>	SC	4		6	4		1						
<i>Probezzia</i> sp.	PR	6						1					
<i>Polypedilum aviceps</i>	SH	4								1		3	
<i>Polypedilum flavum</i>	SH	6					5						
<i>Polypedilum illinoense</i>	SH	6						1					
<i>Stenochironomus</i> sp.	GC	5						1					
Tanytarsini	FC	6	1										
<i>Constempellina</i> sp.	GC	4						1					
<i>Micropsectra</i> sp.	GC	7										1	
<i>Rheotanytarsus distinctissimus</i> gr.	FC	6			3	1	1	21	7	3			1
<i>Rheotanytarsus exiguus</i> gr.	FC	6						1	3	3	8		2
<i>Tanytarsus</i> sp.	FC	6						2					
<i>Pagastia</i> sp.	GC	1		3									
<i>Potthastia longimana</i> gr.	GC	2			1			1		1			
<i>Cardiocladius</i> sp.	PR	5					2						
<i>Cardiocladius albiplumus</i>	PR	5	1		4								
<i>Corynoneura</i> sp.	GC	4	2				1		2			2	
<i>Cricotopus</i> sp.	SH	7			1								1

Table B3. (Continued.)

Final Id	FFG	TV	B0448	B0219	B0460	B0450	B0459	B0449	B0447	B0227	B0446	B0445	B0444
<i>Cricotopus annulator</i>	SH	7					1						
<i>Cricotopus/Orthocladius</i> sp.	GC	7							3				
<i>Eukiefferiella claripennis</i> gr.	GC	8			1								
<i>Eukiefferiella devonica</i> gr.	GC	4			6		7		16		1		
<i>Eukiefferiella gracei</i> gr.	GC	4											1
<i>Nanocladius parvulus</i> gr.	GC	7							2				
<i>Nanocladius (P.) downesi</i>	GC	3	1										
<i>Orthocladius</i> sp.	GC	6					1						
<i>Orthocladius annectans</i>	GC	6							4				
<i>Parachaetocladius</i> sp.	GC	2						1					
<i>Parametricnemus</i> sp.	GC	5				1		2				2	
<i>Rheocricotopus</i> sp.	GC	6	1			1			7	6			
<i>Thienemanniella</i> sp.	GC	6	1				1				1		
<i>Tvetenia</i> sp.	GC	5									1		
<i>Tvetenia bavarica</i> gr.	GC	5			15	2		2				8	
<i>Tvetenia vitracies</i> gr.	GC	5	5				6	1	6	9		1	2
<i>Conchapelopia</i> sp.	PR	6	3			2		7	7				
<i>Larsia</i> sp.	PR	7						1					
<i>Thienemannimyia</i> sp.	PR	6				3			3				
<i>Hemerodromia</i> sp.	PR	6	2	1	2	4	1		2				
<i>Prosimulium</i> sp.	FC	2										1	
<i>Simulium</i> sp.	FC	5							2				
<i>Simulium fibrinflatum</i>	FC	6									18		
<i>Simulium gouldingi</i>	FC	3	4		3								
<i>Simulium nyssa</i>	FC	5									3		
<i>Simulium tuberosum</i> cplx.	FC	4			3								
<i>Simulium venustum</i> cplx.	FC	5	11										
<i>Antocha</i> sp.	GC	3			2		2						
<i>Hexatoma</i> sp.	PR	2										1	
<i>Tipula</i> sp.	SH	6	1										
Total Individuals			97	96	110	101	102	99	96	110	91	102	96

Table B4. RBP scoring summary from the 2000 Millers River watershed biomonitoring survey. Stations were located on Priest Brook, Winchendon (B0448), Otter River near Turner/Bridge St., Templeton/Gardner (B0219), Otter River downstream from Rte. 202, Templeton (B0460), Beaver Brook, Templeton (B0450), Millers River, South Royalston (B0459), Lawrence Brook near Northeast Fitzwilliam Rd., Royalston (B0449), Lawrence Brook near Doane Falls, Royalston (B0447), East Branch Tully River at Tully Rd./Pinedale Ave., Orange/Athol (B0227), Millers River near Farley Road, Erving/Wendell (B0446), Lyons Brook, Wendell/Montague (B0445), and Millers River near the mouth, Erving/Montague (B0444). For more complete station descriptions see Table 1. Abbreviations used for impact categories are: NI = *non-impacted*; SI = *slightly impacted*; Ref. = reference station. Abbreviations used for habitat comparability: Comp. = comparable (≥ 90% of reference habitat score) and Supp. = supporting (between about 75% and 90% of reference habitat score).

STATION:	B0448	B0219	B0460	B0450	B0459	B0449	B0447	B0227	B0446	B0445	B0444
Richness	25	16	23	19	29	33	22	23	24	25	22
HBI	4.37	4.77	4.91	4.32	4.83	4.06	4.93	4.39	4.32	3.91	4.29
EPT	9	6	8	6	11	14	4	10	13	13	12
EPT/Chiro	2.80	7.33	1.29	3.90	1.96	0.81	0.27	1.70	3.73	4.59	8.43
SC/FC	0.73	4.27	0.77	1.60	0.53	0.91	0.38	0.68	0.39	1.38	1.11
% Dom.	13%	58%	20%	25%	19%	21%	17%	15%	20%	25%	25%
Sim. (% Ref. Aff.)	69%	49%	72%	63%	68%	100%	69%	71%	66%	55%	63%
STATION:	B0448	B0219	B0460	B0450	B0459	B0449	B0447	B0227	B0446	B0445	B0444
Richness	76%	48%	70%	58%	88%	100%	67%	70%	73%	76%	67%
HBI	93%	85%	83%	94%	84%	100%	82%	92%	94%	104%	95%
EPT	64%	43%	57%	43%	79%	100%	29%	71%	93%	93%	86%
EPT/Chiro	346%	906%	159%	482%	242%	100%	33%	209%	460%	567%	1041%
SC/FC	80%	467%	84%	175%	58%	100%	41%	74%	42%	150%	121%
% Dom.	13%	58%	20%	25%	19%	21%	17%	15%	20%	25%	25%
Sim. (% Ref. Aff.)	69%	49%	72%	63%	68%	100%	69%	71%	66%	55%	63%
STATION:	B0448	B0219	B0460	B0450	B0459	B0449	B0447	B0227	B0446	B0445	B0444
Richness	4	2	4	2	6	6	4	4	4	4	4
HBI	6	6	4	6	4	6	4	6	6	6	6
EPT	0	0	0	0	2	6	0	2	6	6	4
EPT/Chiro	6	6	6	6	6	6	2	6	6	6	6
SC/FC	6	6	6	6	6	6	4	6	4	6	6
% Dom.	6	0	4	4	6	4	6	6	6	4	4
Sim. (% Ref. Aff.)	6	4	6	4	6	6	6	6	6	4	4
Total Score	34	24	30	28	36	40	26	36	38	36	34
Impact Category	NI	SI	SI	SI	NI	Ref.	SI	NI	NI	NI	NI
Habitat score	163	155	186	190	181	195	180	179	182	159	170
Habitat comparability	Supp.	Supp.	Comp.	Comp.	Comp.	Ref.	Comp.	Comp.	Comp.	Supp.	Supp.

Appendix C

U.S.G.S. Stream Gage Data

Table C1. Monthly mean discharges^A (m³/s) from USGS gages in the Millers River watershed.

Gage 01162000—Millers River near Winchendon, MA; 7Q10 ^B 0.20 m ³ /s												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	2.92	3.17	8.38	13.90	5.83	1.03	0.82	1.83	2.03	3.96	1.33	6.68
1995	7.48	2.97	7.45	3.85	2.48	1.48	0.37	0.43	0.35	6.03	10.17	2.70
1999	3.88	4.19	6.68	2.36	1.27	1.34	2.32	0.34	4.73	7.67	4.39	4.36
2000	3.09	4.30	12.15	9.68	5.89	5.32	1.31	3.11	1.75	2.82	3.00	4.73
Gage 01162500—Priest Brook near Winchendon, MA; 7Q10 ^B 0.011 m ³ /s												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	0.72	0.77	2.23	3.88	1.35	0.25	0.09	0.18	0.24	0.27	0.29	1.62
1995	1.66	0.53	1.59	0.91	0.52	0.16	0.05	0.07	0.03	1.38	2.47	0.55
1999	1.25	1.36	2.31	0.75	0.36	0.49	0.72	0.07	1.41	1.06	0.95	0.99
2000	0.80	0.92	2.83	2.14	1.09	0.89	0.30	0.97	0.50	0.48	0.66	0.97
Gage 01163200—Otter River at Otter River, MA; 7Q10 ^B 0.13 m ³ /s												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	1.63	1.69	4.33	4.87	2.17	0.54	0.67	1.31	0.82	0.72	0.81	2.92
1995	2.82	1.44	2.74	1.47	1.06	0.82	0.26	0.21	0.16	2.50	3.48	1.15
1999	1.88	2.19	3.51	1.39	0.79	0.26	0.26	0.15	1.49	1.25	1.29	1.53
2000	1.28	1.76	3.94	3.99	2.51	2.74	0.77	1.34	0.85	0.81	1.13	1.69
Gage 01166500—Millers River, Erving, MA; 7Q10 ^B 1.33 m ³ /s												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	13.39	14.89	40.24	61.45	24.18	5.78	5.07	7.90	5.55	7.42	6.82	27.58
1995	32.11	14.87	26.93	20.19	11.67	8.81	3.17	2.66	1.43	23.50	43.15	14.16
1999	18.35	25.34	36.98	18.04	8.10	5.21	10.08	1.95	26.76	19.06	16.76	18.86
2000	15.94	20.27	42.50	41.77	23.50	24.30	8.64	17.30	8.07	8.86	11.58	20.70

^A Data obtained over the internet from <http://waterdata.usgs.gov/nwis/discharge>.

^B Values for 7Q10 are from Wandle 1984.

APPENDIX D – SUMMARY OF NPDES AND WMA PERMITTING INFORMATION, MILLERS RIVER WATERSHED

Table D1. Millers River Watershed Municipal Surface Wastewater Discharges.

Permittee	NPDES #	Issuance	Flow (MGD)	Dilution Factor ¹	Special Conditions/Notes	Receiving Water (segment)
Ashburnham & Winchendon Joint Water Authority WTP	MAG640045	2003	0.2	Not calculated		UPPER NAUKEAG LAKE (Segment MA35090)
Athol WWTP*	MA0100005	2003	1.75	10:1	2003 permit includes a requirement for a phosphorus loading, evaluation, and reduction program; total phosphorus limit of 1.0 mg/l effective May 2005, total nitrogen monitoring and reporting is also required; 7Q10 estimate = 23.98 cfs	MILLERS RIVER (Segment MA35-04)
Erving Center, Erving*	MA0101052	1998	3.15	11:1	Treated discharge is comprised of approximately 95% paper mill wastewater and 5% sanitary wastewater, IPP required, total nitrogen monitoring and reporting will also be required, 7Q10 estimate = 46.52cfs	MILLERS RIVER (Segment MA35-05)
Erving POTW #3*	MA0102776	1999	0.01		New permit will include a requirement for total nitrogen monitoring and reporting	Unnamed tributary of MILLERS RIVER (Segment MA35-05)
Erving POTW #1 (Village of Millers Falls)*	MA0101516	1998	1.02	31:1	New permit will include a requirement for total nitrogen monitoring and reporting, IPP(**) required, 7Q10 estimate = 48 cfs	MILLERS RIVER (Segment MA35-05)
Gardner Water Treatment Facility	MAG640041	2002	0.47	1.04:1	Online in May 2000, experiencing operational problems and are planning to upgrade facility, high aluminum concentrations detected in discharge	CRYSTAL LAKE (MA35014) and through storm drain system to POND BROOK (see Otter River Segment MA35-06)
Gardner Wastewater Treatment Facility (WWTF) in East Templeton*	MA0100994	1998	5.0	1.57:1	New permit will include a requirement for a phosphorus loading, evaluation and reduction program; proposed total phosphorus limit is 0.2 mg/L; total nitrogen monitoring and reporting will also be required; EPA scheduled to reissue permit in 2004; IPP required	OTTER RIVER (Segment MA35-07)

Table D1 (cont). Millers River Watershed Municipal Surface Wastewater Discharges.

Permittee	NPDES #	Issuance	Flow (MGD)	Dilution Factor ¹	Special Conditions/ notes	Receiving Water (segment)
Orange WWTP, Orange*	MA0101257	2003	1.1	25:1	2003 permit includes a requirement for a phosphorus loading, evaluation and reduction program; total phosphorus limit will likely be imposed; total nitrogen monitoring and reporting will also be required; 7Q10 estimate = 40.84 cfs	MILLERS RIVER (Segment MA35-04)
Royalston WWTF*	MA0100161	1999	0.039		New permit will include a requirement for total nitrogen monitoring and reporting	MILLERS RIVER (Segment MA35-04)
Templeton Development Center (formerly the Fernald School) WWTF, Templeton	MA0102156	1999	0.05		New permit will include a requirement for a phosphorus loading, evaluation and reduction program; total phosphorus limit will likely be imposed; total nitrogen monitoring and reporting will also be required	BEAVER BROOK (Segment MA35-09)
Templeton WWTF, Templeton	MA0100340	1999	2.8		Facility designed to treat sanitary and industrial wastewater. New permit will include a requirement for a phosphorus loading, evaluation and reduction program; total phosphorus limit will likely be imposed; total nitrogen monitoring and reporting will also be required	OTTER RIVER (Segment MA35-08)
Town of Gardner	MAR041190	2003	Stormwater		Mapped regulated area in community - Partial	MILLERS RIVER (Segment MA35-03), OTTER RIVER (segments MA35-06 and MA35-07)
Town of Templeton	MAR041225	2003	Stormwater		Mapped regulated area in community - Partial	MILLERS RIVER (Segment MA35-03), OTTER RIVER (Segment MA35-07)
Winchendon WPCF, Winchendon*	MA0100862	1998	0.5		New permit will include a requirement for a phosphorus loading, evaluation and reduction program; total phosphorus limit will likely be imposed; total nitrogen monitoring and reporting will also be required	MILLERS RIVER (Segment MA35-02)

* Quarterly monitoring for nitrogen will be required to determine loading to Long Island Sound.

Dilution factor¹ = $Q_e + Q_r / Q_e$ where Q_e is the design effluent flow and Q_r is the estimated 7Q10 of receiving stream

IPP** = industrial pretreatment program

Table D2. Millers River Watershed industrial NPDES wastewater discharge facilities.

Permittee	NPDES #	Issuance	Flow (MGD)	Types of Discharge	Receiving Water (segment)
Bunzl Extrusion of Athol	MAR05B880 and MAR05B879		Stormwater		MILLERS RIVER (Segment MA35-04)
C & W Fabricators of Gardner	MAR05B882		Stormwater		OTTER RIVER (Segment MA35-06)
Duall Plastics Inc. of Athol	MAR05B626		Stormwater		MILLERS RIVER (Segment MA35-04)
Erving Paper Mills of Erving	MAR05C298		Stormwater		MILLERS RIVER (Segment MA35-05)
Kirk Eastern of Gardner	MAR05C291		Stormwater		OTTER RIVER (Segment MA35-06)
L.S. Starrett Company of Athol	MA0001350	2004	Outfall #002 - 0.07 MGD of treated process wastewater (7Q10 of river from FACT SHEET = 21.97 cfs or 14.2 MGD) Outfall #004 - 0.0072 MGD NCCW * Outfall #005 - 0.02 MGD NCCW Outfall #006 - 0.071 MGD NCCW Outfall #007 - 0.02 MGD NCCW (permitted to discharge only up to 0.0982 MGD NCCW in the event of a breakdown of the reuse system)		MILLERS RIVER (Segment MA35-04)
L.S. Starrett Company of Athol	MAR05B615		Stormwater		MILLERS RIVER (Segment MA35-04)
Nichols & Stone Co. of Gardner	MAR05B747		Stormwater		OTTER RIVER (SEGMENT MA35-06)
Rodney Hunt Company of Orange	MAR05B630		Stormwater		MILLERS RIVER (Segment MA35-04)
S. Bent & Bros., Inc.	MA0002801	1987	Facility closed down in 2000. Permit file closed by EPA in Jan 2002.		OTTER RIVER (Segment MA35-06)
Seaman Paper Company of Massachusetts, Inc. WWTF in East Templeton *	MA0000469	1998	1.4 MGD of treated process wastewater		OTTER RIVER (Segment MA35-08)
Simplex Time Recorder, Co. Inc. of Gardner	MA0002411		Tied into Gardner WWTF in Sept 1993		OTTER RIVER (Segment MA35-06)
Toytown Auto Salvage of Winchendon	MAR05B730		Stormwater		MILLERS RIVER (Segment MA35-20)

*NCCW = non-contact cooling water

Table D3. List of WMA registered and permitted average annual water withdrawals in the Millers River Watershed (LeVangie, D. 2002. Water Management Act Database. Massachusetts Department of Environmental Protection, Bureau of Resource Protection, Database Manager. Boston, MA.).

Permit	Registration	PWSID	System Name	Registered Volume (MGD)	20 Year Permitted Volume (MGD)	Source	Well/Source Name (G = groundwater S= surface water)	Withdrawal Location (Segment)
	10709101		American Tissue Mills of Mass, Inc.	2.02	0		Otter River withdrawal (S)	Otter River (MA35-08)
							Depot Pond withdrawal (S)	Depot Pond (MA35018)
	10709102		Erving Paper Mills	2.66	0		Erving Paper Mills well 1 (G)	Millers River (MA35-04)
							Erving Paper Mills well 2 (G)	Millers River (MA35-04)
							Millers River Intake (S)	Millers River (MA35-04)
9P210709101	10719201		International Paper-Strathmore Paper	0.14	0.61		Intake 1A	Millers River (MA35-05)
9P10722301	10722301	1223000	Orange Water Department	0.63	0.33	223-01G	Minute Tapioca Well/ GP Well#1 Crystal Spring (G)	Millers River (MA35-04)
						223-04G	Daniel Shays Hwy Well/GP Well#3 Route 202 (G)	Millers River (MA35-04)
						223-02G	MaGee's Meadow Well (G)	Millers River (MA35-04)
	20701101	2011000	Ashburnham Water Department	0.18	0		Upper Naukeag Lake (S)	Millers River (MA35-01), Upper Naukeag Lake (MA35090)
9P220701501	20701501	2015000	Athol Water Department	1.04	0	2015000-03G	Tully Well #2 (G)	Tully River (MA35-14)
						2015000-02G	Tully Well #1 (G)	Tully River (MA35-14)
						015-01	South Street Well (G)	Millers River (MA35-04)
						015-02S	Newton Reservoir (S)	Millers River (MA35-04)
						015-01S	Phillipston Reservoir (S)	Phillipston Reservoir (MA35060)
						2015000-04G	Tully Well (G)	Tully River (MA35-14)
9P220710302	20710301	2103000	Gardner Water Department	1.69	0.63	2103000-01S	Crystal Lake (S)	Otter River (MA35-06), Crystal Lake (MA35014)
						103-03S	Cowee Pond (Marm Johns) (S)	Otter River (MA35-07), Cowee Pond (MA35013)
						103-02S	Perley Brook (S)	Otter River (MA35-07), Perley Brook Reservoir (MA35059)
						2103000-01G	Otter River Well (also known as Snake Pond Well) (G)	Otter River (MA35-06)

Table D3 cont. List of WMA registered and permitted average annual water withdrawals in the Millers River Watershed (LeVangie, D. 2002. Water Management Act Database. Massachusetts Department of Environmental Protection, Bureau of Resource Protection, Database Manager. Boston, MA.).

Permit	Registration	PWSID	System Name	Registered Volume (MGD)	20 Year Permitted Volume (MGD)	Source	Well/Source Name (G = groundwater S= surface water)	Withdrawal Location (Segment)
9P20729401	20729401	2294000	Templeton Water Department	0.53	0.42	294-04G	Birch Hill Well #1 (G)	Otter River (MA35-08)
						294-06G	Sawyer Street Well (G)	Otter River (MA35-07)
						294-05G	Birch Hill Well #2 (G)	Otter River (MA35-08)
						294-01G	Otter River Well (G)	Otter River (MA35-07)
	20729402		Seaman Paper Co. of Mass, Inc	1.19	0		Otter River Otter River Well	Otter River (MA35-08)
	20734301	2343000	Winchendon Water Department	0.67	0	343-01S	Upper Naukeag Lake (S)	Millers River (MA35-01), Upper Naukeag Lake (MA35090)

APPENDIX E - MA DEP GRANT AND LOAN PROGRAMS

Excerpted from MA DEP/DWM World Wide Web site <http://www.mass.gov/dep/brp/wm/wmpubs.htm#other>. 'Grant and Loan Programs - Opportunities for Watershed Planning and Implementation' and projects specific to the Millers Watershed.

104(b)(3) WETLANDS AND WATER QUALITY GRANT PROGRAM

This Grant Program is authorized under Wetlands and Clean Water Act Section 104(b)(3) of the federal Clean Water Act. The Water Quality proposals received by MA DEP under this National Environmental Performance Partnership Agreement (NEPPA) with the U.S. Environmental Protection Agency is a results oriented approach that will focus attention on environmental protection goals and the efforts to achieve them. The goals of the NEPPA are to: 1) achieve clean air, 2) achieve clean water, 3) protect wetlands, 4) reduce waste generation, and 5) clean up waste sites.

- 97-09/104 *Project on Numeric Biocriteria*. This proposal is designed to address two issues relating to the current Biocriteria Pilot Study; specifically, to evaluate subcoregion difference in stream biota, if any, and formulate the biological indicators (fish and macroinvertebrates) that are essential to assess conditions and monitor changes in streams. Study expects to establish reference streams in 5 of the 13 Massachusetts Ecological Subregions. The study streams are located in the Connecticut, Westfield, Chicopee, Millers and Quinebaug River Basins.

Numeric Biocriteria sampling in the Millers River Watershed. Subcoregion = Lower Worcester-Monadnock Plateau:

Candidate Reference Stream	Station	Sampling Dates
Keyup Brook	WM13KEY	September 1996 September 2000
Mormon Hollow Brook	WM10MOR	September 1996 September 1998 September 2000
Whetstone Brook	WM04WHE	September 1996 September 2000
Boyce Brook	WM17BOY	September/October 1996 September 2000
West Branch Tully River	WM15WBT	September/October 1996 September 2000
Otter River	WM05OTT	September/October 1996
East Branch Tully River	WM16EBT	September/October 1996
Lawrence Brook	WM19LAW	September/October 1996

MA DEP DWM. 2000. Open files. *Biocriteria Development Project files*. Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

- 99-06/104 *Lake Surveys for TMDL Development*. The objective for this statewide study is to provide a database for lakes listed as impaired on the 303(d) List. Data such as secchi, bathymetry, nutrients, aquatic plant species composition and plant coverage will be compiled to determine optimal plant coverage for fisheries. Additionally, the Division will provide technical assistance and transfer of fisheries data to government agencies and private organizations involved in watershed management and assist in the development of volunteer and watershed participant action plans. Two ponds in the Millers River Watershed, Stoddard and Whitney ponds, were sampled as part of this project in 2000.

604(b) WATER QUALITY PLANNING GRANT PROGRAM

This grant program is authorized under Section 604(b) of the Federal Clean Water Act. The program is designed to assist eligible recipients in providing water quality assessment and planning assistance to local communities. Priority is given to projects that provide diagnostic information to support the MA DEP's watershed management activities and to projects located in one of the priority watersheds targeted for assessment work by the MA DEP.

- 00-03/604 *Millers River Watershed Non-point Source Pollution Assessment*. This project will use MASS GIS data layers, state reports, community input, and field work to identify potential non-point source pollution. Additionally, an action plan will be created that incorporates Watershed Basin Team and Watershed Council goals.

319 NONPOINT SOURCE GRANT PROGRAM

This grant program is authorized under Section 319 of the CWA for implementation projects that address the prevention, control, and abatement of nonpoint source (NPS) pollution. In order to be considered eligible for funding projects must: implement measures that address the prevention, control, and abatement of NPS pollution; target the major source(s) of nonpoint source pollution within a watershed/subwatershed; have a 40 percent non-federal match of the total project cost (match funds must meet the same eligibility criteria as the federal funds); contain an appropriate method for evaluating the project results; address activities that are identified in the Massachusetts NPS Management Program Plan.

- 01-03/319 *Parker Pond Restoration, Gardner*. This project will fund part of Gardner's program to restore the warm water fishery and recreational potential of Parker Pond. It will address stormwater discharges by installing three Vortechs® units and a phytoremediation system at the outlet of Wasa Street; increase the frequency of street sweeping and stormdrain maintenance in downtown Gardner; and conduct an outreach and public education program.

MASSACHUSETTS WATERSHED INITIATIVE PROJECT

Each year EOE Watershed Team Leaders, in conjunction with State and Federal agencies, municipal governments and regional planning agencies, universities, local watershed associations, businesses and other groups, develop work plans that identify the most important goals for each watershed and the specific projects and programs which are needed to meet those goals.

- 99-05/MWI *Characterization of Polychlorinated Biphenyls (PCBs) in the Millers River Watershed*. This project will begin to investigate the current sources of PCBs in the Millers River Basin by deploying passive sampling devices at selected locations on the Millers and Otter rivers.
- 00-01/MWI *Characterization of Polychlorinated Biphenyls (PCBs) in the Millers River Watershed Phase 2 Investigations*. This project will continue to investigate the current sources of PCBs in the Millers River Basin by deploying passive sampling devices at selected locations on the Millers and Otter rivers.
- 01-13/MWI *Characterization of Polychlorinated Biphenyls (PCBs) in the Millers River Watershed Phase 3 Investigations*. This project will continue to investigate the current sources of PCBs in the Millers River Basin by deploying passive sampling devices at selected locations on the Millers and Otter rivers.

SOURCE WATER AND TECHNICAL ASSISTANCE/LAND MANAGEMENT GRANT PROGRAM

The Source Water Protection Technical Assistance/Land Management Grant Program provides funds to third party technical assistance organizations that assist public water suppliers in protecting local and regional ground and surface drinking water supplies.

- 00-06/SWT *Crystal Lake Source Water Protection Project*. This project will develop a comprehensive Surface Water Supply Protection Plan for the City of Gardner's surface water supply system consisting of Cowee Pond, Perley Brook Reservoir, and Crystal Lake; identify potential sources and pathways of contamination and provide a plan to reduce non-point discharges to surface waters; and incorporate an all-inclusive educational program.

WELLHEAD PROTECTION GRANT PROGRAM

The wellhead protection grant program provides funds to assist public water suppliers in addressing wellhead protection through local projects and education.

- 99-14/WHP *Templeton Wellhead Protection Project*. This project will install fencing, gates, and protection signs around the Zone I area of two of Templeton's four wells. New fencing will prevent vehicles from gaining access to the Otter River and Sawyer Street wells, and will provide additional security to the pump station.

CLEAN WATER STATE REVOLVING LOAN FUND (SRF) PROGRAM

The Massachusetts State Revolving Loan Fund for water pollution abatement projects was established to provide a low-cost funding mechanism to assist municipalities seeking to comply with federal and state water quality requirements. The focus of the SRF Program is to provide incentives to communities to undertake projects with meaningful water quality and public health benefits and which address the needs of the communities and the watershed.

- 98-130/SRF *The Closure Plan for the Winchendon Sanitary Landfill*. This project will provide for the construction of approximately thirteen acres of an impervious landfill cap with vegetative support layer and associated stormwater management structures and landfill gas venting appurtenances. The site is approximately 1,200 feet from the Millers River.
- 2001 – *Winchendon Sewer System and Waste Water Treatment Facility (WWTF) Improvements* (phased project). The town of Winchendon has experienced raw sewage backing up into storm water drains, sanitary sewer overflows and raw sewerage from the sewer system backing up into private homes. This project includes upgrades and expansion of the capacity of the WWTF as well as improvements to the sewerage collection system. This combination of improvements to the plant and collection system is expected to decrease pollution entering the environment.

DRINKING WATER STATE REVOLVING LOAN FUND (SRF) PROGRAM

The Massachusetts Drinking Water State Revolving Fund (DWSRF) provides low-cost financing to help community public water suppliers comply with federal and state drinking water requirements. The DWSRF Program's goals are to protect public health and strengthen compliance with drinking water requirements, while addressing the Commonwealth's drinking water needs. The Program incorporates affordability and watershed management priorities. The DWSRF Program is jointly administered by the Division of Municipal Services of the Department of Environmental Protection and the Massachusetts Water Pollution Abatement Trust. The current subsidy level is equivalent to a 50% grant, which approximates a two percent interest loan. The Program will initially operate with approximately \$50 million in financing capacity. For calendar years 1999 through 2003, up to \$400 million may be available through the loan program.

- 1998 - *Ashburnham /Winchendon Filtration Plant*. The towns of Ashburnham and Winchendon were under an MA DEP Consent Order to comply with the Surface Water Treatment Rule by providing filtration and disinfection of its water source, Upper Naukeag Lake. Under this project, a 2.0 MGD plant was designed and built, and a Joint Water Authority operates the plant.
- 1998 – *Gardner Crystal Lake Water Filtration Plant*. The city of Gardner was under an MA DEP Consent Order to comply with the Surface Water Treatment Rule by providing filtration and disinfection of its water source, Crystal Lake. Through this project, a 4.0 MGD plant was designed and built and is currently being operated by the Gardner Department of Public Works Water Division.
- 2003 – *Gardner Snake Pond Well Improvements*. This project involves iron and manganese precipitation and removal using pressure filters, insuring that the water is properly conditioned prior to entry into the distribution system to prevent lead and copper from leaching into the water in the distribution system.

APPENDIX F

Technical Memorandum

MILLERS RIVER PERIPHYTON - 2000

Prepared by Joan Beskenis
MA DEP/Division of Watershed Management, Worcester, MA

May 2003

During the summer of 2000, MA DEP personnel collected periphyton (attached algal community) samples from stations in the Millers River basin. Sampling was limited to sites chosen for macroinvertebrate investigations and was conducted as part of the macroinvertebrate/habitat assessment. It consisted of random scrapes of the substrate within the riffle zone for algal identifications and estimations of the percent cover of the algae within the reach. Occasionally other habitats, such as pools, were included for investigation. The aquatic communities (macroinvertebrates, periphyton and fish) are assessed, in part, to determine if the designated uses (Massachusetts Surface Water Quality Standards, 1996) are being supported, threatened or lost in particular segments. The Millers River segments included in this study are all Class B, Warm Water Fisheries. Periphyton data can be used to evaluate two uses of the Millers River: Aquatic Life and Aesthetics.

Aquatic life evaluations are used to determine if suitable habitat is available for "sustaining a native, naturally diverse, community of aquatic flora and fauna." Natural diversity and the presence of native species may not be sustained where there are dense growths of a monoculture of a particular alga. This alteration of the community structure can mean that the aquatic life use support is lost or threatened. Important components of the food chain, which are vital for use support, may be lost from this alteration. In addition, the large amounts of biomass from macroalgae when they deteriorate and die can fill in the interstitial sites in the substrate and degrade this habitat for the benthic invertebrates, thus further compromising the aquatic life use support. Nuisance growths of algae can compromise the substrates and alter water chemistry (e.g., dissolved oxygen values).

Nuisance amounts of algae can be determined by gathering estimates of the percent cover as well as determining the relative amounts of both macroalgae (visible with naked eye) or microalgae (examined microscopically) in a particular habitat (e.g. riffles or pool) (Biggs, 1996, Barbour et al., 1999). The percent cover by filamentous green algae (macroalgae) greater than 40% is an indication that nuisance amounts of algae are present and that use of the benthic habitat by aquatic life may be threatened (Biggs 1996, Barbour et al., 1999).

The algal data are also used to determine if aesthetics have been impacted. Floating rafts of previously attached benthic mats can make an area visually unappealing, as can large areas of the bottom substrates covered with long streamers of algae.

The focus of this memo is to document if nuisance amounts of algal growth were present. This is based upon percent cover of the algal population as well as determination of the type and form of the algae that were present. Other objectives of the periphyton sampling were to learn more about the biota in the streams and rivers, to offer a means of comparing biological communities in conjunction with the macroinvertebrate and habitat information, and to examine community changes over time.

MATERIALS and METHODS

Periphyton Identifications and Relative Abundance

Periphyton data were gathered along with the macroinvertebrate and habitat data using methods described in Barbour et al. (1999). Sampling was done by John Fiorentino and consisted of randomly scraping rocks and cobble substrates, typically within the riffle area, with a knife and collecting the

material in a labeled glass vial. The samples were transported to the lab MA DEP-DWM-Worcester without refrigeration, but once at the lab they were refrigerated until identifications were completed.

The vial was shaken to get a uniform sample before subsampling. If filamentous algae comprised most of the sample they were removed first, identified separately and then the remainder of the sample was examined. An Olympus BH2 compound microscope with Nomarski optics was used for the identifications. Slides were typically examined under 200 power. A modified method for periphyton analysis developed by Bahls (1993) was used. The scheme developed by Bahls for determining abundance is as follows:

R (rare) fewer than one cell per field of view at 200x, on the average;
 C (common) at least one, but fewer than five cells per field of view;
 VC (very common) between 5 and 25 cells per field;
 A (abundant) more than 25 cells per field, but countable;
 VA (very abundant) number of cells per field too numerous to count.

This determination of abundance provides a relative approximation of the taxa that contribute the most to the biomass in the riffle or pool habitats. Information obtained from the algal identifications and relative abundance is combined with information obtained in the habitat assessment; in particular, canopy cover and percent algal cover. Locations where potential problem areas are found based upon percent algal cover and abundance, are noted. The information can be used by assessment personnel in the determination of whether or not aesthetics and aquatic life uses are impaired.

RESULTS

Table 1 lists the stations that were included in this study and presents descriptions of their locations as well as the percent canopy cover and the percent algal cover. The data are included in Appendix A.

Station#	Stream-location	Date	% Canopy Cover	% Algal Cover	Dominant Algal Type/ Forms-Habitat	Nuisance Algal Growth
B0219	Otter River-upstream/southeast from Bridge/Turner St., Gardner/Templeton	Sept. 14	40	5	Greens-Filamentous on rock, moss/riffle	No
B0460	Otter River-approximately 400 m downstream/ west from Rte 202, Templeton	Sept. 13	40	30	Diatoms- rock/riffle, filamentous-green/algal mat	No
B0459	Millers River-approximately 100 m upstream from Royalston WWTP, village of South Royalston, Royalston	Sept. 12	5	75	Green film-rock/riffle Green filamentous-rock/riffle, mat	No
B0227	East Branch Tully River-immediately east from Pinedale Ave., Tully Rd., Athol/Orange	Sept. 12	50	20	Blue-greens mats-pool	No
B0445	Lyons Brook-immediately upstream from the confluence with the Millers River, Wendell/Montague	Sept. 11	5	5	Green filamentous-rock/pool	No
B0444	Millers River-approximately 520 m upstream /south of mouth, Erving/Montague	Sept. 11	<5	80	Green film-rock/riffle	No

Nuisance growth of green macroalgae is not apparent from the visual estimates made at the stations included in the sampling. The two stations with elevated percent cover of algae - station B0459 on the Millers River above the Royalston WWTP (75%) and station B0444 (80%) on the Millers River near the mouth - had algal growth that was not dominated by the green macroalgae. Both of these open canopy stations were dominated by a close-growing, disk-shaped alga *Protoderma* sp. (identification not confirmed) which does not produce massive amounts of biomass (Table 1, Appendix A). Station B0459 appeared to be the more productive station since, in addition to the *Protoderma* sp., it also exhibited mats comprised of the green macroalga *Oedogonium* sp., which is known for its massive growth in nutrient-enriched waters (Biggs, 1996), as well as streamers of the green alga *Ulothrix* sp. that can also grow to nuisance amounts, particularly in cool waters (Wharfe et al., 1984).

At station B0460 on the Otter River, the algal community was dominated by the diatoms, in particular, *Melosira varians*. This centric diatom was present in long chains and was the only dominant alga at this location.

DISCUSSION

None of the stations on the Millers River included in the sampling had algal coverage that would meet the criteria for aquatic nuisance and thus threaten aquatic life or aesthetics. It is interesting that many of the stations supported genera that can form nuisance algal growth by responding to excess nutrients; in particular, *Oedogonium* sp. and *Ulothrix* sp.

The centric diatom *Melosira varians*, found at station B0460 below Rte. 202 in Templeton, is typically found in organically enriched areas (Palmer, 1962). Sources of this enrichment may be from road runoff or from the Baldwinville WWTP discharge. As a heterotroph, *M. varians* can utilize sources of dissolved organic carbon. The macroinvertebrate analysis (Nuzzo, 2003) determined that the area was slightly impacted. This species was a minor component of the algal population at B0459 upstream from the treatment plant in Royalston.

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APPENDIX A: MILLERS RIVER PERIPHYTON – 2000

Date	Habitat	Class	Genus	Abundance
Location: Otter River upstream/southeast from Bridge/Turner St., Gardner/Templeton (B0219)				
14 September 2000	cobble/moss/riffle	Chlorophyceae	<i>Oedogonium</i> sp.	VA
Location: Otter River approximately 400 m downstream/west from Route 202, Templeton (B0460)				
13 September 2000	mats on boulders/riffle	Bacillariophyceae	<i>Fragilaria</i> sp.	C
		Bacillariophyceae	<i>Gyrosigma</i> sp.	R
		Bacillariophyceae	<i>Melosira varians</i>	VA
		Bacillariophyceae	<i>Surirella</i> sp.	R
		Bacillariophyceae	<i>Synedra</i> sp.	R
		Bacillariophyceae	<i>Tabellaria</i> sp.	R
		Chlorophyceae	<i>Closterium</i> sp.	R
Chlorophyceae	<i>Oedogonium</i> sp.	C		
Location: Millers River approx 100 m upstream from Royalston WWTP, Royalston (B0459)				
12 September 2000	mat on cobble/riffle	Chlorophyceae	<i>Ulothrix</i> sp.	VA
		Bacillariophyceae	<i>Cocconeis</i> sp.	R
		Bacillariophyceae	<i>Fragilaria</i> sp.	C
		Bacillariophyceae	<i>Gomphonema</i> sp.	R
		Bacillariophyceae	<i>Melosira varians</i>	R
		Bacillariophyceae	<i>Navicula</i> sp.	C
		Bacillariophyceae	<i>Surirella</i> sp.	R
		Bacillariophyceae	<i>Synedra</i> sp.	C
		Bacillariophyceae	<i>Tabellaria</i> sp.	R
		Chlorophyceae	<i>Mougeotia</i> sp.	R
		Chlorophyceae	<i>Sirogonium</i> sp.	R
		Cyanophyceae	<i>Phormidium</i> sp.	C
		Chlorophyceae	<i>Closterium</i> sp.	R
	Chlorophyceae	<i>Diatoma</i> sp.	C	
	Chlorophyceae	<i>ui desmid</i>	R	
	mat	Chlorophyceae	<i>Oedogonium</i> sp.	VA
		Chlorophyceae	<i>Ulothrix</i> sp.	VA
Cyanophyceae		<i>Phormidium</i> sp.	A	
cobble/riffle	Chlorophyceae	<i>Oedogonium</i> sp.	R	
	Chlorophyceae	<i>Protoderma</i> sp. (not confirmed)	A	
Cyanophyceae	<i>Lyngbya</i> sp.	R		
Location: East Branch Tully River immediately east from Pinedale Ave, Tully Rd, Athol/Orange (B0227)				
11 September 2000	mats/pool	Cyanophyceae	<i>Phormidium</i> sp.	VA
		Cyanophyceae	<i>Spirulina</i> sp.	R
		Cyanophyceae	<i>Lyngbya</i> sp.	R
Location: Lyons Brook immediately upstream from the confluence with the Millers River, Wendell/Montague (B0445)				
11 September 2000	cobble/pool	Chlorophyceae	<i>Spirogyra</i> sp.	VA
Location: Millers River approximately 520 m upstream/south of mouth, Erving/Montague (B0444)				
11 September 2000	cobble/riffle	Bacillariophyceae	<i>Cocconeis</i> sp.	C
		Bacillariophyceae	<i>Surirella</i> sp.	R
		Chlorophyceae	<i>Protoderma</i> sp. (not confirmed)	VA

APPENDIX G

MEMORANDUM

To: Paul Hogan (DEP), Art Johnson (DEP), Rick Dunn (DEP), Dave Pincumbe (EPA)
From: Joan Beskenis (DEP-DWM)
Date: March 24, 2003
Subject: Millers River Algae

The writer along with Heather Parry and Paul Hogan (DEP-DWM-Worcester) and Dave Pincumbe (EPA) traveled to Orange, Massachusetts on September 25, 2002 to observe and sample a reach of the Millers River below the Orange WWTP to learn more about the benthic macroalgae and the periphyton. The benthic algae, both micro and macroscopic forms live on or attached to the substrata; scrapes of the substrates result in the harvesting of both forms. The submerged attached microcommunity constitutes the periphyton. It is composed of algae, bacteria, fungus held within a matrix of polysaccharides. The microalgae included in periphyton are microscopic forms (single celled or multicelled -such as filaments) of green and red algae and diatoms. The benthic macroalgae would not be included in this definition and will instead be referred to as benthic algae. A visual impression is created by the amount of macroalgae present in a stream reach. Large amounts of macroalgae can affect the aesthetics of a reach and impact its uses-including swimming and some forms of non-contact recreation. Estimates of the percent cover of the macroalgae have been correlated with levels of impairment (Barbour et al., 1999) (Biggs, 1996). The biomass of the macroalgae or periphyton can reflect the nutrient inputs to a site. Observations above and below a point source or a non-point source, in comparable habitats, can help determine if a source is having an impact.

The area observed extended from just above the Orange WWTP discharge to Wendell Depot, approximately 2 miles downstream. At three locations percent cover of the filamentous algae was obtained using a point intercept method (Barbour, M. T. et al., 1999). Algae samples for taxonomic identification were collected in representative areas at the following stations:

- Approximately 50 feet above the Orange WWTP discharge;
- Approximately 50 feet below the Orange WWTP; and
- Approximately 2 miles downstream of the Orange WWTP and approximately 50 feet above Rte 2 in Wendell Depot.

Visual observations of the algal and plant populations were made at Millers Falls approximately 12-13 miles downstream of the Wendell Depot location.

Materials and Methods

Percent cover was estimated by using a modified version of the point intercept method which is outlined in Barbour et al. (1999). Where possible, three transects were made per location, each composed of three sampling sites through the riffle/run zone and along the transect. Because of water depth, the sampling at the station just below the Orange WWTP was limited to just left and center (looking upstream) for two transects. At all stations the macroalgal population as well as the micropopulation (periphyton) were recorded. A plastic fish basket with the bottom replaced by Plexiglas marked off in a grid was used in the study. First, the number of points that intercepted the macroalgae were recorded, then the same technique was used for the microalgae. Samples were collected for identification and determination of the maximum length of the macroalgae as well as the thickness of the microalgae. The thickness rating (Barbour et al., 1999) is determined by examining visual accumulation of periphyton on the substrates as well as feeling it to determine if it is slippery. If a microalgae layer of greater than 0.5 mm was present it was measured with a ruler.

Results

The percent cover of the macroalgae did not differ above and below the Orange WWTP outfall pipe (29% and 27%, respectively). Downstream approximately 2 miles, just above Route 2, the percent cover of the macroalgae had dropped to 6%. The entire reach had a partially covered canopy. The algal genera that dominated above and below the treatment plant were the green macroalgae *Oedogonium* sp. and

Hydrodictyon sp. Both of these genera can grow to nuisance amounts when suitable areas for growth are found. Approximately 2 miles downstream the algal community had changed and was dominated by an unidentified green alga that grew closely attached to the substrate surface. At this distance from the treatment plant the long filamentous streamers of *Oedogonium* sp. were gone.

Cover by microalgae (Table 1) was highest at the station farthest downstream where 48 % of the substrate was covered with amorphous matter, fungal hyphae and green microalgae. The thickness (or density) was low at 0.5 mm, representing a slimy substrate but with no visible accumulation of microalgae. The periphyton coverage was slightly higher at the station above the Orange WWTP discharge compared to below (25 to 20%, respectively). Fungal hyphae were found above the Orange WWTP and blue-green algal filaments below. Macrophytes (rooted aquatic plants) had the same cover above and below (11%), but decreased to 5% at the downstream-most station, just above Route 2. Above the WWTP mosses and grasses were part of the cover while moss and *Potamogeton* sp. were found below. Further downstream, above Route 2, moss and *Elodea* sp. were found.

Discussion

None of the locations in the reach below the Orange WWTP exhibited algal cover that would be described as nuisance aquatic growth (Barbour et al., 1999) although the streaming algae - at lengths of 38-40 cm - were very visible from the stream banks. Substantial algal growth can cause clogging of the interstitial waters, and lead to alterations in benthic algal populations, as well as, significant degradation of the aesthetic value of an area. The substantial biomass of *Oedogonium* sp. encountered upstream and downstream from the Orange WWTP is typical of enriched streams (Biggs, 1996). Another green macroalgae found in the vicinity of the Orange WWTP was *Hydrodictyon* sp. This alga can form massive luxuriant growths, particularly in slow moving areas. Attention should be given to how prevalent this alga is in the Millers River as well as other algal species that can grow to nuisance amounts (e.g. *Cladophora* sp., *Oedogonium* sp.). The presence of the long streaming algae may be strongly affected by both water quality and flow conditions that can vary greatly from year to year.

Because of known sources of nutrients upstream (two wastewater treatment plants), future work should include examination of the algal population above the Orange WWTP. At this time, no one source is implicated in the degradation of this reach, but nutrient enrichment is evident.

Interestingly, if the percent coverages of the macrophytes and macroalgae are added together for the stations immediately above and below the Orange WWTP, the resulting values (40% and 38%, respectively) are at or near the 40% macroalgal coverage cited in Biggs (1996) and Barbour et al. (1999) as indicating nuisance levels of algal biomass caused by nutrient or organic enrichment. Although aesthetics are judged by the algal biomass from the shore the macrophytes appeared as clumps of algae and perhaps the visual appeal of the reach was reduced. Consideration should be given as to whether to include macrophyte cover in the determination of nuisance growth. *Elodea* sp., which can grow in massive monocultures in response to nutrient enrichment, was present in this stretch, but not in densities (based on visual estimates) that would indicate problems.

The EPA periphyton method (Barbour et al., 1999) does not include an index for evaluating what thickness of microalgal cover is deleterious to the benthic community. The thickness reported though (0.5 mm) would reflect low biomass of periphyton.

References

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Table 1. Rapid Periphyton Survey Field Sheet-Millers River- Sept. 25, 2002

Location: Approx 50 feet above Orange WWTP									
Transect	# Dots in grid area	Macroalga #1 Dots Covered	Macroalga #2 Dots Covered*	# Dots Microalga Covered	# Dots Macrophyte Covered	Microalga # 1 Dots Covered by Thickness Rank	Type of macrophyte	Max Length (cm) macroalga 1	Max Length (cm) macroalga 2
T1/left	50	15	0	50	0	1		Oedogonium (1)=45	Hydrodictyon (2)=13
T1/center	50	8	0	20	9	1	mosses/grass		
T1/right	50	18	0	10	13	1	mosses/grass		
T2/left	50	15	0	8	0	0.5			
T2/center	50	18	0	8	3	0.5	thin leaved Potamogeton		
T2/right	50	35	0	10	0	0.5			
T3/left	50	9	0	0	8	0.5	mosses/grass		
T3/center	50	11	0	4	15	0.5	mosses/grass		
T3/right	50	4	0	3	0	0.5			
	tot 450	Macroalgae tot 133=29%	*grouped in w/Macroalgae 1	Microalgae tot 113=25%	Macrophytes tot 48=11%				
Location: Approx 50 feet below Orange WWTP									
T1/center	50	10	0	12	0	0.5		Oedogonium (1)=20	Hydrodictyon (2)=13
T1/right	50	10	0	4	15	0.5			
T2/center	50	30	0	22	0	0.5			
T2/right	50	10	0	13	0	0.5			
T3/left	50	6	0	0	19	0.5	moss		
T3/center	50	17	0	10	0	0.5			
T3/right	50	10	0	8	4	0	thin leaved Potamogeton		
	tot 350	macroalgae tot 93=27%	*grouped in w/Macroalgae 1	Microalgae tot 69=20%	Macrophytes tot 38=11%				
Location: Approx. 100 ft upstream of Rte 2 Bridge									
T1/left	50	4	0	15	1	0.5	moss	ui green (1)=2	
T1/center	50	6	0	26	3	0.5	Milfoil/Elodea		
T1/right	50	2	0	18	0	0.5			
T2/left	50	6	0	21	6	0.5	Elodea		
T2/center	50	4	0	8	1	0.5			
T2/right	50	1	0	30	5	0.5	moss		
T3/left	50	1	0	39	0	0.5			
T3/center	50	2	0	31	3	0.5	moss		
T3/right	50	1	0	27	4	0.5	moss		
	tot 450	Macroalgae tot 27=6%	*grouped in w/Macroalgae 1	Microalgae tot 215=48%	Macrophytes tot 23=5%				