APPENDIX A

Technical Memorandum TM-32-4

WESTFIELD RIVER WATERSHED
DWM 2001 WATER QUALITY MONITORING DATA

DWM Control Number: CN 111.0

COMMONWEALTH OF MASSACHUSETTS
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Introduction

Water quality sampling of the Westfield River Watershed was conducted in 2001 to address DWM program objectives. Specific objectives for the Westfield River are outlined below. The DWM sampling plan matrix for the Year Two monitoring is presented in Table 1. Sampling components at river stations included: *in-situ* Hydrolab® measurements, and physico-chemical, nutrient, and bacteria sampling.

Project Objectives

The primary objective of this Year Two sampling, as outlined in CN 062.0 *Quality Assurance Project Plan for Year 2001 Watershed Assessments of the Farmington, Westfield, Concord, Taunton and South Coastal basins*, was to obtain sufficient data to determine the status of selected main stem segments and tributaries with regard to their attainment of the Massachusetts Surface Water Quality Standards.

This technical memorandum presents the water quality sampling component of the survey. Results of other monitoring efforts, such as biological assessments and monitoring to support the development of lake Total Maximum Daily Loads, are reported in separate technical memoranda.

Methods

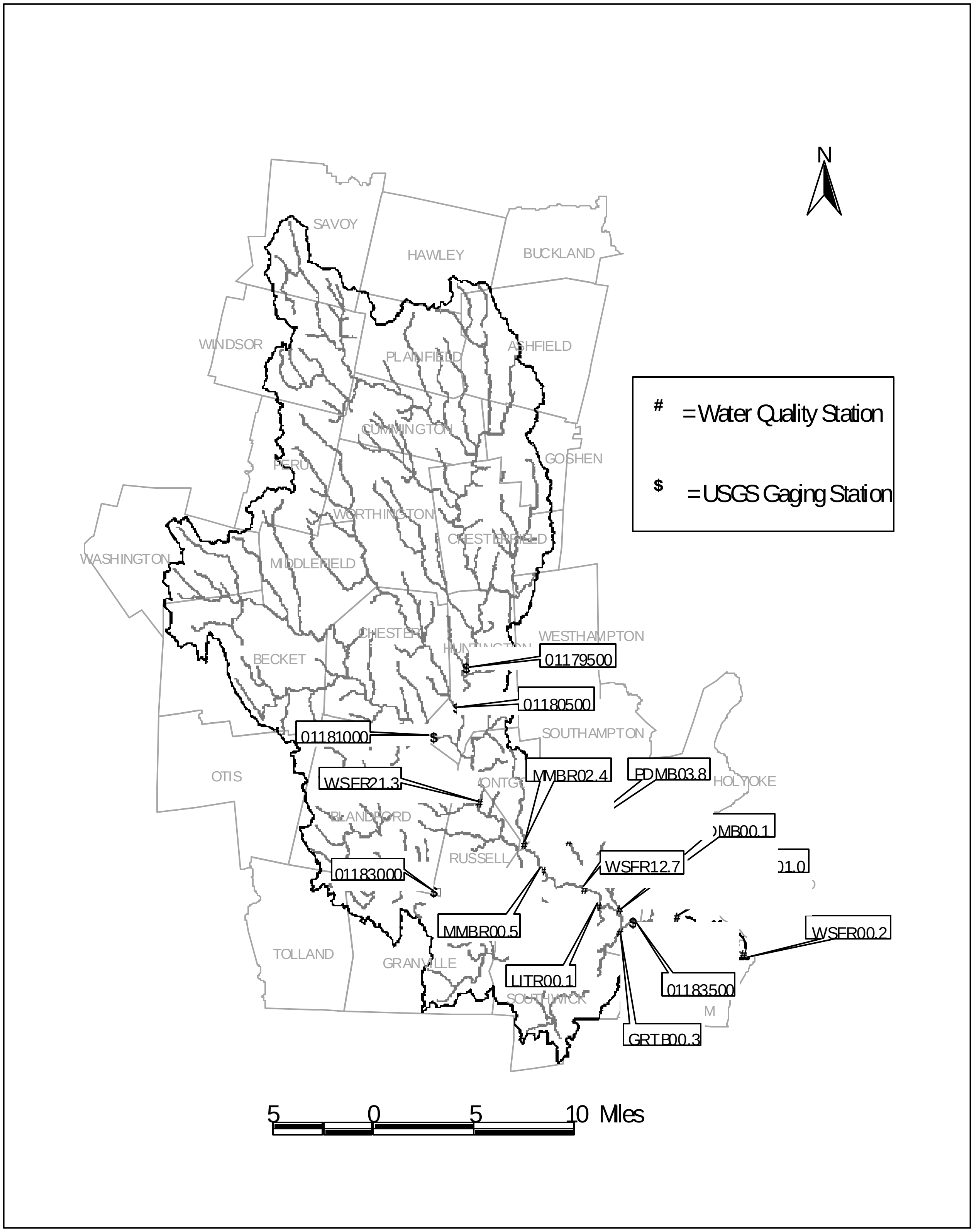
Water quality samples were collected in the Westfield River Watershed on the dates and for the parameters as shown in Table 1. See Figure 1 for station locations. The parameters included in the sampling were: *in-situ* Hydrolab® measurements (dissolved oxygen, percent dissolved oxygen saturation, pH, conductivity, water temperature and total dissolved solids), and alkalinity, hardness, chloride, total suspended solids, ammonia, nitrate-nitrite, total phosphorus, and fecal coliform and E. coli bacteria sampling. The water quality sampling procedures are included in the publication: CN 001.2 *Sample Collection Techniques for DWM Surface Water Quality Monitoring*. Standard operating procedure CN 004.1 *Hydrolab® Series 3/Series 4 Multiprobe* outlines the standard operating procedures for Hydrolab® sampling. Samples for alkalinity, hardness, chloride, total suspended solids, nutrients (nitrate-N, ammonia-N, total phosphorus) and bacteria were analyzed at the Wall Experiment Station (WES), the Department's analytical laboratory in Lawrence, Massachusetts.

DWM quality assurance and database management staff reviewed lab data reports and all Hydrolab® multi-probe data. The data were validated and finalized per data validation procedures outlined in DWM SOP CN 56.0 Draft *Data Validation and Usability Standard Operating Procedure*. In general, all water sample data were validated by reviewing QC sample results, analytical holding time compliance, QC sample frequency and related ancillary data/documentation (at a minimum). A complete summary of censoring and qualification decisions for 2001 DWM data is provided in CN 149.0 *Data Validation Report for Year 2001 Project Data*. A list of Symbols and Qualifiers Used for DWM Data is presented in Appendix 4.

Table 1: Westfield River Watershed 2001 Water Quality Sampling Summary - Site Descriptions, Segment Numbers, Parameters*						
Site Description	**Segment No.**	**Station No.**	**Aug 1**	**Aug 22**	**Sept 12**	**Oct 3**
Westfield River, West Bank at Main Street Bridge, Russell	MA32-05	WSFR21.3	DO, C, N, TSS	DO, C, N, TSS, B	DO, C, N, TSS, B	DO, C, N, TSS, B
Moose Meadow Brook, below Tekoa Res., Montgomery	MA32-23	MMBR02.4	DO, C, N, TSS, B	DO, C, N, TSS, B	DO, C, N, TSS, B	DO, C, N, TSS, B
Moose Meadow Brook off Pochassic Rd., Westfield	MA32-23	MMBR00.5	DO, C, N, TSS, B	DO, C, N, TSS, B	DO, C, N, TSS, B	DO, C, N, TSS, B
Westfield River, upstream from Rte. 202/10 Bridge, Westfield	MA32-05	WSFR12.7	DO, C, N, TSS, B	DO, C, N, TSS, B	DO, C, N, TSS, B	DO, C, N, TSS, B
Little River, upstream from Rte. 20 Bridge, Westfield	MA32-08	LITR00.1	DO, C, TSS, B	DO, C, TSS, B	DO, C, TSS, B	DO, C, TSS, B
Powdermill Brook, Russellville Rd., Westfield	MA32-09	PDMB03.8	DO, C, N, TSS, B	DO, C, N, TSS, B	DO, C, N, TSS, B	DO, C, N, TSS, B
Powdermill Brook downstream from Union St. culvert, Westfield	MA32-09	PDMB00.1	DO, C, TSS, B	DO, C, TSS, B	DO, C, TSS, B	DO, C, TSS, B
Great Brook, upstream from Rte. 187 Bridge, Westfield	MA32-25	GRTB00.3	DO, C, TSS, B	DO, C, TSS, B	DO, C, TSS, B	DO, C, TSS, B
Block Brook, Plymouth Terrace, Agawam	(Undefined)	BLBR01.0	DO, C, TSS, B	DO, C, TSS, B	DO, C, TSS, B	DO, C, TSS, B
Westfield River, upstream from Rte. 5 Bridge, Agawam	MA32-07	WSFR00.2	DO, C, TSS, B	DO, C, TSS, B	DO, C, TSS, B	DO, C, TSS, B

* Parameters:
DO = dissolved oxygen (pre-dawn)
C = total alkalinity, total hardness, chlorides
N = nitrates, ammonia, total phosphorus (low-level)
TSS = total suspended solids
B = bacteria (fecal coliform and E. coli)

Figure 1: Westfield River Watershed 2001 Water Quality Sampling Stations and USGS Stream Gages



Survey Conditions

Meteorological and hydrological conditions antecedent to each sampling date were characterized by analyzing precipitation and streamflow data. Rainfall data from the National Weather Service station at Barnes Municipal Airport (BAF) was reviewed for the five days prior to the sampling dates (Table 2). These data were taken from the NOAA website (http://tgsv5.nws.noaa.gov/er/box/clstns.htm).

Data from three USGS stream gages were used for discharge assessment (Tables 3 – 5). Those gages are 01179500 on Westfield River at Knightville, MA; 01181000 on West Branch Westfield River at Huntington, MA; and 01183500 on West Branch Westfield River near Westfield, MA. Locations of the gages are depicted in Figure 1. Streamflow statistics for these gages are available from USGS (Socolow *et al.* 2002 and 2003 and USGS 2004).

Gage 01179500 is located 0.2 miles downstream of Knightville Dam (Huntington, MA). This impoundment is managed by the ACOE. There is a power generating facility associated with this impoundment that is capable of producing 3000kwh. As such, the gage reading is a measurement of the release from Knightville Dam, rather than a measurement of natural flow conditions. Gage 01181000 is located upstream of Huntington center. The flow at this gage does not appear to be regulated by any major upstream impoundment, and represents the best measure of natural flow conditions. A chart of the 2001 summer discharge and dates of sample collection may be seen in figure 2. Gage 01183500 is located in the city of Westfield. Borden Brook Reservoir, Cobble Mountain Reservoir, Knightville Reservoir, and Littleville Lake regulate flow past this gage.

Appendix 1 contains figures of the discharge and precipitation data combined for the days prior to the sampling dates. In general, water conditions in the Westfield River Watershed, during the 2001 DWM water quality sampling season, were normal to dry. This resulted in a decrease in instream flow below historic mean levels.

August 1, 2001 - This survey was conducted during a dry period, with no rain reported at Barnes Municipal Airport (BAF, Westfield, MA) during the week prior to sampling. Gage data (USGS gage 01181000) revealed a consistent decline in flow in the week prior to sample collection.

August 22, 2001 - This survey was conducted during a relatively dry period, with less than ¼ inch of rain falling on any one day during the week prior to sampling. The total rainfall during the week prior to sampling was 0.29 inches. Discharge (at USGS gage 01181000) remained relatively steady (~13cfs), with less than a 1cfs variation in discharge during the week prior to sample collection.

September 12, 2001 - This survey was conducted during a relatively dry period, with less than ¼ inch of rain falling on any one day during the week prior to sampling. The total rainfall during the week prior to sampling was 0.18 inches. Discharge (USGS gage 01181000) remained low, with a mean discharge of 9cfs during the week prior to sample collection.

October 3, 2001 - This survey was conducted during a relatively dry period, with less than ¼ inch of rain falling on any one day during the week prior to sampling. However, a rain event that dropped 0.83 inches at BAF occurred on September 25th. This event resulted in a short-term (<48hr) increase in measured discharge at USGS gage 01181000. The discharge during the week prior to sampling displayed a steady decline, with a mean discharge of 48cfs for the week.

Figure 2: Discharge at USGS Gage 01181000 – 2001 Mean Daily Discharge, 7Q10, and Mean Daily Discharge for the period of record (67 years)

Figure deleted for this copy see original document for chart.

Table 2: Westfield River Watershed 2001 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
National Weather Service at Barnes Airfield, MA (unofficial NWS data at http://tgsv5.nws.noaa.gov/er/box/clstns.htm)						
01 Aug 2001	0.00	0.00	0.00	0.00	0.00	0.00
22 Aug 2001	0.24	0.00	0.01	0.03	0.01	0.00
12 Sep 2001	0.00	0.01	0.00	0.16	0.00	0.01
03 Oct 2001	0.00	0.00	0.08	0.03	0.00	0.01

Table 3: Westfield River at Knightville, MA-USGS Flow Data Summary Mean Daily Discharge in Cubic Feet per Second (cfs) Gage # 01179500								
Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Sample Date	Monthly Mean	POR* Monthly Mean
1 Aug 2001	154	113	88	73	63	56	125	130
22 Aug 2001	31	30	28	28	27	26	44.9	108
12 Sep 2001	23	20	19	17	47	53	124	126
3 Oct 2001	168	119	103	86	74	64	124	126
7Q10 @ USGS Gage 01179500 = 10.9 cfs, Westfield Period of Record: 1910-1990, 1996-present (mean annual discharge = 333 cfs)								

Table 4: West Branch Westfield River at Huntington, MA-USGS Flow Data Summary Mean Daily Discharge in Cubic Feet per Second (cfs) Gage # 01181000								
Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Sample Date	Monthly Mean	POR* Monthly Mean
1 Aug 2001	36	26	23	20	18	16	42.7	67.8
22 Aug 2001	13	13	13	11	12	13	13.8	58.4
12 Sep 2001	8.3	7.4	7.0	7.1	9.6	14	48.6	64.3
3 Oct 2001	63	46	39	32	32	29	23.8	106
7Q10 @ USGS Gage 01181000 = 5.79 cfs, Westfield Period of Record: 1935 - present (mean annual discharge = 191 cfs)								

Table 5: West Branch Westfield River near Westfield, MA-USGS Flow Data Summary Mean Daily Discharge in Cubic Feet per Second (cfs) Gage # 01183500								
Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Sample Date	Monthly Mean	POR* Monthly Mean
1 Aug 2001	216	201	158	145	130	122	291	407
22 Aug 2001	121	133	114	113	110	104	145	387
12 Sep 2001	104	98	98	80	83	105	299	400
3 Oct 2001	507	398	342	292	250	239	299	400
7Q10 @ USGS Gage 01183500 = 77.3 cfs, Westfield Period of Record: 1935 - present (mean annual discharge = 931 cfs)								

Water Quality Data

Water quality data are included for Hydrolab® parameters (dissolved oxygen, percent saturation, pH, temperature, dissolved solids and conductivity) (Appendix 2), as well as for nutrients (total phosphorus, nitrate-nitrite, ammonia), and chemistry (alkalinity, hardness, chloride, total suspended solids), and fecal coliform and E. coli bacteria (Appendix 3).

Quality control sample data are also provided in Appendix 3. Based on acceptable relative percent differences for field duplicates and the lack of contamination (i.e. less than method detection limits) for ambient field blanks, there were no censoring or qualification decisions made for 2001 Westfield River Watershed water quality data in rivers (except for minor Hydrolab® data qualifications, i.e. unstable readings-see Appendix 2).

References Cited

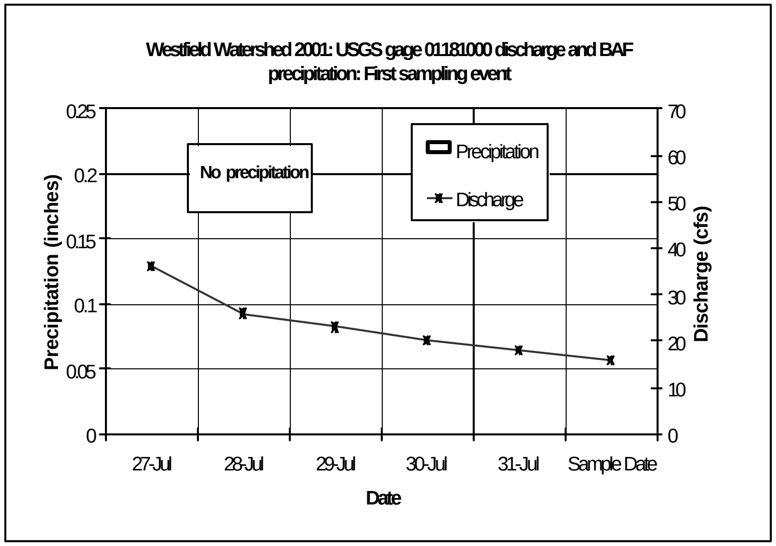
Socolow, R.S., C.R. Leighton, J. S. Whitley, and D.J. Ventetuolo. 2002. *Water Resources Data for Massachusetts and Rhode Island, Water Year 2001.* U.S. Geological Survey Report MA-RI-01-1. Water Resources Division, Northborough, MA.

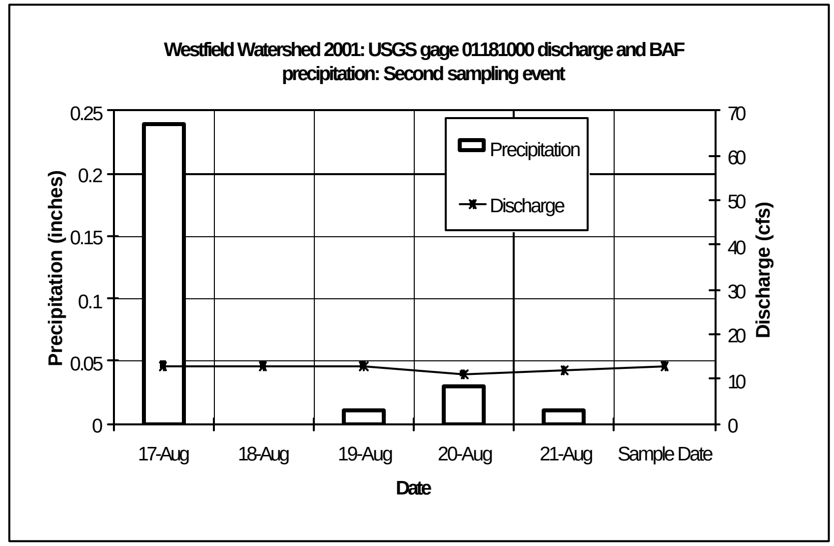
Socolow, R.S., G.G. Girouard, and L.R. Ramsbey. 2003. *Water Resources Data for Massachusetts and Rhode Island, Water Year 2002.* U.S. Geological Survey Report MA-RI-02-1. Water Resources Division, Northborough, MA.

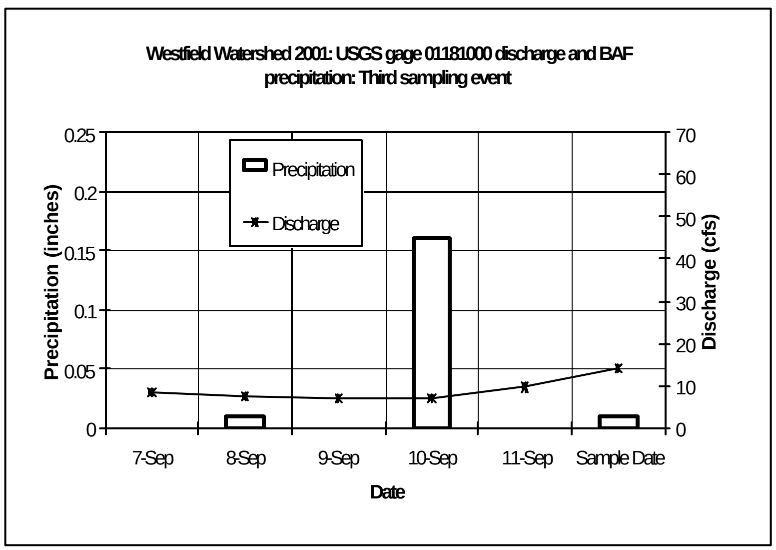
USGS. 2004. U.S. Geological Survey. [Online] http://ststdmamrl.er.usgs.gov/streamstats/expert.htm

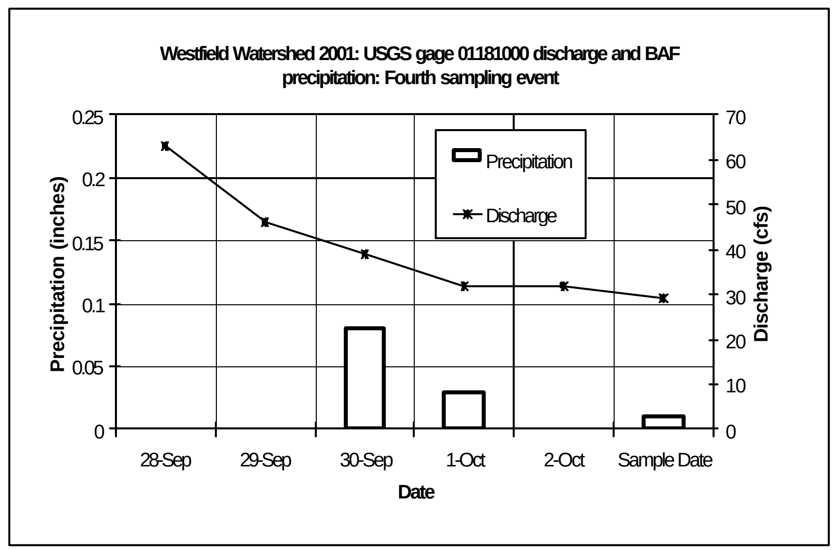
Appendix 1: Graphs of Precipitation and Discharge Data

Westfield Watershed 2001 Precipitation (inches) measured at Barnes Municipal Airport (BAF) Westfield, MA and Discharge (cfs) measured at USGS gage 01181000 West Branch Westfield at Huntington.









Appendix 2: Westfield River Watershed Survey 2001 Hydrolab® Data - Temperature, pH, Conductivity, Total Dissolved Solids, Dissolved Oxygen, % Saturation
(Note: Symbols and Qualifiers Used for DWM Data can be found in Appendix 4.)

WESTFIELD RIVER (Saris: 3208250)
Station: WSFR21.3, Mile Point: 22.1, Unique ID: W0810
Description: Western bank at Main Street Bridge, Russell

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(µS/cm)	(mg/l)	(mg/l)	(%)
08/01/01	32-0113	04:33	##I	22.4u	7.3c	108	69.3	8.2u	92u
08/22/01	32-0148	04:08	0.8	24.0	7.3cu	120	77.1	8.5u	99u
09/12/01	32-0174	04:16	0.6	20.6	7.3cu	119	76.0	8.9iu	96iu
10/03/01	32-0203	11:08	0.4	14.2	7.0cu	96.2	61.6	10.0u	96u

MOOSE MEADOW BROOK (Saris: 3209700)
Station: MMBR02.4, Mile Point: 2.5, Unique ID: W0809
Description: ~250 feet downstream of Tekoa Reservoir, Montgomery

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(µS/cm)	(mg/l)	(mg/l)	(%)
08/01/01	32-0112	03:13	##I	18.1	6.8u	43.0	27.5	9.5u	98u
08/22/01	32-0147	03:13	1.0	20.1	6.8u	44.7	28.6	8.9	96
09/12/01	32-0173	03:20	0.9	17.3	6.9u	41.5	26.6	9.5iu	97iu
10/03/01	32-0202	10:09	0.9	12.1	6.6u	46.1	29.5	10.8u	99u

MOOSE MEADOW BROOK (Saris: 3209700)
Station: MMBR00.5, Mile Point: 0.4, Unique ID: W0812
Description: at farm road (private road off Pochassic Road) bridge, Westfield

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(µS/cm)	(mg/l)	(mg/l)	(%)
08/01/01	32-0111	02:29	##I	18.8	6.8	175	112	7.2	76
08/22/01	32-0146	02:36	0.5	20.3	6.7u	214	137	6.2	67
09/12/01	32-0172	02:41	0.3	18.2	7.0c	410	263	4.7iu	49iu
10/03/01	32-0201	09:28	0.3	12.1	6.9cu	165	105	10.1	93

WESTFIELD RIVER (Saris: 3208250)
Station: WSFR12.7, Mile Point: 13, Unique ID: W0807
Description: ~350 feet upstream of Route 202/10 bridge, Westfield

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(µS/cm)	(mg/l)	(mg/l)	(%)
08/01/01	32-0116	05:09	##I	22.3	7.2cu	122	78.2	8.1	91
08/22/01	32-0151	04:43	0.5	23.3	7.2cu	149	95.1	7.9u	91u
09/12/01	32-0177	04:55	0.4	20.0	7.3cu	149	95.0	8.6iu	92iu
10/03/01	32-0206	11:48	0.2	14.1	7.2cu	106	67.9	11.1u	107u

LITTLE RIVER (Saris: 3208725)
Station: LITR00.1, Mile Point: 0.04, Unique ID: W0808
Description: ~100 feet upstream of Route 20 bridge, Westfield

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(µS/cm)	(mg/l)	(mg/l)	(%)
08/01/01	32-0125	01:54	##I	21.8	7.2c	134	85.7	8.3u	92u

08/22/01	32-0152	02:00	0.1i	22.5	7.1cu	139	89.1	7.9	89
09/12/01	32-0178	01:58	0.2	19.4	7.2cu	149	95.5	8.5i	90i
10/03/01	32-0207	08:53	0.1i	12.7	7.0c	120	76.7	10.2	94

POWDERMILL BROOK (Saris: 3208575)
Station: PDMB03.8, Mile Point: 5.4, Unique ID: W0234
Description: at Russellville Road

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(µS/cm)	(mg/l)	(mg/l)	(%)
08/01/01	32-0117	01:46	##I	17.1	6.9cu	133	84.9	8.9	90
08/22/01	32-0145	02:02	0.4	18.9	6.8u	142	90.8	8.3u	88u
09/12/01	32-0171	02:11	0.4	16.3	6.6	175	112	6.1iu	61iu
10/03/01	32-0200	08:58	0.2	11.0	6.7u	156	100	10.6u	94u

POWDERMILL BROOK (Saris: 3208575)
Station: PDMB00.1, Mile Point: 0.3, Unique ID: W0805
Description: downstream of Union Street culvert, Westfield

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(µS/cm)	(mg/l)	(mg/l)	(%)
08/01/01	32-0128	03:19	0.2	17.9	7.8c	292	187	9.9u	102u
08/22/01	32-0154	02:51	0.4	18.4	7.4cu	283	181	9.1	96
09/12/01	32-0180	02:49	0.4	16.4	7.6cu	311	199	9.5iu	95iu
10/03/01	32-0209	09:38	0.3	11.9	7.3cu	299	191	9.9	90

GREAT BROOK (Saris: 3208375)
Station: GRTB00.3, Mile Point: 0.3, Unique ID: W0804
Description: ~250 feet upstream of Route 187 bridge, Westfield

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(µS/cm)	(mg/l)	(mg/l)	(%)
08/01/01	32-0126	02:29	0.3	16.0	7.2c	230	147	7.7u	76u
08/22/01	32-0153	02:27	0.3	17.5	7.2cu	224	144	7.8	80
09/12/01	32-0179	02:23	0.4	15.5	7.2cu	227	145	7.5i	74i
10/03/01	32-0208	09:16	0.4	11.0	7.1cu	225	144	9.0	81

BLOCK BROOK (Saris: 3208275)
Station: BLBR01.0, Mile Point: 1, Unique ID: W0806
Description: at Plymouth Terrace crossing, West Springfield

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(µS/cm)	(mg/l)	(mg/l)	(%)
08/01/01	32-0129	04:10	0.1i	17.9	7.6c	594	380	8.0u	82u
08/22/01	32-0155	03:30	0.2	19.4	7.6c	486	311	8.0	85
09/12/01	32-0181	03:22	0.2	16.7	7.5cu	515	329	7.4i	74i
10/03/01	32-0210	10:06	0.2	12.1u	7.5cu	510	327	9.5	87

WESTFIELD RIVER (Saris: 3208250)
Station: WSFR00.2, Mile Point: 0.4, Unique ID: W0857
Description: ~250 feet upstream of Route 5 bridge, Agawam

Date	OWMID	Time	Depth	Temp	pH	Conductivity @ 25°C	TDS	DO	Saturation
		(24hr)	(m)	(°C)	(SU)	(µS/cm)	(mg/l)	(mg/l)	(%)
08/01/01	32-0130	04:51	0.4	22.3	7.1c	190	122	6.6u	74u
08/22/01	32-0158	04:01	0.4	23.7	7.1c	226	145	6.3u	72u
09/12/01	32-0184	04:00	0.5	21.0	7.2c	259	166	6.6iu	72iu
10/03/01	32-0213	10:39	0.6	14.3	7.1cu	158	101	9.7	93

Appendix 3: Westfield River Watershed Survey 2001 Water Quality Data

(Note: Symbols and Qualifiers Used for DWM Data can be found in Appendix 4.)

Field Blank Sample

Station: BLANK

Description: QAQC: Field Blank Sample

Date	OWMID	Fecal Coliform	E. Coli	Chloride	Alkalinity	Hardness	NH3-N	NO3-NO2-N	TP	TSS
		cfu/100ml	cfu/100ml	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
08/01/01	32-0114	--	--	<1	<2	<0.66	<0.02	<0.06	<0.005	<1.0
08/01/01	32-0122	--	--	<1	<2	<0.66	--	--	--	<1.0
08/01/01	32-0131	<5	<5	--	--	--	--	--	--	--
08/22/01	32-0149	--	--	<1	<2	<0.66	<0.02	<0.06	<0.005	<1.0
08/22/01	32-0156	--	--	<1	<2	<0.66	--	--	--	<1.0
08/22/01	32-0168	<5	<5	--	--	--	--	--	--	--
09/12/01	32-0175	--	--	<1	<2	<0.66	<0.02	<0.06	<0.005	<1.0
09/12/01	32-0182	--	--	<1	<2	<0.66	--	--	--	<1.0
09/12/01	32-0194	<2	<2	--	--	--	--	--	--	--
10/03/01	32-0204	--	--	<1	<2	<0.66	<0.02	<0.06	<0.005	<1.0
10/03/01	32-0211	--	--	<1	<2	<0.66	--	--	--	<1.0
10/03/01	32-0223	<5	<5	--	--	--	--	--	--	--

Field Duplicate Sample

WESTFIELD RIVER (Saris: 3208250)

Station: WSFR21.3, Mile Point: 22.1, Unique ID: W0810

Description: Western bank at Main Street Bridge, Russell

Date	OWMID	QAQC	Chloride	Alkalinity	Hardness	NH3-N	NO3-NO2-N	TP	TSS
			(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
08/01/01	32-0115	32-0113	15	20	28	<0.02	<0.06	0.010	<1.0
08/01/01	32-0113	32-0115	14	22	28	<0.02	<0.06	0.011	<1.0
Relative Percent Difference			*6.9%*	*9.5%*	*0.0%*	*0.0%*	*0.0%*	*9.5%*	*0.0%*
08/22/01	32-0150	32-0148	20	22	30	<0.02	0.06	0.011	<1.0
08/22/01	32-0148	32-0150	20	22	30	<0.02	0.06	0.011	<1.0
Relative Percent Difference			*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
09/12/01	32-0176	32-0174	18	20	28	<0.02	0.12	0.015d	1.3d
09/12/01	32-0174	32-0176	19	21	28	<0.02	0.12	0.030d	2.9d
Relative Percent Difference			*5.4%*	*4.9%*	*0.0%*	*0.0%*	*0.0%*	*66.7%*	*76.2%*
10/03/01	32-0205	32-0203	13	18	25	<0.02	<0.06	0.009d	<1.0
10/03/01	32-0203	32-0205	13	18	25	<0.02	<0.06	0.019d	<1.0
Relative Percent Difference			*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*71.4%*	*0.0%*

Field Duplicate Sample
BLOCK BROOK(Saris: 3208275)
Station: BLBR01.0, Mile Point: 1, Unique ID: W0806
Description: at Plymouth Terrace crossing, West Springfield

Date	OWMID	QAQC	Fecal Coliform (Log10)	E. coli Log10	Chloride	Alkalinity	Hardness	TSS
			cfu/100ml	cfu/100ml	(mg/l)	(mg/l)	(mg/l)	(mg/l)
08/01/01	32-0121	32-0120	--	--	110	82	158	7.8
08/01/01	32-0120	32-0121	--	--	110	83	158	7.3
Relative Percent Difference					*0.0%*	--	*0.0%*	*6.6%*
08/22/01	32-0157	32-0155	--	--	82	85	135	4.9
08/22/01	32-0155	32-0157	--	--	84	85	135	5.2
Relative Percent Difference					*2.4%*	--	*0.0%*	*5.9%*
08/22/01	32-0169	32-0167	2.643	2.041	--	--	--	--
08/22/01	32-0167	32-0169	2.519	2.204	--	--	--	--
Relative Percent Difference			*4.8%*	*7.7%*	--	--	--	--
09/12/01	32-0183	32-0181	--	--	93	83	126	4.6
09/12/01	32-0181	32-0183	--	--	95	83	126	4.8
Relative Percent Difference					*2.1%*	*0.0%*	*0.0%*	*4.3%*
09/12/01	32-0195	32-0193	2.954	1.462	--	--	--	--
09/12/01	32-0193	32-0195	2.613	0.699	--	--	--	--
Relative Percent Difference			*12.3%*	*70.6%*	--	--	--	--
10/03/01	32-0212	32-0210	--	--	92	83	139	<1.0
10/03/01	32-0210	32-0212	--	--	92	83	140	<1.0
Relative Percent Difference			--	--	*0.0%*	*0.0%*	*0.7%*	*0.0%*
10/03/01	32-0224	32-0222	2.230	2.041	--	--	--	--
10/03/01	32-0222	32-0224	2.255	1.633	--	--	--	--
Relative Percent Difference			*1.1%*	*22.2%*	--	--	--	--

Field Duplicate Sample
POWDERMILL BROOK (Saris: 3208575)
Station: PDMB00.1, Mile Point: 0.3, Unique ID: W0805
Description: downstream of culvert at Union Street, Westfield

Date	OWMID	QAQC	Fecal Coliform (Log10)	E. coli (Log10)
			cfu/100ml	cfu/100ml
08/01/01	32-0137	32-0138	1.826	1.462
08/01/01	32-0138	32-0137	2.146	1.756
Relative Percent Difference			*16.1%*	*18.2%*

WESTFIELD RIVER (Saris: 3208250)
Station: WSFR21.3, Mile Point: 22.1, Unique ID: W0810
Description: Western bank at Main Street Bridge, Russell

Date	OWMID	Time	Fecal	E. coli	Alkalinity	Hardness	Chloride	NH3-N	NO3-NO2-N	TP	TSS
		24hr	cfu/100ml	cfu/100ml	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
08/01/01	32-0115	**	--	--	15	20	28	<0.02	<0.06	0.010	<1.0
08/01/01	32-0113	04:15	--	--	14	22	28	<0.02	<0.06	0.011	<1.0
08/22/01	32-0150	**	--	--	20	22	30	<0.02	0.06	0.011	<1.0
08/22/01	32-0148	04:10	--	--	20	22	30	<0.02	0.06	0.011	<1.0
08/22/01	32-0162	09:53	90	19	--	--	--	--	--	--	--
09/12/01	32-0176	**	--	--	18	20	28	<0.02	0.12	0.015d	1.3d
09/12/01	32-0174	04:10	--	--	19	21	28	<0.02	0.12	0.030d	2.9d
09/12/01	32-0188	09:54	57	<5	--	--	--	--	--	--	--
10/03/01	32-0205	**	--	--	13	18	25	<0.02	<0.06	0.009d	<1.0
10/03/01	32-0217	09:33	5	5	--	--	--	--	--	--	--
10/03/01	32-0203	11:00	--	--	13	18	25	<0.02	<0.06	0.019d	<1.0

MOOSE MEADOW BROOK (Saris: 3209700)
Unique_ID: W0809 Station: MMBR02.4, Mile Point: 2.5
Description: approximately 250 feet downstream of Tekoa Reservoir, Montgomery

Date	OWMID	Time	Fecal	E. coli	Alkalinity	Hardness	Chloride	NH3-N	NO3-NO2-N	TP	TSS
		24hr	cfu/100ml	cfu/100ml	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
08/01/01	32-0112	**	--	--	7	5	8.8	<0.02	<0.06	0.018	<1.0
08/01/01	32-0133	09:40	19	<5	--	--	--	--	--	--	--
08/22/01	32-0147	03:10	--	--	7	6	9.5	<0.02	0.12	0.014	<1.0
08/22/01	32-0161	09:11	10	<2	--	--	--	--	--	--	--
09/12/01	32-0173	03:18	--	--	7	6	9	<0.02	0.09	0.013	1.0
09/12/01	32-0187	09:13	10	<5	--	--	--	--	--	--	--
10/03/01	32-0216	08:54	<2	5	--	--	--	--	--	--	--
10/03/01	32-0202	10:10	--	--	8	4	8.7	<0.02	<0.06	0.020	1.5

MOOSE MEADOW BROOK (Saris: 3209700)
Unique_ID: W0812 Station: MMBR00.5, Mile Point: 0.4
Description: at Farm Road (private road south off Pochassic Road) bridge, Westfield

Date	OWMID	Time	Fecal	E. coli	Alkalinity	Hardness	Chloride	NH3-N	NO3-NO2-N	TP	TSS
		24hr	cfu/100ml	cfu/100ml	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
08/01/01	32-0134	**	4700	2000	--	--	--	--	--	--	--
08/01/01	32-0111	02:29	--	--	39	15	32	<0.02	1.6	0.049	2.0
08/22/01	32-0146	02:30	--	--	43	18	38	<0.02	1.7	0.069	5.3
08/22/01	32-0160	08:48	3300	1200	--	--	--	--	--	--	--
09/12/01	32-0172	02:13	--	--	78	53	61	1.3	0.86	0.29	<1.0
09/12/01	32-0186	08:50	24000	300	--	--	--	--	--	--	--
10/03/01	32-0215	08:32	7100	5000	--	--	--	--	--	--	--
10/03/01	32-0201	09:30	--	--	31	14	26	0.33	0.97	0.052	<1.0

WESTFIELD RIVER (Saris: 3208250)
Unique_ID: W0807 Station: WSFR12.7, Mile Point: 13
Description: approximately 350 feet upstream/west of Route 202/10 bridge, Westfield

Date	OWMID	Time	Fecal	E. coli	Alkalinity	Hardness	Chloride	NH3-N	NO3-NO2-N	TP	TSS
		24hr	cfu/100ml	cfu/100ml	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
08/01/01	32-0116	**	--	--	18	20	30	<0.02	0.23	0.012	1.9
08/01/01	32-0135	10:15	300	180	--	--	--	--	--	--	--
08/22/01	32-0151	04:45	--	--	25	24	34	<0.02	0.27	0.008	<1.0
08/22/01	32-0163	10:17	210	48	--	--	--	--	--	--	--
09/12/01	32-0177	04:20	--	--	23	26	33	<0.02	0.29	0.009	<1.0
09/12/01	32-0189	10:17	62	<5	--	--	--	--	--	--	--
10/03/01	32-0218	09:57	690	410	--	--	--	--	--	--	--
10/03/01	32-0206	11:45	--	--	15	18	27	<0.02	0.12	0.009	<1.0

LITTLE RIVER (Saris: 3208725)
Unique_ID: W0808 Station: LITR00.1, Mile Point: 0.04
Description: approximately 100 feet upstream/west of Route 20 bridge, Westfield

Date	OWMID	Time	Fecal	E. coli	Alkalinity	Hardness	Chloride	NH3-N	NO3-NO2-N	TP	TSS
		24hr	cfu/100ml	cfu/100ml	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
08/01/01	32-0118	02:00	--	--	22	17	32	--	--	--	<1.0
08/01/01	32-0136	10:25	670	76	--	--	--	--	--	--	--
08/22/01	32-0152	01:43	--	--	22	21	35	--	--	--	<1.0
08/22/01	32-0164	10:32	590	300	--	--	--	--	--	--	--
09/12/01	32-0178	01:55	--	--	22	22	35	--	--	--	1.5
09/12/01	32-0190	10:31	210	<5	--	--	--	--	--	--	--
10/03/01	32-0207	08:50	--	--	19	18	29	--	--	--	<1.0
10/03/01	32-0219	10:13	200	110	--	--	--	--	--	--	--

POWDERMILL BROOK (Saris: 3208575)
Unique_ID: W0234 Station: PDMB03.8, Mile Point: 5.4
Description: at Russellville Road, Westfield

Date	OWMID	Time	Fecal	E. coli	Alkalinity	Hardness	Chloride	NH3-N	NO3-NO2-N	TP	TSS
		24hr	cfu/100ml	cfu/100ml	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
08/01/01	32-0117	01:45	--	--	19	15	30	<0.02	0.40	0.019	1.6
08/01/01	32-0132	09:00	24	5	--	--	--	--	--	--	--
08/22/01	32-0145	02:05	--	--	29	17	31	<0.02	0.51	0.021	<1.0
08/22/01	32-0159	08:30	43	19	--	--	--	--	--	--	--
09/12/01	32-0171	02:00	--	--	35	18	36	<0.02	0.36	0.017	14
09/12/01	32-0185	08:29	52	<5	--	--	--	--	--	--	--
10/03/01	32-0214	08:15	10	10	--	--	--	--	--	--	--
10/03/01	32-0200	08:55	--	--	29	18	34	<0.02	0.21	0.016	7.0

POWDERMILL BROOK (Saris: 3208575)
Unique_ID: W0805 Station: PDMB00.1, Mile Point: 0.3
Description: downstream of culvert at Union Street, Westfield

Date	OWMID	Time	Fecal	E. coli	Alkalinity	Hardness	Chloride	NH3-N	NO3-NO2-N	TP	TSS
		24hr	cfu/100ml	cfu/100ml	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
08/01/01	32-0124	03:20	--	--	48	41	78	--	--	--	1.9
08/01/01	32-0137	11:00	67d	29	--	--	--	--	--	--	--
08/01/01	32-0138	11:00	140d	57	--	--	--	--	--	--	--
08/22/01	32-0154	02:41	--	--	43	52	75	--	--	--	2.3
08/22/01	32-0166	10:59	81	29	--	--	--	--	--	--	--
09/12/01	32-0180	02:50	--	--	51	56	77	--	--	--	1.7
09/12/01	32-0192	11:04	57	<5	--	--	--	--	--	--	--
10/03/01	32-0209	09:40	--	--	45	55	81	--	--	--	<1.0
10/03/01	32-0221	10:55	62	19	--	--	--	--	--	--	--

GREAT BROOK (Saris: 3208375)
Unique_ID: W0804 Station: GRTB00.3, Mile Point: 0.3
Description: approximately 250 feet upstream of Route 187 bridge, Westfield

Date	OWMID	Time	Fecal	E. coli	Alkalinity	Hardness	Chloride	NH3-N	NO3-NO2-N	TP	TSS
		24hr	cfu/100ml	cfu/100ml	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
08/01/01	32-0119	02:37	--	--	24	53	82	--	--	--	1.9
08/01/01	32-0139	11:10	52	<5	--	--	--	--	--	--	--
08/22/01	32-0153	02:20	--	--	25	53	76	--	--	--	4.4
08/22/01	32-0165	10:42	120	19	--	--	--	--	--	--	--
09/12/01	32-0179	02:20	--	--	23	53	73	--	--	--	2.7
09/12/01	32-0191	10:48	130	<5	--	--	--	--	--	--	--
10/03/01	32-0208	09:15	--	--	23	55	76	--	--	--	<1.0
10/03/01	32-0220	10:35	33	<5	--	--	--	--	--	--	--

BLOCK BROOK (Saris: 3208275)
Unique_ID: W0806 Station: BLBR01.0, Mile Point: 1
Description: at Plymouth Terrace crossing, West Springfield

Date	OWMID	Time	Fecal	E. coli	Alkalinity	Hardness	Chloride	NH3-N	NO3-NO2-N	TP	TSS
		24hr	cfu/100ml	cfu/100ml	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
08/01/01	32-0121	**	--	--	110	82	158	--	--	--	7.8
08/01/01	32-0120	04:15	--	--	110	83	158	--	--	--	7.3
08/01/01	32-0140	11:25	570	210	--	--	--	--	--	--	--
08/22/01	32-0157	**	--	--	82	85	135	--	--	--	4.9
08/22/01	32-0169	**	440	110	--	--	--	--	--	--	--
08/22/01	32-0155	03:25	--	--	84	85	135	--	--	--	5.2
08/22/01	32-0167	11:21	330	160	--	--	--	--	--	--	--
09/12/01	32-0183	**	--	--	93	83	126	--	--	--	4.6
09/12/01	32-0195	**	900d	29d	--	--	--	--	--	--	--
09/12/01	32-0181	03:25	--	--	95	83	126	--	--	--	4.8
09/12/01	32-0193	11:25	410d	<5d	--	--	--	--	--	--	--
10/03/01	32-0212	**	--	--	92	83	139	--	--	--	<1.0
10/03/01	32-0224	**	170	110d	--	--	--	--	--	--	--
10/03/01	32-0210	10:12	--	--	92	83	140	--	--	--	<1.0
10/03/01	32-0222	11:17	180	43d	--	--	--	--	--	--	--

WESTFIELD RIVER (Saris: 3208250)
Unique_ID: W0857 Station: WSFR00.2, Mile Point: 0.4
Description: approximately 260 feet upstream of Route 5 bridge, Agawam

Date	OWMID	Time	Fecal	E. coli	Alkalinity	Hardness	Chloride	NH3-N	NO3-NO2-N	TP	TSS
		24hr	cfu/100ml	cfu/100ml	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
08/01/01	32-0123	04:55	--	--	36	31	50	--	--	--	1.7
08/01/01	32-0141	11:45	29	<5	--	--	--	--	--	--	--
08/22/01	32-0158	03:50	--	--	35	37	58	--	--	--	4.8
08/22/01	32-0170	11:50	52	<5	--	--	--	--	--	--	--
09/12/01	32-0184	03:55	--	--	39	42	61	--	--	--	4.1
09/12/01	32-0196	11:45	>10000j	<5	--	--	--	--	--	--	--
10/03/01	32-0213	10:46	--	--	18	28	41	--	--	--	<1.0
10/03/01	32-0225	11:39	24	14	--	--	--	--	--	--	--

Appendix 4: Symbols and Qualifiers Used for DWM Data

The following data qualifiers or symbols are used in the MA DEP DWM WQD database for qualified and censored water quality and multi-probe 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.

General Symbols (applicable to all types):

“ ## ” = Censored data (i.e., data that has been discarded for some reason).
NOTE: Prior to 2001 data, “**” denoted either censored or missing data.

“ ** ” = Missing data (i.e., data that should have been reported). See NOTE above.

“ -- ” = 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).

Multi-probe-specific Qualifiers:

“ i ” = inaccurate readings from Multi-probe 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, ie. that all positive readings may be in error.)

“ m ” = method not followed; one or more protocols contained in the DWM Multi-probe SOP not followed, ie. 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 Multi-probe 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. See Section 4.1 for acceptance criteria.

“ 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). See Section 4.1 for acceptance criteria.

“ ? ” = Light interference on Turbidity sensor (Multiprobe 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 reagant 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, including the possibility of “outlier” data.

APPENDIX B

Technical Memorandum TM-32-3

WESTFIELD RIVER WATERSHED 2001 BIOLOGICAL ASSESSMENT

John Fiorentino and Peter Mitchell
Massachusetts Department of Environmental Protection
Division of Watershed Management
Worcester, MA

9 March 2004

CN 186.0

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INTRODUCTION

Biological monitoring is a useful means of detecting anthropogenic impacts to the aquatic community. Resident biota (e.g., benthic macroinvertebrates, fish, periphyton) in a water body are natural monitors of environmental quality and can reveal the effects of episodic and cumulative pollution and habitat alteration (Barbour et al. 1999, Barbour et al. 1995). Biological surveys and assessments are the primary approaches to biomonitoring.

As part of the Massachusetts Department of Environmental Protection/Division of Watershed Management's (MA DEP/DWM) 2001 Westfield River watershed assessments, aquatic benthic macroinvertebrate biomonitoring and fish population biomonitoring were conducted to evaluate the biological health of selected portions of the watershed. A total of 12 macroinvertebrate biomonitoring stations and 8 fish population biomonitoring stations were sampled to investigate the effects of various nonpoint source (NPS) and point source stressors on resident biological communities. Some stations were historical MA DEP biomonitoring stations—most recently assessed in 1996 (Szal 1998). The 2001 data, then, allow MA DEP to determine if water quality and habitat conditions at these stations have improved or worsened over time.

In some cases (e.g., point source investigations), a site-specific sampling approach was implemented, in which the aquatic community and habitat downstream from the perceived stressor (downstream study site) were compared to an upstream reference station (control site) representative of "least dsturbed" biological conditions in the waterbody. While the alternative to this site-specific approach is to compare the study site to a regional or watershed reference station (i.e., "best attainable" condition), the site-specific approach is more appropriate for an assessment of a known or suspected stressor, provided that the stations being compared share basically similar instream and riparian habitat characteristics (Barbour et al. 1999). Since both the quality and quantity of available habitat affect the structure and composition of resident biological communities, effects of such features can be minimized by sampling similar habitats at stations being compared, providing a more direct comparison of water quality conditions (Barbour et al. 1999). Sampling highly similar habitats also reduces metric variability, attributable to factors such as current speed and substrate type. Upstream reference stations were established in the Westfield and Little rivers and in Yokum Brook. To minimize the effects of temporal (seasonal and year to year) variability, sampling was conducted at approximately the same time of the year as the 1996 biosurveys.

To provide additional information necessary for making basin-wide aquatic life use-support determinations required by Section 305(b) of the Clean Water Act, all Westfield River watershed biomonitoring stations were compared to a reference station most representative of the "best attainable" (i.e., least-impacted) conditions in the watershed. Use of a watershed reference station is particularly useful in assessing nonpoint source pollution originating from multiple and/or unknown sources in a watershed (Hughes 1989). Watershed reference stations were established in the Westfield River (fourth-order) and Yokum Brook (second/third-order). Both stations were unaffected by point sources of water pollution, and they were also assumed (based on topographic map examinations and field reconnaissance) to be relatively unimpacted by nonpoint sources. The decision of which reference station to use for comparisons to a study site was based on comparability of stream morphology, flow regimes, and drainage area.

During "year 1" of its "5-year basin cycle", problem areas within the Westfield River watershed were defined more specifically through such processes as coordination with appropriate groups (EOEA Westfield River Watershed Team, local watershed associations, MA DEP/DWM, MA DEP/WERO), assessing existing data, and conducting site visits. Following these activities, the 2001 biomonitoring plan was more closely focused and the study objectives better defined. Biomonitoring station locations, along with station identification numbers and sampling dates, are noted in Table 1. Sampling locations are also shown in Figure 1. A summary of the existing conditions and perceived problems—both historical and current—identified prior to the 2001 Westfield River watershed biomonitoring survey are listed in Table 2.

The main objectives of biomonitoring in the Westfield River watershed were: (a) to determine the biological health of streams within the watershed by conducting assessments based on aquatic macroinvertebrate and fish communities; and (b) to identify impaired stream segments so that efforts can be focused on developing NPDES and Water Management Act permits, stormwater management, and control of other nonpoint source pollution. Specific tasks were:

1. Conduct benthic macroinvertebrate and fish population sampling and habitat assessments at locations throughout the Westfield River watershed;
2. Based upon the benthic macroinvertebrate, fish population, and habitat data, identify river segments within the watershed with potential nonpoint source and/or point source pollution problems; and
3. Using the benthic macroinvertebrate and fish population data, and supporting water chemistry (when available) and field/habitat data:

- assess the types of water quality and/or water quantity problems that are present.
- make recommendations for remedial actions or additional monitoring and assessment.
- provide macroinvertebrate, fish population, and habitat data to MA DEP/DWM's Environmental Monitoring and Assessment Program for assessments of aquatic life use and aesthetics use-support status required by Section 305(b) of the Federal Clean Water Act (CWA).
- provide macroinvertebrate, fish population, and habitat data for other informational needs of Massachusetts regulatory agencies, non-governmental organizations, and others.

Table 1. List of biomonitoring stations sampled during the 2001 Westfield River watershed survey, including station identification number, mile point (distance from mouth), upstream drainage area, station description, and date. Due to equipment constraints, fish population sampling was not conducted at WR06B, WR06A, WR05, and LR02A.

Station ID	Mile Point	Upstream Drainage Area (mi^2)	Westfield River Watershed Station Description	Sampling Date
WR01*	25.6	168.26	Westfield River, dnst. from Knightville Dam, near Rt. 112, Huntington, MA	6 Sept. 2001 - benthos 5 Sept. 2001 - fish
WR06B	11.3	445.56	Westfield River, outside Westfield WWTP discharge mix.zone, Westfield, MA	6 Sept. 2001 - benthos
WR06A*	11.0	452.63	Westfield River, 340 m dnst. from Westfield WWTP discharge, Westfield, MA	6 Sept. 2001 - benthos
WR05*	18.2	352.43	Westfield River, 250 m dnst. from Strathmore Paper, Russell, MA	5 Sept. 2001 - benthos
LR02A	11.5	47.60	Little River, dnst. from Cobble Mountain Reservoir, Russell, MA	4 Sept. 2001 - benthos
LR02B	7.1	52.38	Little River, 20 m upst. from Cook Brook, Russell, MA	4 Sept. 2001 - benthos 5 Sept. 2001 - fish
LR02C	6.9	53.89	Little River, 100 m dnst. from Cook Brook, Russell, MA	4 Sept. 2001 - benthos 5 Sept. 2001 - fish
YB01A	0.4	8.50	Yokum Brook, 50 m upst. from large dam, dnst. from Rt. 8, Becket, MA	5 Sept. 2001 - benthos 6 Sept. 2001 - fish
YB01B	0.2	8.58	Yokum Brook, 100 m upst. from Prentice Place, Becket, MA	5 Sept. 2001 - benthos 6 Sept. 2001 - fish
YB01C	0.0	8.60	Yokum Brook, near mouth, Becket, MA	5 Sept. 2001 - benthos 6 Sept. 2001 - fish
WB01	5.5	2.18	West Branch Walker Brook, dnst. from Robin Hood Lake, Becket, MA	5 Sept. 2001 - benthos 6 Sept. 2001 - fish
PB00	3.8	4.12	Powdermill Brook, dnst. From I-90, behind High School, Westfield, MA	4 Sept. 2001 - benthos 5 Sept. 2001 - fish

* sampled by DEP in 1996

Table 2. List of existing conditions and perceived problems identified prior to the 2001 Westfield River watershed biomonitoring survey.

Station	Issues/Problems
Westfield River (WR01)	-reference condition for mainstem Westfield and Little rivers[1,2]
Westfield River (WR05)	-industrial discharge (Strathmore Paper) – post-removal[1, 2, 3]
Westfield River (WR06A; WR06B)	-Westfield WWTP (increased discharge proposed) [1, 2, 3]
Little River (LR02A)	-flow diversion to adjacent power tunnel[2,4]; unassessed for aquatic life[2,4]
Little River (LR02B; LR02C)	-siltation via Cook Brook; flow diversion effects [2]; unassessed for aquatic life[2,4]
Yokum Brook (YB01A)	-reference condition for tributaries; unassessed for aquatic life[2,4]
Yokum Brook (YB01B)	-dams (scheduled for removal); unassessed for aquatic life[4]
Yokum Brook (YB01C)	-dams (scheduled for removal); unassessed for aquatic life[4]
West Branch Walker Brook (WB01)	-impoundment effects; unassessed for aquatic life[2,4]
Powdermill Brook (PB00)	-303d listed for silt, pathogens, solids, turbidity; misc. NPS pollution[2, 4]

[1](Szal 1998); [2](MA DEP 1998); [3](MA DEP 2003); [4](MA DEP 2002)

WESTFIELD RIVER WATERSHED
BIOMONITORING STATIONS

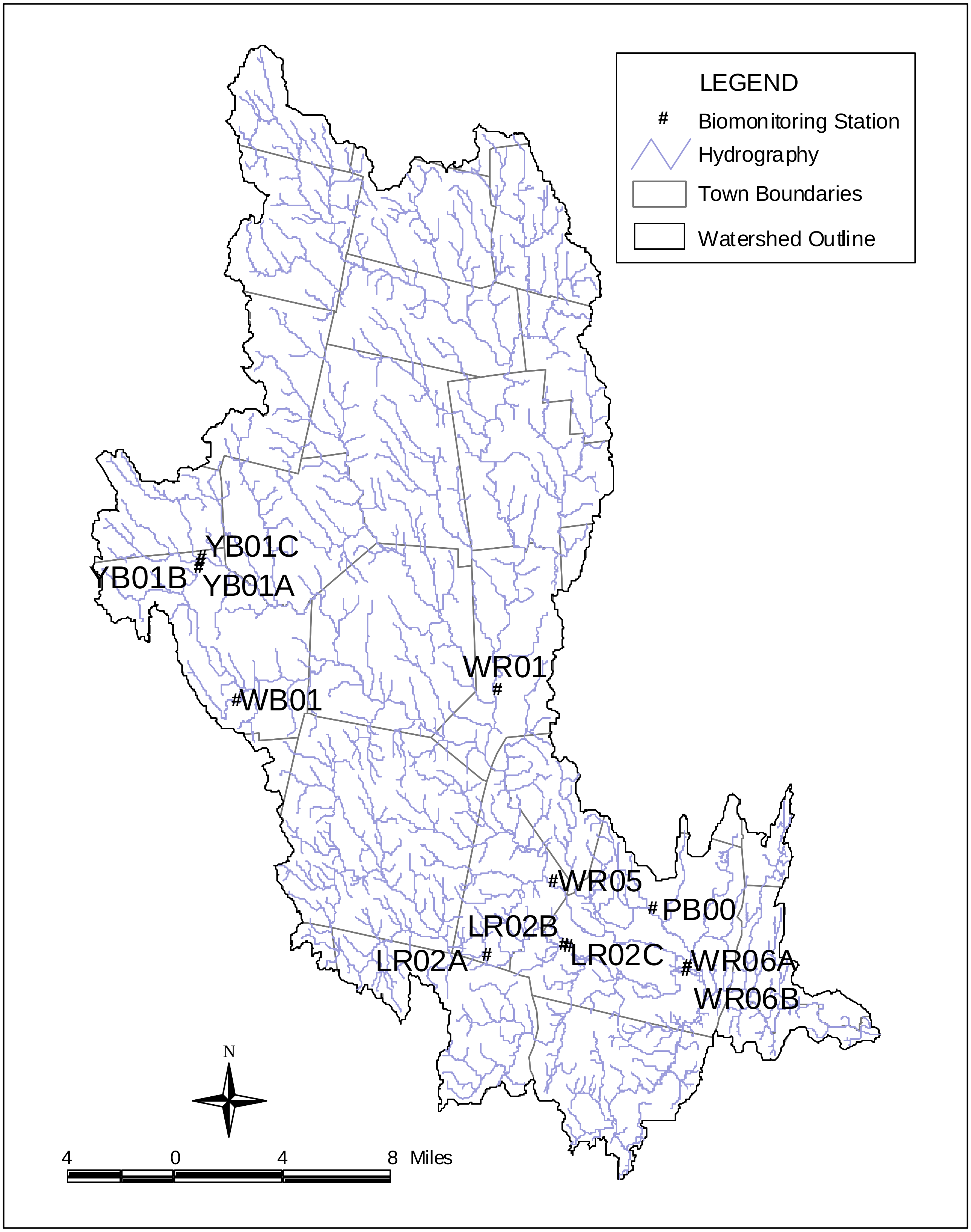

Figure 1. Location of MA DEP biomonitoring stations for the 2001 Westfield River watershed survey.

METHODS

Macroinvertebrate Sampling

The macroinvertebrate sampling procedures employed during the 2001 Westfield River watershed biomonitoring survey are described in the *CN 39.0 Water Quality Monitoring In Streams Using Aquatic Macroinvertebrates* standard operating procedures (Nuzzo 1999), and are based on US EPA Rapid Bioassessment Protocols (RBPs) for wadeable streams and rivers (Barbour et al. 1999). The macroinvertebrate collection procedure utilized kick-sampling, a method of sampling benthic organisms by kicking or disturbing bottom sediments and catching the dislodged organisms in a net as the current carries them downstream (Figure 2). Sampling activities were conducted in accordance with the Quality Assurance Project Plan (QAPP) for benthic macroinvertebrate biomonitoring (Fiorentino 2001). Sampling was conducted by MA DEP/DWM biologists throughout a 100 m reach, in riffle/run areas with fast currents and rocky (boulder, cobble, pebble, and gravel) substrates—generally the most productive habitats, supporting the most diverse communities in the stream system. Ten kicks in squares approximately 0.46 m x 0.46 m were composited for a total sample area of about 2 m^2. Samples were labeled and preserved in the field with denatured 95% ethanol, then brought to the MA DEP/DWM lab for further processing.

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Figure 2. MA DEP/DWM biologist collecting macroinvertebrates using the “kick-sampling” technique.

Fish Population Sampling

The fish sampling and processing procedures employed during the 2001 Westfield River watershed biomonitoring survey are described in *CN 75.1 Fish Collection Procedures for Evaluations of Resident Fish Populations, Method 003/11.20.95* standard operating procedures (Maietta and Decesare 2001), and are similar to Rapid Bioassement Protocol V (RBPV) as described originally by Plafkin (1989) and later by Barbour et al. (1999). Fish populations were sampled by electrofishing using a Coffelt Mark 18 gas-powered backpack electrofisher (Figure 3). A reach of between 80 m and 100 m in length was sampled by passing a pole-mounted anode ring side to side through the stream channel and in and around likely fish cover. All fish observed were netted and held in buckets. Sampling proceeded from an obstruction or constriction at the downstream end of the reach to an endpoint at another obstruction or constriction such as a waterfall or shallow riffle at the upstream end of the reach. Following completion of a sampling run, all fish were identified to species, measured, weighed, and released.

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Figure 3. MA DEP/DWM biologists collecting fish using backpack electrofisher.

Macroinvertebrate Sample Processing and Analysis

The macroinvertebrate sample processing and analysis procedures employed for the 2001 Westfield River watershed biomonitoring samples are described in the standard operating procedures (Nuzzo 1999) and were conducted in accordance with the Quality Assurance Project Plan (QAPP) for benthic macroinvertebrate biomonitoring (Fiorentino 2001). Macroinvertebrate sample processing entailed distributing whole samples in pans, selecting grids within the pans at random, and sorting specimens from the other materials in the sample until approximately 100 organisms (±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 III) metrics and scores (Plafkin et al. 1989). RBPIII offers a more rigorous bioassessment than RBPII, which was employed in the analysis of the 1996 family-level macroinvertebrate data for the Westfield River watershed. By increasing the level of taxonomic resolution; that is, by performing taxonomic identification to the lowest practical level, the ability to discriminate the level of impairment is enhanced. In addition, this increased taxonomic effort will provide information on population as well as community level effects. While this additional taxonomy requires considerably more time, discrimination of additional degrees of aquatic impairment is achieved. Based on the taxonomy, various community, population, and functional parameters, or “metrics”, were calculated which allow measurement of important aspects of the biological integrity of the community. This integrated approach provides more assurance of a valid assessment because a variety of biological parameters are evaluated. Deficiency of any one metric should not invalidate the entire approach (Barbour et al. 1999). Metric values for each station were scored based on comparability to the reference station, and scores were totaled. The percent comparability of total metric scores for each study site to those for a selected “least-impacted” reference station yields an impairment score for each site. The analysis separates sites into four categories: non-impacted, slightly impacted, moderately impacted, and severely impacted. Each impact category corresponds to a specific aquatic life use-support determination used in the CWA Section 305(b) water quality reporting process—non-impacted and slightly impacted communities are assessed as “support” in the 305(b) report; moderately impacted and severely impacted communities are assessed as “impaired.” A description of the *Aquatic Life* use designation is outlined in the *Massachusetts Surface Water Quality Standards* (SWQS) (MA DEP 1996). Impacts to the benthic community may be indicated by the absence of generally pollution-sensitive macroinvertebrate taxa such as Ephemeroptera, Plecoptera, and Trichoptera (EPT); dominance of a particular taxon, especially the pollution-tolerant Chironomidae and Oligochaeta taxa; low taxa richness; or shifts in community composition relative to the reference station (Barbour et al. 1999). Those biological metrics calculated and used in the analysis of 2001 Westfield River watershed macroinvertebrate data are listed and defined below {For a more detailed description of metrics used to evaluate benthos data, and the predicted response of these metrics to increasing perturbation, see Barbour et al. (1999)}:

1. Taxa Richness—a measure based on the number of taxa present. Generally increases with increasing water quality, habitat diversity, and habitat suitability. The lowest possible taxonomic level is assumed to be genus or species.

2. EPT Index—a count of the number of genera/species from the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). As a group these are considered three of the more pollution sensitive aquatic insect orders. Therefore, the greater the contribution to total richness from these three orders, the healthier the community.

3. Biotic Index—Based on the Hilsenhoff Biotic Index (HBI), this is an index designed to produce a numerical value to indicate the level of organic pollution (Hilsenhoff 1987). Organisms have been assigned a value ranging from zero to ten based on their tolerance to organic pollution. Tolerance values (TV) currently used by MA DEP/DWM biologists were originally developed by Hilsenhoff and have since been supplemented by Bode et al. (1991) and Lenat (1993). A value of zero indicates the taxon is highly intolerant of pollution and is likely to be found only in pollution-free waters. A value of ten indicates the taxon is tolerant of pollution and may be found in highly polluted waters. The number of organisms and the individually assigned values are used in a mathematical formula that describes the degree of organic pollution at the study site. The formula for calculating HBI is:

   $$HBI = \sum \frac{x_i t_i}{n}$$

   where
   x_i = number of individuals within a taxon
   t_i = tolerance value of a taxon
   n = total number of organisms in the sample

4. Ratio of EPT and Chironomidae Abundance—The EPT and Chironomidae abundance ratio uses relative abundance of these indicator groups as a measure of community balance. Skewed populations having a disproportionate number of the generally tolerant Chironomidae (“midges”) relative to the more sensitive insect groups may indicate environmental stress.
5. Percent Contribution Dominant Taxon—is the percent contribution of the numerically dominant taxon (genus or species) to the total numbers of organisms. A community dominated by few species indicates environmental stress. Conversely, more balance among species indicates a healthier community.

6. Ratio of Scraper and Filtering Collector Functional Feeding Groups—This ratio reflects the community food base. The proportion of the two feeding groups is important because predominance of a particular feeding type may indicate an unbalanced community responding to an overabundance of a particular

food source (Barbour et al. 1999). Scrapers predominate when diatoms are the dominant food resource, and decrease in abundance when filamentous algae and mosses prevail. Filtering collectors thrive where filamentous algae and mosses are prevalent and where fine particulate organic matter (FPOM) levels are high.

7. Community Similarity—is a comparison of a study site community to a reference site community. Similarity is often based on indices that compare community composition. Most Community Similarity indices stress richness and/or richness and abundance. Generally speaking, communities with comparable habitat will become more dissimilar as stress increases. In the case of the Westfield River watershed bioassessment, an index of macroinvertebrate community composition was calculated based on similarity (i.e., affinity) to the reference community, expressed as percent composition of the following organism groups: Oligochaeta, Ephemeroptera, Plecoptera, Coleoptera, Trichoptera, Chironomidae, and Other. This approach is based on a modification of the Percent Model Affinity (Novak and Bode 1992). The reference site affinity (RSA) metric is calculated as:

   $100 - (\Sigma\ \delta \times 0.5)$

   where δ is the difference between the reference percentage and the sample percentage for each taxonomic grouping. RSA percentages convert to RBPIII 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 for ≥65%.

Fish Sample Processing and Analysis

The RBP V protocol (Plafkin et al. 1989; Barbour et al. 1999) calls for the analysis of the data generated from fish collections using an established Index of Biotic Integrity (IBI) similar to that described by Karr et al. (1986). However, since no formal IBI exists for Massachusetts' surface waters, the data provided by this sampling effort were used to qualitatively assess the general condition of the resident fish population as a function of overall abundance (number of species and individuals) and species composition classifications listed below.

1. Tolerance Classification – Classification of tolerance to environmental stressors similar to that provided in Plafkin et al. (1989), Barbour et al. (1999), and Halliwell et al. (1999). Final tolerance classes (TC) are those provided by Halliwell et al. (1999).

2. Macrohabitat Classification – Classification by common macrohabitat use as presented by Bain and Meixler (2000) modified regionally following discussions with MA DEP and MA Division of Fisheries and Wildlife (DFW) biologists.

3. Trophic Classes – Classification that utilizes both dominant food items as well as feeding habitat type as presented in Halliwell et al. (1999).

Habitat Assessment

An evaluation of physical and biological habitat quality is critical to any assessment of ecological integrity (Karr et al. 1986; Barbour et al. 1999). Habitat assessment supports understanding of the relationship between physical habitat quality and biological conditions, identifies obvious constraints on the attainable potential of a site, assists in the selection of appropriate sampling stations, and provides basic information for interpreting biosurvey results (US EPA 1995). Before leaving the sampling reach during the 2001 Westfield River watershed macroinvertebrate biosurveys, habitat qualities were scored using a modification of the evaluation procedure in Barbour et al. (1999). The matrix used to assess habitat quality is based on key physical characteristics of the water body and related streamside features. Most parameters evaluated are instream physical attributes often related to overall land-use and are potential sources of limitation to the aquatic biota (Barbour et al. 1999). The ten habitat parameters are as follow: instream cover, epifaunal substrate, embeddedness, sediment deposition, channel alteration, velocity/depth combinations, channel flow status, right and left (when facing downstream) bank vegetative protection, right and left bank stability, right and left bank riparian vegetative zone width. Habitat parameters are scored, totaled, and compared to a reference station to provide a final habitat ranking.

QUALITY CONTROL

Field and laboratory Quality Control (QC) activities were conducted in accordance with the Quality Assurance Project Plan (QAPP) for biomonitoring and habitat assessment (Fiorentino 2001). Quality Control procedures are further detailed in the standard operating procedures (Maietta and Decesare 2001; Nuzzo 1999).

Field Sampling Quality Control

Macroinvertebrate Sampling:

Field Sampling QC entails: 1) Pre- and post-sampling rinses, inspection of, and picking of nets, sieves, and pans to prevent organisms collected from one station to be transferred to samples taken elsewhere. 2) On-site preservation of benthos sample in 95% ethanol to ensure proper preservation, and 3) To assess the consistency of the sampling effort, collection of a duplicate sample is performed at one of the biomonitoring stations. Two samples are collected "side by side"—a second kick sample (i.e., the duplicate) is taken adjacent to (where different assessment results are not expected due to the apparent absence of additional stressors) the original kick at each of the ten kicks conducted in a given 100 m sample reach. Duplicate samples are composited in a similar manner to the original sample; yet, they are preserved in a separate sample bottle marked "duplicate" and with all other information regarding station location remaining the same. Duplicate samples are used for the calculation of Precision of the benthos data.

Fish Population Sampling:

All field equipment must be in good operating condition, and a plan of routine inspection, maintenance and/or calibration must be developed to ensure consistency and quality of field data. Field data must be complete and legible, and must be entered on standardized field data forms and chains-of custody for all anticipated sampling sites, as well as copies of all applicable SOPs.
Field validation is conduced at selected sites and involves the collection of a replicate sample taken from an adjacent reach upstream of the initial sampling site. The adjacent reach must be similar to the initial site with respect to habitat and stressors. Sampling QC data are evaluated in order to determine a level of acceptable variability and the appropriate replication frequency.

Field Analytical Quality Control

Macroinvertebrate Survey:

Field Analytical QC entails multiple observers (at least both DWM benthic biologists, and a third person) performing the Habitat Assessment at each macroinvertebrate biomonitoring station. A standardized Habitat Assessment Field Scoring Sheet is completed at all biomonitoring stations. Disagreement in habitat parameter scoring is discussed and resolved before the Habitat Assessment can be considered complete.

Fish Population Survey:

Field Analytical QC entails taking appropriate measures to ensure accurate fish identifications. Field identification of fish must be conducted by qualified/trained fish taxonomists, familiar with Massachusetts ichthyofauna.

Questionable records are prevented by preserving select specimens and those that cannot be readily identified in the field for laboratory verification and /or examination by a second qualified fish taxonomist. Specimens must be properly preserved and labeled. Specimens may be sent to authorities for particular taxonomic groups.

Fixed Laboratory Quality Control

Macroinvertebrate Samples:

Fixed Laboratory QC entails the following: 1) Taxonomy bench sheets are examined by a reviewer (the DWM biologist not responsible for the initial taxonomic identifications) for errors in transcription from bench notebook, count totals, and spelling. All bench sheets are examined, and detected errors are brought to the taxonomists attention, discussed, and corrected. 2) Taxonomic duplication, in which “spot checks” are performed by a reviewer (the DWM biologist not responsible for the initial taxonomic identifications) on taxonomy, are performed at the reviewer’s discretion. In general, all taxa that are rarely encountered in routine benthos samples, or taxa that the primary taxonomist may be less than optimally proficient at identifying, are checked. Spot checks are performed for all stations. Specimens may be sent to authorities for particular taxonomic groups. 3) Data reduction and analysis, including biological metric scoring (metric values are calculated through queries run in the DWM Benthic Macroinvertebrate Database), comparisons to reference station metrics, and impairment designations, are checked by a reviewer (the DWM biologist not responsible for performing the initial taxonomy and data analysis) for all benthos data at all stations. Detected errors are brought to the original taxonomist’s attention and resolved. 4) Precision, a measure of mutual agreement among individual measurements or enumerated values of the same property of a sample and usually expressed as a standard deviation in absolute or relative terms, is compared using raw benthos data and metric values. If metric values and resulting scoring are significantly different (i.e., beyond an acceptable Relative Percent Difference) between the original and duplicate samples, the investigators will attempt to determine the cause of the discrepancy. Guidance regarding the calculation of Precision, including Relative Percent Difference (RPD) calculations and recommendations, can be found in US EPA (1995).

RESULTS AND DISCUSSION

The biological and habitat data collected at each sampling station during the 2001 biomonitoring survey are attached as an Appendix (Tables A1 – A6). Fish population data were collected at 8 of the 12 stations where macroinvertebrates were collected. Included in the macroinvertebrate and fish taxa lists (Table A1 and A6) are total organism counts, the functional feeding group designation (FG) for each macroinvertebrate taxon, the habitat and trophic class for each fish taxon, and the tolerance designation (TV for macroinvertebrates; TC for fish) for each taxon (macroinvertebrates and fish).

Summary tables of the macroinvertebrate data analysis, including biological metric calculations, metric scores, and impairment designations, are also included in the Appendix. Table A2 is the summary table for those biomonitoring stations compared to the Westfield River watershed reference station (WR01). Table A3 is the summary table for station comparisons to the Yokum Brook reference site (YB01A). Table A4 shows the analysis of those stations (LR02C, WR06A, YB01B, YB01C) being compared to a site-specific control (i.e., upstream reference station) station (WR02B, WR06B, YB01A). Habitat assessment scores for each station are also included in the summary tables, while a more detailed summary of habitat parameters is shown in Table A5.

As was determined following the 1996 Westfield River watershed biomonitoring survey, the 2001 biological data generally indicated good overall water quality and biological health at most sampling stations investigated. Impacts to resident biota observed at some stations were mainly the result of urban runoff, habitat degradation, and other forms of NPS pollution. In addition, the effects of water quality degradation may be exacerbated by compromised assimilative capacities in those streams affected by drought and/or anthropogenic-induced low baseflows. Reference-quality biomonitoring stations in both the mainstem Westfield River and tributary streams continue to support diverse and well-balanced aquatic communities expected in a “least-impacted” stream system.

Westfield River Watershed

The Westfield River watershed drains 517 square miles (1340 km^2) from the eastern Berkshires to the Connecticut River. The Main, or East Branch as it is sometimes called, originates in the high country of Savoy and Windsor and flows 27 miles (43 km) in a southeasterly direction where it joins the Connecticut River. The Middle Branch begins in Peru and forms the border between Worthington and Middlefield before flowing through Chester to join the Main Branch in the town of Huntington. The West Branch, formed by the confluence of Depot and Yokum Brooks in Becket flows easterly, also meeting the main stem in Huntington. There are a total of 850 miles (1368 km) of rivers, streams, and brooks and 4,200 acres (17 km^2) of lakes and ponds in the watershed. Approximately forty-three miles (69 km) of the Westfield River have been designated by the National Park Service as "Wild and Scenic". Included in this first ever designation for a Massachusetts river are parts of the Main, Middle and West Branches.

The Westfield River watershed is bordered by the Deerfield, Hoosic, Housatonic, Farmington and Connecticut River basins and is contained almost entirely within Massachusetts. The basin covers all or a part of twenty-eight municipalities: Savoy, Windsor, Hawley, Plainfield, Ashfield, Peru, Cummington, Goshen, Chesterfield, Worthington, Middlefield, Washington, Becket, Chester, Huntington, Westhampton, Montgomery, Russell, Blandford, Otis, Tolland, Granville, Westfield, Southampton, Holyoke, West Springfield, Agawam and Southwick.

Because the headwaters originate in mountains with little soil to retain water, the Westfield River rises quickly in response to large storms and snowmelt. After those flows subside, little water is left for baseflows. Consequently, the river naturally fluctuates between high and low flows. Both the Main Branch and the Middle Branch have U.S. Army Corps of Engineer Dams to alleviate some of the danger of flooding. Several water supply reservoirs capture spring runoff, storing it for use throughout the year. Cobble Mountain in Blandford, Littleville in Huntington, and Bearhole in Westfield are the largest reservoirs. The lower reaches of the Westfield flow through a broad valley filled with stratified drift, forming the Barnes Aquifer, a major groundwater resource that stretches from Holyoke to Southwick.

The upper portion of the watershed is very rural and timber harvesting and agricultural activities dominate the land-use. The lower portion of the watershed is more developed and includes heavily urbanized areas of Agawam, West Springfield, and Westfield. The Westfield River Basin supplies both surface water (12 withdrawal sites) to seven public water supply systems and three industrial users (four withdrawal sites) and groundwater to four of the seven municipal supply systems.

During the settlement of the watershed, hydro-power available from the Westfield and an abundance of raw materials fueled industrial development. The major historic mill sites are still industrial sites even though hydro-power has diminished in importance. In the past, sewage and industrial discharges greatly impacted the water and habitat quality of the lower Westfield River. Currently these point source discharges are regulated by NPDES permits. There are seven municipal wastewater discharge permits and three industrial wastewater permits in the basin. Although these permits, and their strict effluent limits, have resulted in a marked improvement in water quality over the last twenty years, several facilities occasionally have difficulty in meeting permit limits. In addition, there may be a need to regulate contaminants that were not considered a priority when previous NPDES permits were issued.

Hydrologic Conditions

The Westfield River watershed was affected by drought conditions during the 2001 biomonitoring survey (USGS 2004). Precipitation was virtually absent (0.11 inches) during the month leading up to the biosurvey, reducing stream discharges well below the expected mean for their period of record (USGS 2004) (Figure 4). The net effect was a reduction in available instream habitat, exposure of substrates, and an increase in instream water temperatures. These habitat constraints may result in the stranding or concentration of biota (both benthic macroinvertebrates and fish) into the remaining available habitats. In addition, these conditions tend to increase the stress upon sensitive species, and increase the metabolic rate of poikilothermic biota.

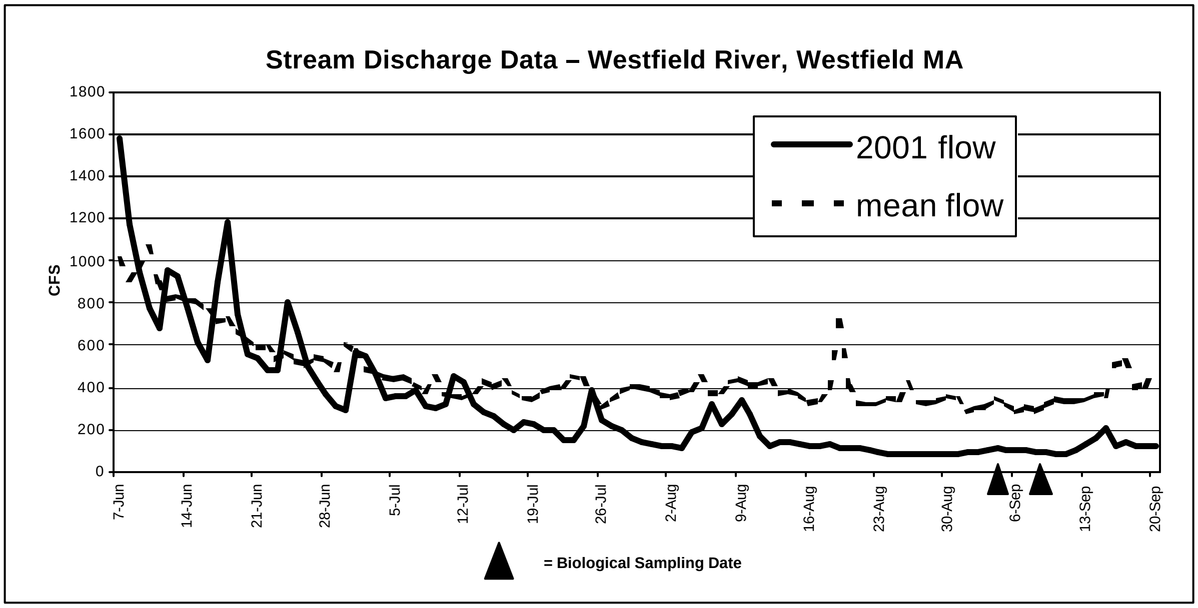

Figure 4. Discharge data at mainstem USGS gage 01183500: 2001 flow and mean flow over 88-year period of record (USGS 2004).

Westfield River

The Westfield River begins at the confluence of Center Brook and Drowned Land Brook in Savoy on the eastern flanks of the Hoosac Range. The river flows in a southeast direction through mostly undeveloped steep terrain with little floodplain development through the towns of Windsor and Cummington. At Cummington Center the floodplain widens but then narrows as the river continues southeast through Cummington in a narrow steep valley. Just before entering Chesterfield, the river turns east and then sharply to the north where the Swift River joins it. The Westfield River then turns abruptly to the south and flows into Chesterfield in a narrow steep valley which then enters a state forest in a reach called The Gorge with extremely steep slopes and a narrow river channel. The floodplain then widens as the river enters Huntington continuing to flow south. The river then enters the Army Corps of Engineers Knightville Dam area and several miles below the dam is the confluence with the Middle Branch of the Westfield River.

From the confluence with the Middle Branch Westfield River (below Littleville Dam), the Westfield River continues flowing south past the town center of Huntington to the confluence with the West Branch Westfield River. Here the river receives the Huntington WWTP (NPDES permit no. MA0101265) treated municipal wastewater in the uppermost end of this segment, approximately 2.3 miles (3.7 km) below the Middle Branch confluence. The Westfield River then begins to flow in a southeasterly direction. Just before passing by the Village of Crescent Mills, the river becomes impounded at the USM Corp. Texon Division Dam (MA0005282), a major NPDES discharger. The river "zig-zags" to the southeast through steep terrain to the town of Russell where it encounters a hydroelectric dam and where the Russell

Wastewater Treatment Plant discharges (MA0100960) just downstream of the dam. A few miles downstream in Woronoco, the river is again impounded. Strathmore Paper Co. (MA0004995) has historically discharged into the river in this reach; however, the facility is no longer operational. The river continues to the southeast passing under Interstate Route 90 and then enters the City of Westfield. Here the topography changes to a broad floodplain and the river gradient decreases. The river then enters the urbanized part of Westfield where the Westfield WWTP (MA0101800) discharges. The Westfield River then flows southeast where the Little River joins it and then continues to the Route 20 bridge. This segment also historically received wastewater from the Westfield River Paper Company, although this discharge is no longer active.

From the Route 20 bridge in Westfield, the Westfield River continues to meander to the southeast through an industrial area and then loops to the northeast to where it crosses the city of Westfield municipal boundary. The river then flows to the east and the floodplain narrows and the banks steepen as the river passes by Westfield's boundary with West Springfield and Agawam. The Westfield State Hospital (MA0102270), a minor NPDES permit, discharges into a small unnamed brook which flows a short distance to the Westfield River.

From the Westfield city boundary with West Springfield and Agawam, the Westfield River continues to meander in an easterly direction through a narrow floodplain with steep banks. The river then becomes the municipal boundary between West Springfield and Agawam, then flows through an industrial area in West Springfield and urbanized areas of Agawam before entering a delta at its confluence with the Connecticut River in Agawam. Decorative Specialities (MA0032492) discharges into this segment of the Westfield River.

WR01—Westfield River, mile point 25.6 (41.1 km), downstream from Knightville Dam, off Rocky Hill Road near Route 112, Huntington, MA

Habitat

The WR01 sampling reach was located approximately 2 miles (3.2 km) downstream from the Knightville Dam and a short distance (700 m) above the mainstem Westfield River's confluence with the Middle Branch in Huntington. The biomonitoring station was accessed via the backyard of a private residence at the cul-de-sac of Rocky Brook Road. Despite the forested nature of this portion of the watershed, the width (30 m) of the river here precluded the presence of any meaningful canopy cover. Riffles of varying depth (0.1 – 0.5 m) and an abundance of boulder substrates provided exceptional habitat for macroinvertebrates. Fish habitat was also excellent, with ample deep (0.5 – 1.0 m) water areas and stable cover in the form of boulder, bedrock ledge, and submerged logs. In fact, this was the only Westfield River biomonitoring station to receive perfect scores for both the instream cover and epifaunal substrates habitat parameters. Sediment deposition or other signs of NPS pollution were absent. Water reached the base of both stream banks, leaving only minimal amounts of instream substrates exposed. Instream aquatic vegetation was absent, and only occasional (<1% cover) patches of periphyton were observed as thin films attached to boulders in riffle areas. Both banks were well vegetated and stable, save for a small area where tree clearing and slight bank erosion had occurred on the right (west) bank. Riparian vegetation was undisturbed along the left (east) bank and comprised shrubby (alder, *Alnus* sp.; sweet pepperbush, *Clethra alnifolia*) and herbaceous (ferns, Joe-Pye weed, *Eupatorium* sp.) growth along the stream margin before giving way to a dense mixed hardwood (birch, *Betula* sp.; slippery elm, *Ulmus rubra*; white ash, *Fraxinus americana*) and hemlock (*Tsuga canadensis*) forest.

WR01 received a total habitat score of 184/200 (Table A5). This was used as the primary reference station for biomonitoring stations in the mainstem Westfield River and the Little River—all of which are predominately open-canopied reaches with comparable flow regimes and instream habitat. Designation of WR01 as a reference condition was based on its high habitat evaluation, historically good water quality and biological integrity (Szal 1998), absence of nonpoint source pollution inputs, and minimal surrounding land-use impacts (e.g., absence of point source influences, lack of channelization, minimal development or agricultural activity nearby, undisturbed and well vegetated riparian zone).

Benthos

As was the case during the 1996 Westfield River watershed biological assessments (Szal 1998), WR01 was characterized by a macroinvertebrate assemblage indicating a healthy aquatic community, with metric values indicative of good water quality and “least-impacted” conditions (Table A2). In particular, those attributes that measure components of community structure (i.e., Taxa Richness, EPT Index)—which display the lowest inherent variability among the RBP metrics used (Resh 1988)—scored well, further corroborating the designation as a reference station. A low Biotic Index (4.10) and a high (highest value in the survey) EPT Index (17) indicated the dominance of pollution-sensitive taxa among the WR01 benthos assemblage. Filter-feeding caddisflies (*Chimarra* sp.) were fairly well represented (n=23), as was the case during the 1996 biosurvey (Szal 1998). Their presence resulted in slight point reductions (score=4) for the Percent Dominant Taxon metric for both the 1996 data set and current benthos evaluations here. Filter-feeders did not dominate the WR01 sample, however. Indeed, pollution sensitive algal scraping taxa such as the Elmidae and Heptageniidae were numerous as well, indicating good trophic balance and the presence of multiple (FPOM, periphyton, etc.) important food resources in this portion of the river. The WR01 benthic community received a total metric score of 40 out of a possible score of 42 (Table A2).

Fish

Fifty-five fish were collected at WR01 (Table A6). The width of the river at this station decreased the efficiency of the backpack electrofishing device. The dominant species present in the sampled population was smallmouth bass (*Micropterus dolomieu*, n=22). The sub-dominant species collected was white sucker (*Catostomus commersoni*, n=12). These two species accounted for 62% of the specimens collected at this station. Both of these fish are capable of inhabiting thermal regimes intermediate to those of cold-water species (e.g., Atlantic salmon, *Salmo salar*; eastern brook trout, *Salvelinus fontinalis*) and warm-water species (e.g., largemouth bass, *Micropterus salmoides*; pumpkinseed, *Lepomis gibbosus*). Smallmouth bass and white sucker are mid-tolerant and tolerant respectively. The dominance of these two species may be a response to the drought conditions observed in this watershed during the 2001 biosurveys, or a result of the impounded (Knightville Dam is just upstream) nature of the upper Westfield River.

WR05—Westfield River, mile point 18.2 (29.3 km), 250 m downstream from Strathmore Paper Company discharge (inactive), Russell, MA

Habitat

The WR05 sampling reach was located approximately 250 m downstream from the inactive wastewater and thermal discharges of the now-defunct Strathmore Paper Company in the Woronoco section of Russell. The open-canopied reach was wide (12 m) and of swift current velocity—numerous riffle areas (0.2 – 0.4 m deep) and boulder/cobble substrates provided macroinvertebrates with excellent epifaunal habitat. Fish habitat was also considered optimal, with boulders and submerged woody materials in deep pools providing ample stable cover. Fish population data were not collected here, however, as the wide and deep nature of much of the WR01 sampling reach precluded the use of backpack electrofishing as a viable means of fish population sampling. Sediment deposition was not observed, nor were other NPS pollution inputs. Aquatic macrophytes and algae were absent despite the open canopy. Only habitat parameters for velocity-depth combinations and channel flow status were less than optimal (score of 15 and 14 respectively), the result of a lack of deep riffle areas and some channel substrate exposure. Parameters for bank and riparian habitat scored high—banks were well-vegetated and stable along both sides of the channel. Riparian vegetation was undisturbed and equally comprised of grasses and herbaceous (Japanese knotweed and smartweeds, *Polygonum* spp.) growth, vines (riverbank grape, *Vitis riparia*), shrubs (bittersweet, *Calastrus* sp.; dogwood, *Cornus* sp.), and mixed hardwoods (maple, *Acer* spp.; white ash, *Fraxinus americana*; elm, *Ulmus* spp.; sycamore, *Platanus occidentalis*).

WR05 received a total habitat score of 185/200—the highest habitat evaluation recorded during the 2001 Westfield River watershed biomonitoring survey (Table A5). Habitat quality was only slightly compromised by the drought-induced low baseflow conditions observed during the 2001 biosurveys.

Benthos

The WR05 benthos assemblage received a total metric score of 30, representing 75% comparability to the mainstem reference station and resulting in an assessment of "slightly impacted" for biological condition (Table A2). Point reductions for compositional metrics were most noticeable, with Taxa Richness and EPT Index receiving scores of only 2. The preponderance of filter-feeding caddisflies (especially *Chimarra* sp.) contributed to the displacement of other more pollution sensitive taxa, although their presence was not enough to impact the Scraper/Filterer metric (score=6). The numerous filter-feeders observed here probably results from an ample supply of FPOM originating from large upstream impoundments (e.g., Littleville Lake) and is delivered to downstream benthic communities such as WR05. Urban runoff associated with downtown Russell, as well as treated wastewater from the town's WWTP, may contribute organic loads to this portion of the river as well.

The current bioassessment of WR01 is dramatically improved from that observed following the 1996 survey, when Strathmore still maintained both a heated discharge and a second discharge of treated paper process wastewater. The 1996 macroinvertebrate biomonitoring efforts found a "severely impacted" community relative to watershed and upstream reference conditions, with extreme reductions of both total and sensitive taxa, and the highest Biotic Index in the survey (Szal 1998). Coupled with a hyperdominance of chironomids (n=79), benthos metrics for the 1996 sample suggested severe water quality degradation in the form of organic enrichment attributable to the Strathmore discharges. With the removal of the Strathmore discharges water quality at WR01, as reflected in the resident benthos, appears to have improved significantly. Chironomids and other taxa highly tolerant (e.g., Naididae) of organic pollutants and observed in the 1996 sample were virtually absent from the 2001 benthos sample, while the Biotic Index has returned to a level comparable to that of the reference community.

WR06B—Westfield River, mile point 11.3 (18.1 km), opposite the Westfield WWTP discharge (i.e., outside of the effluent plume), Westfield MA

Habitat

The WR06B sampling reach began approximately 400 m downstream from the Little River's confluence with the mainstem Westfield River and was confined to a short channel opposite (i.e., along the south bank and clearly outside the effluent plume) the WWTP discharge that entered the river from the left (north) bank. The reach was about 420 m downstream from DEP's historical biomonitoring station (WR06) in this segment of the river. Habitat constraints (lack of riffle areas) at WR06 and elsewhere upstream from the discharge outfall resulted in less than ideal conditions for kick sampling and led to DEP's decision to establish the new station at WR06B. In addition, moving the biomonitoring station farther downstream (i.e., below the mouth of the Little River) allowed for a "tighter" bracketing of the Westfield WWTP, resulting in a more accurate assessment of discharge impacts by eliminating the potentially confounding effects of water quality factors originating from the Little River.

The constricted nature of WR06B—formed by the riverbank to the south and a small island to the north—resulted in good current velocity and well formed riffles of varying depths (0.2 – 0.5 m) throughout the 2 m wide sampling reach. Hard substrates mainly comprised of cobble provided macroinvertebrates with optimal epifaunal habitat. Fish habitat was also good, with undercut banks, occasional boulder, and submerged logs providing stable cover in both shallow and deep (up to 1 m) areas. Dense algal growth, especially filamentous green forms, covered rocky substrates in the majority of the reach and was afforded full sunlight penetration due to the mostly (30% shaded) open-canopied nature of this wide (20 m) portion of the Westfield River. Channel flow status, in both the side channel where sampling was conducted and the river as a whole here, was optimal. Banks were well-vegetated with shrubs (bittersweet, *Celastrus* sp.; elderberry, *Sambucus canadensis*) and herbaceous (ferns) growth; streambank vegetation also provided good bank stability, as did the "rip-rap" deposited along much of the bank here. The riparian zone was wide and undisturbed along the left (north) bank of the river, with a mix of hardwoods (cottonwood, *Populus deltoides*; maple, *Acer* spp.; white ash, *Fraxinus americana*; elm, *Ulmus* sp.; sycamore, *Platanus occidentalis*) providing a good vegetative buffer. Riparian vegetation was much reduced along the right (south) bank due to adjacent commercial/industrial activities and parking lots. Turbidity in the water column was observed, and the effluent odor emanating from the outfall across the river was quite pronounced.

WR06B received a total habitat assessment score of 165/200 (Table A5). Most of the habitat point reductions were a result of the urbanized nature of this portion of the watershed.

Benthos

The WR06B macroinvertebrate community received a total metric score of 28, representing 70% comparability to the reference community at WR01 and resulting in an assessment of "slightly impacted" for biological condition (Table A2). EPT Index and EPT/Chironomidae metrics performed particularly poorly (score=0), indicating that chironomids have displaced some of the more sensitive EPT taxa in this portion of the river. Suppression of the EPT community is consistent with the findings of Szal (1998) during the last DEP biomonitoring survey conducted in this segment (i.e., upstream from Westfield WWTP) of the Westfield River. But despite the Chironomidae comprising greater than 25% of the WR06B benthos sample (Table A1), no one species dominated nor did their presence negatively affect the Biotic Index (score=6). High scoring values for Scraper/Filterers and Percent Dominant Taxon metrics suggest community structure and function remain relatively balanced among the benthos assemblage here despite the potential for runoff effects originating in downtown Westfield.

WR06A—Westfield River, mile point 11.0 (17.7 km), 340 m downstream from Westfield WWTP discharge, Westfield, MA

Habitat

WR06A was located approximately 340 m downstream from the Westfield WWTP outfall. Though land-use is highly urbanized in this portion of the watershed, the area immediately adjacent to the sampling reach was forested and relatively undisturbed. Trees provided only minimal (20% canopy cover) shading in this wide (20 m) segment of the Westfield River. The reach was rocky (mostly cobble) and riffle-dominated, with swift current velocity of varying (0.2 – 0.5 m) depths providing ideal epifaunal benthos habitat. Some areas of cobble stream bottom were left exposed and unavailable for macroinvertebrates due to the suboptimal channel flow status here during the time of the biosurvey. Fish habitat was only marginal at best due to the lack of stable cover and well-defined pools. Various types of green algae covered virtually all the stream bottom in the sampling reach. In addition to the luxuriant algal growth, an abundance of sewage fungus was noted along the margins of the reach. The smell of treated sewage was quite strong here, and instream turbidity was obvious. Bank and riparian habitat quality was excellent at WR06A. Banks were well-vegetated with ferns and grasses and stabilized with boulders and tree roots. The deciduous (cottonwood, *Populus deltoides*; maple, *Acer* spp.; sycamore, *Platanus occidentalis*) forest on both sides of the river provided a wide and undisturbed riparian zone.

WR06A received a total habitat assessment score of 168/200 (Table A5). The habitat evaluation conducted here during the 1996 biosurvey yielded similar results (Szal 1998). Habitat quality, especially instream parameters, was highly comparable to conditions recorded just upstream at WR06B.

Benthos

The WR06A benthos assemblage received a total metric score of 24, representing 60% comparability to the watershed reference station located on the Westfield River. Chironomids dominated the community, comprising half of the assemblage and resulting in displacement of pollution sensitive taxa (an EPT Index of 5 was the lowest in the entire Westfield River watershed biomonitoring survey) and a low scoring EPT/Chironomidae metric value (Table A2). The resulting bioassessment—"slightly impacted"—was similar to previous assessments in this portion of the river. In 1996, biomonitoring efforts detected an assemblage with metric scores that were 60% comparable to watershed reference conditions and an assessment of “moderately impacted”; however, analysis of benthos metrics for that biosurvey was based on only family-level (i.e., RBPII) taxonomy. Chironomids were an even larger component of the benthos sample collected in 1996, comprising almost 80% of the total assemblage (Szal 1998).

To better assess the potential impacts of the Westfield WWTP discharge, WR06A was compared to an upstream control station (WR06B). Again, the comparison of benthic communities yielded an assessment of “slightly impacted” for biological condition (Table A4). Impairment here appears to be the result of water quality degradation, as habitat scores were comparable (better in fact) to the upstream reference station. Most notable among the benthic metrics for WR06A was the EPT Index, which was greatly reduced (by more than half) compared to WR06B due to the displacement of EPTs by chironomids (EPT/Chironomidae metric score=2). That DWM biologists were able to closely bracket the Westfield WWTP discharge with both the macroinvertebrate test station and control station suggests biological impairment at WR06A can be at least partially attributed to discharge effects, as was concluded by DEP following the 1996 biosurvey here (Szal 1998).

Little River

The Little River begins at the outfall of Cobble Mountain Reservoir. This reservoir has 15 streams (including the outfall of Borden Brook Reservoir) contributing to its 96.5 million cubic meter volume. The Springfield Water and Sewer Commission operate the reservoir and the West Parish Filtration Plant, and sells water to approximately 250,000 people in Westfield, Southwick, West Springfield, Agawam, and other surrounding towns. Much of the land (approximately 12,000 acres (4.85 km^2)) surrounding the reservoir (mostly in the town of Blandford) has been taken by the City of Springfield through eminent domain and purchase. Public access to Cobble Mountain Road, and by default, the reservoir, has been forbidden since the fall of 2001.

Water from the reservoir may be discharged through a spill gate at the base of the dam (the headwaters of the Little River) or an aqueduct leading to a 33 megawatt generating facility on the banks of the Little River (4 km downstream of the dam). The Little River emerges from the base of the Cobble Mountain Dam and flows through a steep-sided and heavily forested valley. The river receives the flows of Pitcher Brook and three other unnamed low-order streams within the first 3 km of its length. After receiving the thermal discharge from the generating facility, the Little River enters the impoundment known as The Gorge. Water from this impoundment may either be released back into the Little River streambed, or sent by aqueduct to the West Parish Filtration Plant. Water released to the Little River courses northeasterly for 2.5 km, where it receives the flow from Sodom Brook. After flowing around Westfield Mountain, the river turns southeasterly. After the river leaves the slopes of Westfield Mountain, it loses most of its high-gradient nature, and enters the Westfield River valley. The mean gradient of the Little River is 100 feet per mile (19 meters per kilometer) to the base of Westfield Mountain. The gradient for the remaining 12-km course of the river is just over 16 feet per mile (3 meters per kilometer). 4 km below Sodom Brook, the Little River receives the flows from Cook Brook. Cook Brook is a small, first-order stream that receives the effluent from the West Parish Filtration Plant. This filtration plant is a gravity-fed slow-sand, and mixed media filtration system designed to clarify raw water. The sand and media must, on occasion, be back-flushed to remove sediment from the filtration beds. This process has led to local concerns regarding potential degradation of instream habitat and associated biota from increased sedimentation in both Cook Brook and its receiving water, the Little River.

LR02A—Little River, mile point 11.5 (18.5 km), downstream from Cobble Mountain Reservoir, immediately below Pitcher Brook, Russell, MA

Habitat

LR02A was established in order to document biological conditions at this relatively “pristine", albeit flow-modified, location. The LR02A sampling reach was located approximately 2 km downstream from the Cobble Mountain Reservoir outlet in a remote and densely forested portion of the Little River subwatershed. The reach was accessed via a trail off of Wildcat Gorge Road and required a long hike over extremely steep-sloping terrain. The stream was approximately 3 m wide and ranged in depth from 0.2 m in the riffle areas to almost half a meter in the deepest pools. Rocky substrates were plentiful and consisted mainly of boulders and large cobble, which, coupled with swift current velocity provided excellent habitat for macroinvertebrates throughout the reach. Fish habitat was also optimal, with a good mix of snags, submerged logs, and other stable cover in the majority of the reach. Aquatic mosses covered about 50% of the sampling reach, while algal growth (mostly filamentous green forms) was observed in 25% of the reach. Channel flow status here was suboptimal, with water filling just over 75% of the channel. Shrubs (elderberry, *Sambucus canadensis*), vines (riverbank grape, *Vitis riparia*), and herbaceous (Joe-Pye weed, *Eupatorium* sp.; various ferns; turtlehead, *Chelone glabra*) growth not only provided good vegetative protection, but also aided in the stabilization of these extremely steep banks. The dense forest, with a mix of hardwoods (birch, *Betula* sp.; red maple, *Acer rubrum*) and evergreens (hemlock, *Tsuga canadensis*; white pine, *Pinus strobus*), provided a 50% canopy cover and offered an unlimited riparian zone in all directions.

LR02A received a total habitat assessment score of 182/200 (Table A5). Only those habitat parameters most closely associated with baseflow (i.e., velocity depth combinations and channel flow status) received less than optimal scores.

Benthos

The LR02A macroinvertebrate community received a total metric score of 26, representing 65% comparability to the reference station and resulting in a bioassessment of “slightly impacted” (Table A2). Low values for EPT Index and EPT/Chironomidae metrics affected the overall metric score most negatively. Yet despite the lack of EPT taxa, the Plecoptera—generally considered the most pollution-sensitive insect order—were well-represented in the LR02A sample, contributing to one of the lowest Biotic Indexes (3.30) in the entire Westfield River watershed survey (Tables A2-A4). And while high densities of chironomids were responsible for the displacement of EPTs, the numerically dominant midge, *Eukiefferiella brehmi* gr., is fairly intolerant of organic pollution with a preference for cold-water trout streams (Bode and Novak 1998). In general, the benthic community here was well-balanced—Percent Dominant Taxon was low—with all major trophic groups represented, including numerous pollution sensitive algal scrapers (e.g., *Promoresia tardella*, n=18, TV=2).

The high densities of pollution sensitive taxa in the LR02A benthos assemblage suggest that water quality does not limit biological potential in this portion of the Little River. Rather, it is probably low baseflow, as indicated by the marginal channel flow status here, that compromises aquatic health. Potential impacts to instream habitat and resident biota at LR02A may be caused by the diversion of water from the reservoir outlet to the power generating station further downstream, and may have been more pronounced during the time of the 2001 biosurvey due to drought conditions.

LR02B—Little River, mile point 7.1 (11.4 km), 20 m upstream from Cook Brook, Russell, MA

Habitat

The LR02B biomonitoring station began approximately 50 m upstream from the mouth of Cook Brook and about 550 m downstream from Northwest Road in a relatively undeveloped portion of Westfield. The sampling reach, essentially a long shallow (0.2 m) riffle, ranged in width from 2 – 6 m and completely lacked canopy cover. Low baseflow resulted in a channel only half full of water, and with a significant amount of rocky substrates left completely exposed along the margins of the stream. Grasses were well established along the dry portions of the streambed, suggesting that substrate exposure had occurred for some time. The shallow nature of the stream and lack of stable cover other than a few boulders resulted in less than optimal fish habitat. Epifaunal substrates that were submerged offered suboptimal benthos habitat due to a lack of riffle variety. There were no obvious signs of NPS pollution; however, an active sand and gravel operation was located adjacent to the reach along the (left) north bank and was only marginally buffered with riparian vegetation. In addition, substantial (almost 100%) periphyton cover throughout much of the reach (also easily visible from the Northwest Road bridge) suggested an upstream nutrient source. A dense shrub (witchhazel, *Hamamelis virginiana*; willow, *Salix* sp.; alder, *Alnus* sp.) and herbaceous (goldenrod, S*alidago* sp.;Joe-Pye weed, *Eupatorium* sp.; ferns) layer provided good bank vegetation and stability along the right (south) bank, while the steep nature of the left (north) bank resulted in a few small areas of bank instability and vegetative disruption. Streamside vegetation along the right (south) bank gave way to an undisturbed riparian forest comprised of a mix of hardwoods (red oak, *Quercus rubra*; red maple, *Acer rubrum*; slippery elm, *Ulmus rubra*; birch, *Betula* sp.) and white pine (*Pinus strobus*). Riparian zone width was reduced to about 15 m along the left (north) bank due to the encroaching sand and gravel pit.

LR02B received a total habitat assessment score of 154/200 (Table A5). Point reductions for instream cover, epifaunal substrate, velocity-depth combinations, and channel flow status were the direct result of low baseflow conditions during the time of the biosurvey. The extreme habitat constraints caused by drought conditions here were probably exacerbated by the effects of upstream flow diversion.

This station was established as an upstream reference station for comparisons to biological conditions (i.e., benthic and fish community health, habitat quality) immediately downstream (at LR02C) from Cook Brook. Cook Brook receives the input from the West Parish Filtration Plant. This drinking water supply system treats waters from the Cobble Mountain Reservoir before transmission to the city of Springfield. The waters entering the West Parish filtration system are drawn from the Little River as it flows down Cobble Mountain. An aqueduct transports these waters to the filtration system. The majority of these waters are sent to the city of Springfield; however, the system requires occasional back-flushing to clean the sands. The debris and silt from back-flushing has a potentially deleterious effect upon the instream habitat and biota of both Cook Brook and its receiving water, the Little River.

Benthos

The benthic community at LR02B received a total metric score of 34, representing 85% comparability to the reference station and placing resident biota in the “non-impacted” category for biological condition (Table A2). Only EPT Index and EPT/Chironomidae metric values suffered point reductions, the result of a displacement of EPT taxa by midges. But while the presence of numerous chiromonids in a macroinvertebrate assemblage often leads to an increased Biotic Index, in this case the Biotic Index actually was lower than the reference condition. This was the result of an abundance of pollution sensitive midges—most notably, *Polypedilum aviceps*, which is known to be a “clean water” indicator rarely associated with impacted water quality (Bode and Novak 1998). And while low baseflow clearly compromises habitat quality in this portion of the river, these effects were not reflected in the benthic community during the time of the biosurvey, as was observed farther upstream at LR02A. The seemingly healthy aquatic community here corroborates its use as an upstream reference station for LR02C.

Fish

Two hundred four fish were collected at this station (Table A6). The dominant species collected was blacknose dace (*Rhinichthys atratulus*, n=147). The sub-dominant species collected was longnose dace (*Rhinichthys cataractae*) (n=44). These two species accounted for 94% of the specimens collected at this station. Both of these species are fluvial specialists, requiring flowing-water habitats for all life stages of development. This points towards the perennial nature of this stream and some degree of tolerance to encountered drought conditions.

LR02C—Little River, mile point 6.9 (11.1 km), 100 m downstream from Cook Brook, Russell, MA

Habitat

The LR02C sampling reach began approximately 100 m downstream from the Cook Brook confluence, ending immediately at its mouth. As with the upstream control station, channel flow status was only marginal in this portion of the river, although epifaunal and fish habitat were not affected as negatively as at LR02B—probably due to stream discharge contributions from Cook Brook. Nevertheless, riffles were extremely shallow (0.2 m) here, and while macroinvertebrate habitat was considered optimal, fish habitat remained somewhat reduced due the lack of pool areas and stable cover. Instream algal cover was noticeably reduced (<50%) compared to the near-100% cover observed at LR02B. Bank and riparian habitat quality were highly comparable to conditions observed at the upstream reference station (LR02B).

LR02C was established to examine the potential effects of Cook Brook (and the discharge from the West Parish Filtration Plant) on the instream biota (macroinvertebrates and fish) and habitat quality of the Little River. That this station is geomorphically similar to conditions observed at the upstream reference station (LR02B) in terms of width, depth, flow regimes, and habitat allows for a direct comparison of biological conditions. There were dear indications that sediment had entered the Little River from Cook Brook—sediment deposition was observed in approximately 30% of the sampling reach, and a "trail" of sediment could be easily traced to a silty delta at the mouth of Cook Brook. This resulted in the second lowest score (11) for sediment deposition in the entire biomonitoring survey.

LR02C received a total habitat assessment score of 156/200 (Table A5). While the overall habitat evaluation was highly comparable to the upstream reference station, habitat parameters most closely associated with instream sedimentation—embeddedness and sediment deposition—were extremely reduced relative to reference conditions. Sand and other fine sediments drastically reduce macroinvertebrate microhabitat by filling the interstitial spaces of epifaunal substrates. In addition, the filling of pools with sediment reduces fish cover and may be detrimental to fish spawning habitat and egg incubation at LR02C.

Benthos

When compared to the watershed reference station on the Westfield River, the LR02C benthos assemblage received a total metric score of 21, representing 50% comparability to WR01 and resulting in an assessment of "moderately impacted" (Table A2). Low densities of EPTs and scraping taxa contributed most to the reduced total metric score. Reduced substrate microhabitat due to embeddedness and sediment deposition may contribute to the suppressed EPT community observed at LR02C, as these organisms may be susceptible to increases in sediment loading due to their inability to burrow (Johnson et al. 1993). The absence of algal scrapers here may also be a result of instream deposition, as the smothering and/or scouring of hard substrates and associated periphyton cover may negate the use of benthic algae as a viable food resource for macroinvertebrates in this portion of the river.

The LR02C benthic community was also compared to an upstream reference community to more effectively assess the potential impacts originating from Cook Brook. Metric comparisons to LR02B, which was located immediately upstream from the Cook Brook mouth, yielded a total score of 26 and resulted in an assessment of "slightly impacted" for biological condition at LR02C (Table A4). Reductions in EPT taxa and scrapers once again contributed to low scoring metrics. In addition, a low scoring (score=2) Percent Dominant Taxon value indicated a lack of community balance. Given the "tight" bracketing of the Cook Brook confluence by LR02B and LR02C and the fact that both stations were highly similar in terms of overall habitat type and flow regime, it appears highly likely that sediment inputs or other unknown impacts originating from Cook Brook are directly responsible for impairment of the resident biota at LR02C. In addition, the effects of sedimentation may be more pronounced in this portion of the Little River due to epifaunal habitat already compromised by reductions (both anthropogenic and naturally occurring) in baseflow (channel flow status at both LR02B and LR02C scored only an 8 out of a possible 20). The combination of instream sediment deposition and reduced flow here may explain why the LR02C community was considered slightly impacted relative to upstream reference conditions subjected to similar flow regimes, yet moderately impacted compared to the watershed reference condition where flow constraints were less pronounced.

Fish

The fish examined at LR02C were similar to those collected at the upstream reference station. Two hundred thirty-eight fish were collected at this station compared to 204 collected just upstream at LR02B. The dominant species was blacknose dace (n=149). The sub-dominant species collected was common shiner (*Luxilus cornutus*, n=37). These two species accounted for 84% of the specimens collected at this station. There were 30 more common shiner collected at this station compared to the seven common shiner collected at the reference station. It is unlikely that the observed increase in the numbers of common shiner represents a response to the inputs from Cook Brook. Rather, it is likely that a school of common shiner was encountered at this location and time. If the common shiners are discounted, then the sub-dominant species would be longnose dace (n=31). This mirrors the dominant and sub-dominant species collected at the reference station.

Common shiners are fluvial dependents, requiring lotic habitats for at least part of their life cycle. However, the community structure at this station (like the reference station) remains dominated by fluvial specialists. It is possible that resident fish populations in this portion of the river can better withstand drought conditions due to the hydrologic influences of Cook Brook. In addition, sediment inputs originating from Cook Brook appeared to have a less discernable impact on the LR02C fish community than the benthic community.

Yokum Brook

Yokum Brook begins at the confluence of the outfalls of Buckley-Dunton Lake (impounded) and Yokum Pond (impounded) on the eastern edge of October Mountain State Forest in Becket, MA. The stream flows easterly through a high-gradient, heavily forested landscape as it parallels Yokum Brook Road. After flowing under Route 8, Yokum Brook receives the flow from Rudd Pond Brook. The bed-gradient remains relatively high as Yokum Brook parallels Route 8, flowing through the thickly settled town of Becket. Two dams existed on this stream in the town of Becket at the time of the 2001 biosurveys. These dams were built during the industrial revolution to power small mills. The dams pose a barrier to upstream migration by aquatic fauna, and due to more than a century of siltation, perform little to no flood control. Yokum Brook encounters the upper dam approximately 0.27 km downstream from Carter Road. The brook continues easterly from this upper dam for 0.4 km where it encounters the lower dam near the Becket Elementary School. Yokum Brook then flows the short (0.11 km) remainder of its course to the West Branch of the Westfield River. The total watershed area of this second-order stream is approximately 22.7 km^2.

Three biological monitoring stations were prescribed for Yokum Brook—located above, between, and below the Becket dams. During the time of the 2001 biomonitoring survey, both dams were scheduled for removal, and biological examinations were conducted to assess aquatic faunal health and pre-removal conditions. To date, the upper-most dam has been removed, and progress is currently being made to remove the lower dam. It is anticipated that, with the removal of these dams, catadromous, anadromous, and fresh-water fish species will have access to a greater area and variety of aquatic habitats.

YB01A—Yokum Brook, mile point 0.4 (0.65 km), 50 m upstream from upper dam, downstream from Route 8, Becket, MA

Habitat

YB01A meanders through a forested portion of the watershed with some residential development nearby. The small size of the adjacent trees limits the canopy cover at this reach to approximately 75%. Nevertheless, the reach remains mostly shaded. This upper-most station on Yokum Brook is upstream from both dams, and extends from an obstructing riffle at the top of the pool behind the upper dam to a bedrock constriction approximately 100 meters upstream. Stream width ranges from 3 – 4 m. Fish are unable to migrate to this station from the downstream portions of Yokum Brook; however, access from portions upstream of this station (including Rudd Pond) is possible. Boulder and cobble-dominated substrates subjected to swift current velocity provided optimal, albeit shallow (0.1 – 0.3 m), riffle habitat for macroinvertebrates. The larger boulders provided some stable fish cover; however, the shallow nature of the stream resulted in less than optimal fish habitat. Indeed, channel flow status was marginal at best, with water filling only about half the available channel and leaving much exposed substrate. Both aquatic vegetation and algae were absent. Large boulders stabilized both stream banks, which were well-vegetated with grasses and herbaceous (Joe-Pye weed, *Eupatorium* sp.; various ferns) growth. Riparian vegetative zone width was good along both sides of the channel. Main Street (Route 8) parallels the course of this reach along the right (east) bank but does not cross the stream within the reach, and remains at least 18 meters from the stream. The riparian zone between the road and the stream is forested with smaller deciduous trees (cottonwood, *Populus deltoides*; maple, *Acer* spp.; white ash, *Fraxinus americana*; slippery elm, *Ulmus rubra*; sycamore, *Platanus occidentalis*) and occasional shrubs. Nearby residences reduce the riparian zone width only slightly along the right (west) bank. Obvious signs of NPS pollution were not observed, although upstream road crossings offer a potential source of runoff.

YB01A received a total habitat score of 151/200 (Table A5). This was used as the primary reference station for comparisons to biomonitoring stations in the lower-order tributaries of the Westfield River watershed—all of which are predominately closed-canopied reaches with comparable flow regimes and instream habitat. Designation of YB01A as a reference condition was based on its presumed good water quality and biological integrity, absence of nonpoint source pollution inputs, and minimal surrounding land-use impacts (e.g., absence of point sources, lack of channelization, minimal development and agricultural activity nearby, undisturbed and well vegetated riparian zone). YB01A was also used as the upstream control station in the assessment of damming impacts (prior to dam removal) to downstream communities at YB01B and YB01C.

Benthos

YB01A supported an extremely diverse macroinvertebrate assemblage that displayed optimum community structure and balanced trophic structure. And a Biotic Index of 3.07, the lowest value in the entire Westfield River watershed survey, indicated that the YB01A benthic community was comprised mainly of pollution sensitive taxa. Indeed, the numerically dominant taxon was the heptageniid mayfly *Epeorus* sp., a highly intolerant taxon with a Tolerance Value of 0. The YB01A benthos received a total metric score of 42 out of a possible 42 (Table A3), further supporting that this station represents the "best attainable" conditions in the watershed and warrants its status as a reference station (watershed and upstream reference).

Fish

One hundred fifty-six fish were collected at this station. The dominant species collected was Atlantic salmon (*Salmo salar*, n=76). The sub-dominant species collected was blacknose dace (*Rhinichthys atratulus*, n=59). These two species accounted for 87% of the specimens collected at this station. Fifty-two percent of the fish collected at this station were fluvial dependents. Top carnivores dominated (58%) the feeding groups encountered here. However, the Atlantic salmon (top carnivore) collected were all of a size (mean=8.2 cm) that precludes their ability to fulfill this role. This station appears capable of supporting a fish community dominated by cold-water to cool-water insectivore species.

YB01B—Yokum Brook, mile point 0.2 (0.3 km), 100 m upstream from Prentice Place, Becket, MA

Habitat

The middle Yokum Brook station was located between the two Becket dams. The YB01B sampling reach extends from a bedrock constriction located approximately 100 m upstream from Prentice Place (the driveway to Becket Elementary School) to a large "plunge" pool located immediately downstream from Route 8 near Becket center. The lower dam (below this station) provides a complete barrier to upstream migration of fish species (i.e., fish collected at this station must have originated within this sampling reach, or passed over the dam at the top of this reach). The stream is approximately 3 m wide and is mostly (75% canopy cover) shaded. The gradient is steep here, with boulders, bedrock, and cobble dominating the substrate and providing excellent benthos habitat in a series of cascades and shallow (0.1 – 0.3 m) riffles. Deep pools (0.75 m) with large boulders and bedrock ledge provided fish with optimal habitat as well. Instream vegetation was minimal and composed only of mosses. Algal growth was also greatly reduced (coverage within reach <1%) and consisted of thin layers of periphyton on rocky substrates. Channel flow status appeared considerably better than at the upstream reference station, with water reaching the base of both banks and leaving only a minimal amount of channel substrate exposed. The right (east) bank was well-vegetated with shrubs (dogwood, *Cornus* sp.; barberry, *Berberis* sp.) and herbaceous (Joe-Pye weed, *Eupatorium* sp.; various ferns) growth, while a nearby park disrupted streambank vegetation slightly along the left (west) bank. Massive boulders and bedrock slabs provided banks with good stability. Riparian vegetative zone width was reduced along the right bank due to an encroaching residential property, and along the left bank due to the adjacent road and park (Route 8).

YB01B received a total habitat assessment score of 168/200, which was higher than that received by the reference station at YB01A (Table A5). The effects of reduced baseflow, such as those observed upstream at YB01A, did not appear as pronounced in this segment of Yokum Brook.

Benthos

The YB01B macroinvertebrate community received a total metric score that was highly (100%) comparable to the reference condition located just upstream (Table A3 and A4). In fact, metrics outperformed those for the reference station for Taxa Richness and Scrapers/Filterers, suggesting good diversity and balanced trophic structure among the YB01B assemblage. In addition, high Reference Affinity values corroborate good overall comparability to the reference community. Thus, the resident benthos here does not appear to be negatively impacted by the dammed nature of this portion of Yokum Brook, as reflected in its "non-impacted" biological assessment compared to the upstream control.

Fish

Sixty-four fish were collected at this station—a lower number than were collected at either YB01C (n=187) or YB01A (n=156). It is probable that the reduced fish densities are a result of the barriers to migration provided by the dams at the upstream and downstream ends of this segment. The dominant species collected was Atlantic salmon (n=35). The sub-dominant species collected was eastern brook trout (*Salvelinus fontinalis*, n=15). These two species accounted for 78% of the specimens collected at this station. The abundance, and the relatively small size, of Atlantic salmon encountered (mean length=10.4 cm) suggest the presence of salmon restocking efforts within this stream. Atlantic salmon (and eastern brook trout) are classified as fluvial dependents. Atlantic salmon are also classified as top carnivores. However, the small size of the salmon collected indicates that these fish are still primarily insectivores at this life stage. This station appears to be capable of supporting a fish community dominated by cold-water insectivores.

YB01C—Yokum Brook, mile point 0.0 (0.0 km), immediately upstream from confluence with the West Branch Westfield River, Becket, MA

Habitat

The lower Yokum Brook station is located below both dams. The YB01C sampling reach extends from Yokum Brook's confluence with the West Branch of the Westfield River upstream to the base of the first dam (near the Becket Elementary School). Fish at this station, then, have access to and from the West Branch of the Westfield River although a minor barrier to fish passage, consisting of boulders and rubble, exists at the mouth of Yokum Brook. Cobble/boulder substrates and swift current velocity, which is probably enhanced by the channelized and constricted nature of the stream, provided optimal epifaunal habitat for macroinvertebrates. Areas of instream sedimentation, consisting mainly of sand deposits, were avoided during kick sampling. Fish habitat was also considered optimal, with boulders providing most of the stable cover. Channel flow status was slightly less than optimal, though water filled >75% of the channel and left only minimal (<25%) amounts of substrate exposed. Instream algae and aquatic vegetation were not observed. Both stream banks have been highly modified at this station. The left (west) bank is a vertical stone wall built of (presumably) native stone and cemented in place. The right bank (east) is a 45-degree stone wall. Both retaining walls measure approximately 6 feet in height. A single line of deciduous trees (maple, *Acer* spp.; white ash, *Fraxinus americana*; birch, *Betula* sp.; slippery elm, *Ulmus rubra*; hemlock, *Tsuga canadensis*) lines the tops of the retaining walls. These trees extend out over the stream and provide approximately 90% canopy cover. The understory and riparian zone beyond this single line of trees is maintained lawn. Beyond the lawn along the right bank is a road, offering an obvious potential source of NPS pollution (e.g., sand), as does the Prentice Place crossing. YB01C received a total habitat assessment score of 140/200 (Table A5). This was the second lowest evaluation for the entire Westfield River watershed survey. Riparian disturbances and instream sediment deposition were most responsible for the low overall score.

Benthos

Despite a degraded habitat in terms of riparian quality (and to a lesser extent, sediment deposition), the macroinvertebrate assemblage at YB01C received a total metric score of 42, representing 100% comparability to the upstream reference station (Table A3 and A4). Metric values for Taxa Richness, EPT Index, and EPT/Chironomidae not only outperformed those for the reference station, but they also outperformed all other biomonitoring stations in the 2001 survey (Table A2-A4). In addition, a Biotic Index of 3.27 (second lowest in the entire survey) and a Percent Dominant Taxon metric value of 10% (lowest in the entire survey) indicate an extremely well balanced community dominated by highly sensitive taxa.

As was the case at YB01B, the presence of upstream dam(s) does not appear to negatively impact macroinvertebrate community health in this portion of the stream. Rather, sediment inputs—probably originating from upstream and adjacent roads—may pose the greatest threat to future biological potential at YB01C. The effects of runoff may be exacerbated by the removal of an adequate riparian buffer in this lower portion of Yokum Brook.

Fish

One hundred eighty-seven fish were collected at this station. The dominant species collected was blacknose dace (n=60). The sub-dominant species collected was slimy sculpin (*Cottus cognatus*, n=52). These two species accounted for 60% of the specimens collected at this station. The majority (55%) of the species collected at this station were fluvial specialists. This stands in contrast to the fluvial dependents that dominated YB01A and YB01B. It is possible that the species collected at YB01C are more representative of species present in the West Branch of the Westfield River. It appears that flow regimes at this station are capable of supporting species requiring lotic conditions for all stages of their life cycle. It is possible that the slimy sculpin are immigrants from the West Branch of the Westfield River, as this was the only station in Yokum Brook at which they were encountered. The majority (51%) of fish collected at this station are classified as benthic insectivores. The abundance of slimy sculpin (n=52) collected at this station accounts for the dominance of benthic insectivores at this station. This station seems capable of supporting a community dominated by cold-water benthic insectivores.

The fish communities examined at the upstream Yokum Brook biomonitoring stations (YB01A and YB01B) appeared different from the downstream biomonitoring station (YB01C). Yellow perch were present in the specimens collected at both YB01A and YB01B, but were absent from YB01C. This lacustrine species may be emigrating from upstream impoundments (Buckley-Dunton Lake, Yokum Pond, Rudd Pond), or may be residing in the limited pools behind the dams. Creek chub were also collected at both upstream stations, but absent form the downstream station. In addition, many more stocked juvenile Atlantic salmon were collected at upstream stations than were at YB01C. Conversely, slimy sculpin (an indicator of a cold-water fishery) were present at YB01C, but not at either upstream station. It appears that the differences observed in the fish population at YB01C and the upstream stations YB01A/YB01B are related to the unrestricted access to YB01C by the fish residing in the West Branch of the Westfield River.

West Branch Walker Brook

The West Branch Walker Brook begins at an unnamed pond near Woodchuck Road in Becket, MA. The stream flows approximately 0.77 km, then receives the flow from a small unnamed stream. The West Branch continues its southerly course through a heavily forested, mid-gradient landscape and crosses under Route 8/20 approximately 2 km from its source. On the south side of Route 8/20, the stream enters the Robin Hood Lake residential development and a series of ponds—the largest of these waterbodies being Robin Hood Lake. From the outlet of Robin Hood Lake, the West Branch Walker Brook flows north then east, through two unnamed ponds before merging with Walker Brook just east of Bonny Rigg Corners. This stream is second-order to its confluence with Walker Brook.

It was originally planned to perform biological sampling at two locations on the West Branch Walker Brook. One station was to be near the bridge crossing on Goldfinch Road (upstream of Route 8/20 and Robin Hood Lake). However, upon arrival during the biological sampling period, the streambed here was dry. The second (lower) station (near Porcupine Road) did contain enough water for sampling activities. This lower station (WB01) receives the flow from approximately 90% of the entire West Branch Walker Brook subwatershed.

WB01—West Branch Walker Brook, mile point 5.5 (8.9 km), near Porcupine Road and downstream from Robin Hood Lake, Becket, MA

Habitat

The WB01 sampling reach was located approximately midway between the outlet of Robin Hood Lake and Bonnie Rigg Hill Road in Becket. The contributing subwatershed was heavily affected by drought—the portion of Walker Brook that flows into Robin Hood Lake was dry during the week of the biomonitoring survey. These drought conditions also had an obvious affect downstream from Robin Hood Lake in the WB01 sampling reach. Baseflow was extremely low here, with water filling only about half the available 3 m wide channel and leaving bottom substrates mostly exposed. Despite the shallow nature of this portion of the stream, those rocky substrates that remained submerged provided good epifaunal habitat in the numerous, albeit shallow (0.1 – 0.2 m), riffle areas. Additional benthic microhabitat was provided by mosses, although deposits of fine organic matter coated much of these and other instream substrates. Other types of aquatic vegetation and algae were absent, which is not surprising given the completely closed (100% shaded) canopy cover. The low baseflow here probably impacted fish habitat more than benthos habitat, as much of the potential fish cover (snags and woody debris, undercut banks) at WB01 was exposed and unavailable. Those pool areas present contained shallow (0.3 m), isolated pockets of water. Both stream banks were well vegetated with mosses and ferns, and despite their steepness (especially along the east bank) banks were stabilized with boulder, dense moss cover, and root mats. Hemlocks (*Tsuga canadensis*) dominated the riparian zone at this station and provided extensive shading of the sampling reach. Other vegetation (hardwoods) contributing to the wide and undisturbed riparian zone included maple (*Acer* spp.), birch (*Betula* sp.), and beech (*Fagus* sp.). With the exception of a few ferns, there was virtually no understory, as is typical of most hemlock forests. Obvious signs of NPS pollution (other than the aforementioned FPOM deposits) were absent, although turbidity in the water column was observed.

WB01 received a total habitat assessment score of 165/200 (Table A5). Increased flow here would have resulted in a considerably better evaluation of instream habitat quality.

Benthos

The WB01 benthic community received a total metric score of 32, representing 76% comparability to the watershed reference station (YB01A) and resulting in a bioassessment of “slightly impacted” (Table A3). While overall taxa richness remained high here, the conspicuous loss of taxa sensitive to organic pollution resulted in a low scoring EPT Index and an elevated Biotic Index relative to reference conditions. Robin Hood Lake, located immediately upstream from WB01 and subjected to heavy shorefront development (both seasonal and year-round homes are numerous here), may contribute the organic loads that appear to shape benthic community composition at WB01. The effects of organic enrichment (e.g., FPOM deposits, instream turbidity, high Biotic Index) or other water quality effects observed at WB01 may be exacerbated by reduced baseflow here and the resulting reduced assimilative capacity of this small stream. In addition, instream habitat constraints related to low baseflow (e.g., poor channel flow status and resulting substrate exposure) observed in this portion of the stream may compromise biological integrity at WB01. Decreasing discharge and the subsequent elimination of epifaunal habitat may contribute—at least partially—to the reductions in EPT taxa here, as many of these organisms are particularly susceptible to substrate exposure and stranding (Minshall 1984). Additionally, the dominance of *Micropsectra* sp. among the chironomid constituency may corroborate the presence of low flow effects at WB01, as this taxon has been known to predominate in streams subjected to periods of reduced flow (Fiorentino 2000 and 1999; Bode, NY DEC, personal communication 1998).

Fish

One hundred nine fish were collected at this station (Table A6). Blacknose dace dominated the sampled population (n=85). The sub-dominant species collected was white sucker (*Catostomus commersoni*, n=21). These two species accounted for 98% of the specimens collected. Both of these species are tolerant, cool-water species. There was only one cold-water species (eastern brook trout) collected at this station. Although the rather high gradient, rocky substrates, and extensive canopy cover point towards a cold-water regime, the proximal (upstream) Robin Hood Lake supplied this reach with warm water. This relatively shallow impoundment also allowed the migration of pond species not readily encountered in a stream habitat (largemouth bass, *Micropterus salmoides*; yellow perch, *Perca flavescens*).

Powdermill Brook

Powdermill Brook begins at an unnamed stream just east of Pitcher Road in Montgomery MA, and soon parallels Montgomery Road. The stream is high-gradient for its first 2.7 km with an elevational drop of 157 meters (approximately 17 meters per kilometer). The stream receives the flow from an unnamed first-order stream, in a heavily forested portion of the subwatershed, during this first 2.7 km. After this point, Powdermill Brook leaves the southern tip of Grindstone Mountain and enters the Westfield River Valley near West Farms. Here, the high-gradient nature of the brook is replaced by a low-gradient disposition, with increasing meanders. The surrounding riparian zone changes as well—from heavily forested to abutting pastures and agricultural (and residential) land use. After receiving the flow from an unnamed first-order stream, Powdermill Brook continues through agricultural lands, flows under the Massachusetts Turnpike, and receives the flow from Fuller Reservation Pond at approximately eight km from its headwaters. The stream meanders behind the Westfield Regional High School, then flows through a discontinued flood control dike before reaching the Conrail railroad tracks. Powdermill Brook then receives the discharge from Arm Brook below the Conrail tracks. Below this confluence, the riparian land use changes again, and the agricultural lands are replaced by urbanized and dense residential and commercial zones. About 0.8 km from the Conrail tracks, Powdermill Brook crosses under Route 10/202, and parallels the Westfield River as it flows easterly. The stream then receives the flow from Pond Brook 2.4 km from Route 10/202. At 1.4 km from the confluence with Pond Brook, Powdermill Brook forms a delta (known as Frog Hole) as it empties into the Westfield River. The entire Powdermill Brook watershed measures 49.5 km^2.

PB00—Powdermill Brook, mile point 3.8 (6.1 km), downstream from Interstate 90, behind Westfield High School, Westfield, MA

Habitat

The PB00 biomonitoring station was approximately 800 m downstream from Interstate 90, and was accessed via the parking lot behind the Westfield High School. Land use in the immediate area of the sampling station was forest, which provided a mostly (60% shaded) closed canopy over the meandering reach. Stream width was 3 – 4 m and depth ranged from 0.2 m in the riffle and run areas to 0.3 in the deepest pools. While macroinvertebrate sampling was confined to cobble-dominated riffle areas, the majority of the substrates in the sampling reach were sand. As a result, epifaunal habitat was considered less than optimal. Fish habitat was also suboptimal, with snags and anthropogenic debris providing most of the stable cover. Trash was scattered throughout the reach, but was especially concentrated along the steep left (south) bank in the form of scrap metal and a mostly-intact automobile. Instream sedimentation was substantial throughout the PB00 sampling reach, contributing to the lowest scoring parameters for embeddedness and sediment deposition in the entire survey (Table A5). Potential sources of sedimentation are numerous and include highway (I-90) runoff, a sand and gravel operation adjacent to the right (north) bank of the PB00 reach, and agricultural (livestock) runoff (streambank erosion and inadequate riparian buffer) at the Russellville Road crossing about 1.5 km upstream. Green algae (filamentous and matted forms) covered approximately 40% of the streambed in the reach and were especially dense on both the rocky and sandy surfaces of the pool areas. Grasses, vines (riverbank grape, *Vitis riparia*), and various herbaceous floodplain vegetation provided fairly good bank vegetative protection on both sides of the stream, though less so along the left (south) bank which was vulnerable to erosion due to its steepness and the aforementioned trash. Riparian vegetative zone width was optimal—the adjacent sand/gravel operation (right bank) and high school property (left bank) appeared fairly well buffered with a dense layer of mixed hardwoods (cottonwood, *Populus deltoides*; red maple, *Acer rubrum*; white ash, *Fraxinus americana*; slippery elm, *Ulmus rubra*; red oak, *Quercus rubra*; birch, *Betula* sp.; hop hornbeam, *Ostrya virginiana*).

PB00 received a total habitat assessment score of 138/200—the lowest score in the entire Westfield River watershed survey. While extremely reduced scores for embeddedness and sediment deposition parameters were major determinants of the low habitat assessment here, bank instability and habitat degradation related to reduced baseflow also contributed to the poor habitat evaluation.

Benthos

The PB00 macroinvertebrate community received a total metric score of 32, representing 76% comparability to the reference station at Yokum Brook and resulting in an assessment of "slightly impacted" for biological condition (Table A3). Most notable among PB00 metrics were low scoring EPT Index and EPT/Chironomidae values (Table A3), a result of low densities of EPT taxa relative to other tributary stations sampled.

While water quality factors cannot be completely ruled out, the sediment inputs responsible for instream habitat degradation at PB00 most certainly compromise biological potential here, at least for resident macroinvertebrate populations. A recent study by Zweig and Rabeni (2001) found EPT density and EPT richness to be significantly negatively correlated with deposited sediment. As noted above, EPT richness was reduced at PB00 during the 2001 biosurvey.

Fish

One hundred eighty-three fish were collected at this station. Slimy sculpin (*Cottus cognatus*) dominated the sampled population (n=100). The second most dominant species collected was eastern brook trout (n= 75). These two species accounted for more than 95% of the specimens sampled. Both species prefer cold water and are known to be "intolerant" of eutrophication and increased temperatures. Their presence in such numbers alludes to a healthy, cold-water fish population at this station. In addition, the presence of numerous pollution sensitive forms among the PB00 fish assemblage suggests that it is habitat quality rather than water quality that is most responsible for the impacts observed in the benthic community here.

SUMMARY AND RECOMMENDATIONS

Reference-quality biomonitoring stations in both the upper Westfield River and Yokum Brook continue to support the diverse and well-balanced aquatic communities expected in a "least-impacted" stream system. In addition, three Westfield River watershed biomonitoring study stations were found to be non-impacted and six stations were considered slightly impacted relative to reference conditions. One station was considered moderately impacted compared to its watershed reference station. Impacts to resident biota were generally a result of habitat degradation (especially sedimentation and flow-related habitat constraints) and/or nonpoint source-related water quality impairment, with point source effects observed as well.

The schematic below (Figure 5) is based on a proposed conceptual model that predicts the response of aquatic communities to increasing human disturbance. It incorporates both the biological condition impact categories outlined in the RBPIII biological assessment methodology currently used by MA DEP and the Tiered Aquatic Life Use (TALU) conceptual model developed by the US EPA and refined by various state environmental agencies (US EPA 2003). The model summarizes the main attributes of an aquatic community (in this case the benthic macroinvertebrate community only) that can be expected at each level of the biological condition category, and how these metric-based bioassessments can then be used to make aquatic life use determinations as part of the 305(b) reporting process. Minimally or non-impacted aquatic communities, such as those encountered at WR01, WR05, WR06A, WR06B, LR02A, LR02B, YB01A, YB01B, YB01C, PB00, and WB01 *support* the Massachusetts SWQS designated *Aquatic Life* use in addition to meeting the objective of the Clean Water Act (CWA), which is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (Environmental Law Reporter 1988). The moderately impacted (*impaired*) aquatic community observed at LR02C does not support the *Aquatic Life* use and fails to meet the goals of the CWA.

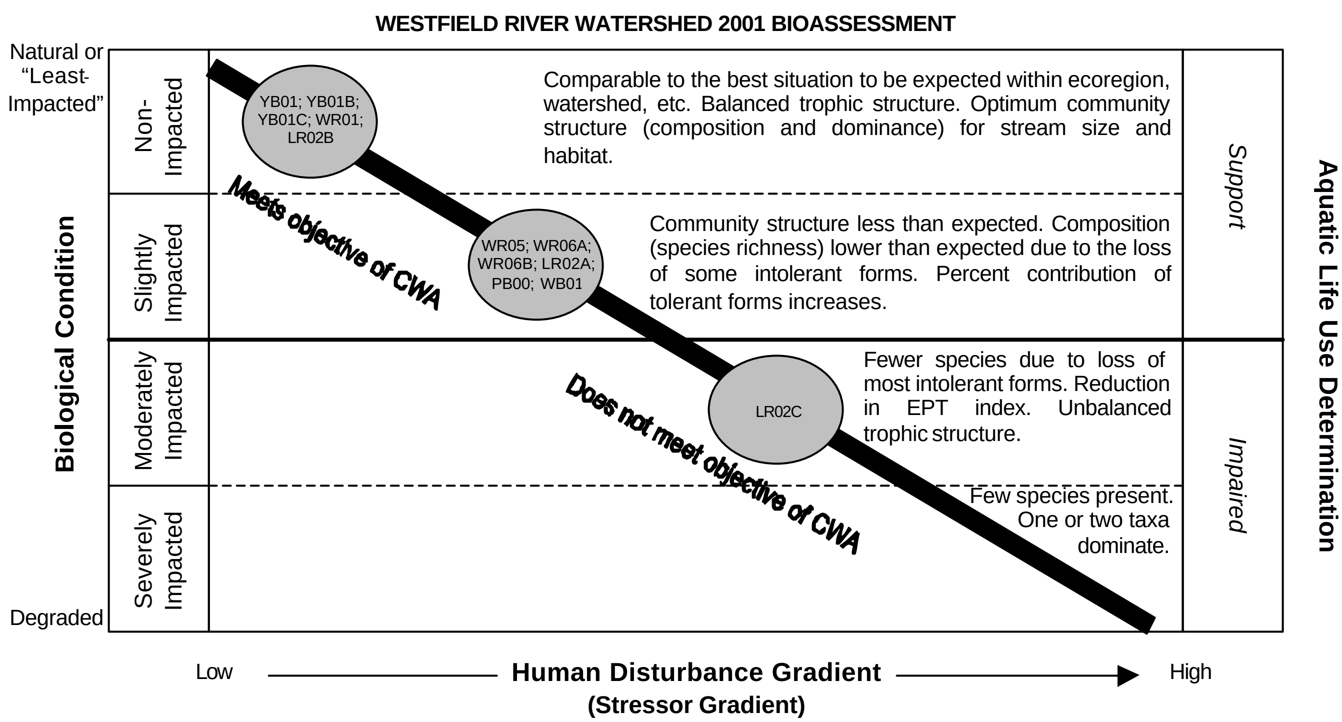

Figure 5. Schematic of the predictive response of aquatic communities to increasing human disturbance. Included is the performance (Biological Condition and Aquatic Life Use determinations) of the Westfield River watershed 2001 biomonitoring stations along the Human Disturbance Gradient.

Westfield River

WR01 - downstream from Knightville Dam, off Rocky Hill Road near Route 112, Huntington, MA
Biota: Watershed reference for study stations in high-order streams.
Habitat: Watershed reference for study stations in high-order streams.

The WR01 benthic community was thought to represent the "best attainable" conditions in the watershed with respect to biological integrity, habitat quality, and water quality. Fish community composition appeared structured in response to drought conditions and/or the impounded nature of the river upstream from WR01. As a reference condition, biomonitoring is recommended here during the next MA DEP Westfield River watershed survey in 2006, especially if evaluations of third to fifth-order stream biota are again planned. Fish population sampling should again accompany the macroinvertebrate sampling effort, although to more efficiently sample the WR01 reach, use of multiple backpack electrofishing units or a barge-mounted electrofisher should be utilized. In addition, water quality monitoring here would help to establish baseline conditions while supplementing the biological data. To maintain the biological integrity of the upper Westfield River, every effort should be made to properly manage land development in this relatively "pristine" portion of the watershed.

WR05 - 250 m downstream from Strathmore Paper Company discharge (inactive), Russell, MA
Biota: "Slightly impacted" compared to reference station (WR01)
Habitat: 100% comparable to reference station (WR01)

The slightly impacted benthic community observed at WR05 was dramatically improved from the severely impaired assemblage documented by DEP in 1996 (Szal 1998). Improvements in water quality and biological integrity in this portion of the river are probably the direct result of the removal of the Strathmore wastewater discharge. Current impacts to the macroinvertebrate community appear related to water quality factors associated with organic enrichment. Upstream impoundments, urban runoff, and treated wastewater (Russell WWTP), may provide the organic inputs that support the filter-feeder dominated benthos assemblage found at WR05.

Macroinvertebrate biomonitoring is recommended here during the next DEP Westfield River watershed survey in 2006. Fish population sampling, using multiple crews (i.e., two backpack electrofishers) or a barge-mounted electrofishing unit due to the wide nature of the WR05 reach, should accompany the macroinvertebrate sampling effort. In addition, water quality monitoring may help to determine the type(s) of water quality degradation present here.

WR06B - opposite the Westfield WWTP discharge (i.e., outside and "upstream" of the effluent plume), Westfield MA
Biota: "Slightly impacted" compared to reference station (WR01)
Habitat: 90% comparable to reference station (WR01)

Impairment of the benthic community at WR06B probably results from a combination of habitat quality and water quality degradation associated with the highly urbanized nature of this portion of the watershed. While it may be difficult to eliminate or isolate some sources of urban runoff (stormwater, parking lot runoff, riparian disturbances) that threaten habitat and biological quality at WR06B, streambank stabilization and restoration of an adequate riparian buffer along the right (south) bank may help to alleviate the effects of some nonpoint source inputs to this portion of the river.

Macroinvertebrate biomonitoring is recommended here during the next DEP Westfield River watershed survey in 2006, especially if WR06B is to again be used as an upstream control station in the assessment of discharge impacts to biota downstream from the Westfield WWTP. Fish population sampling, which has not historically been performed by DEP in the lower Westfield River, should accompany the macroinvertebrate sampling effort. Due to the wide nature of the WR06B sampling reach, the fish population survey may require multiple crews or a barge-mounted electrofishing unit. In addition, water quality monitoring may help to determine the type(s) of water quality degradation present here.

WR06A - 340 m downstream from Westfield WWTP discharge, Westfield, MA
Biota: "Slightly impacted" compared to watershed reference station (WR01) and upstream reference station (WR06B)
Habitat: 91% comparable to watershed reference station (WR01); 100% comparable to upstream reference station (WR06B)

Generally good habitat quality here suggests that impacts to the resident biota are a result of water quality degradation. That habitat quality was highly comparable to conditions documented at the nearby upstream reference station implies that the midge-dominated, slightly impacted benthic community observed at WR06A is strongly influenced by wastewater discharge effects. Other observations here—most notably, dense algal cover, presence of sewage fungus, and instream turbidity—corroborate effluent-related water quality degradation in this portion of the Westfield River.

In light of the anticipated discharge increases presently proposed for the Westfield WWTP, biomonitoring is recommended here during the next DEP Westfield River watershed survey in 2006. Fish population sampling, which has not historically been performed by DEP in the lower Westfield River, should accompany the macroinvertebrate sampling effort. Due to the wide nature of the WR06B sampling reach, the fish population survey may require multiple crews or a barge-mounted electrofishing unit. As water quality appears to limit biological integrity in this portion of the Westfield River, additional monitoring of various physico-chemical parameters in 2006 would be instrumental in determining the specific types of water quality degradation present here. In addition, a NPDES permit review is recommended for the Westfield WWTP. The MA DEP may wish to consider new modifications to the facility's permit (including a reevaluation of proposed nutrient limits) prior to its upcoming reissuance.

Little River

LR02A - downstream from Cobble Mountain Reservoir, immediately below Pitcher Brook, Russell, MA
Biota: "Slightly-impacted" compared to reference station (WR01)
Habitat: 100% comparable to reference station (WR01)

The high densities of pollution sensitive non-EPT taxa in the LR02A benthos assemblage suggest that habitat constraints rather than water quality limit biological potential in this portion of the Little River. The diversion of water from the reservoir outlet to the power generating station further downstream has the potential to impact instream habitat and resident biota at LR02A. Current impacts may be exacerbated by the drought conditions observed during the 2001 biosurvey. The potential for habitat here to support healthy benthic and fish populations corroborates the importance of maintaining minimum baseflow in the upper Little River.

Biomonitoring and instream flow measurements are recommended here during the next DEP Westfield River watershed survey in 2006 to establish baseline biological and hydrological conditions during non-drought periods. Biomonitoring should again be limited to the sampling of macroinvertebrates, as the remoteness of this station precludes the ability to safely utilize standard electrofishing gear.

LR02B - 20 m upstream from Cook Brook, Russell, MA
Biota: "Non-impacted" compared to reference station (WR01)
Habitat: 84% comparable to reference station (WR01)

While low baseflow clearly compromised habitat quality at LR02B, these effects were not reflected in the resident fish or benthic community during the time of the biosurvey. The potential for habitat here to support healthy benthic and fish populations illustrates the need to maintain minimal baseflow in this portion of the Little River.

As an upstream reference station, biomonitoring (fish, periphyton, and macroinvertebrates) is recommended here during the next DEP Westfield River watershed survey in 2006 to continue to assess potential impacts (or remediation-based improvements associated with the West Parish Filtration Plant) originating from Cook Brook. Water quality monitoring (especially nutrient sampling) is also recommended at LR02B during the next Westfield River watershed survey, as the dense algal cover observed here suggests nitrogen and/or phosphorus loading to this portion of the Little River.

LR02C - 100 m downstream from Cook Brook, Russell, MA
Biota: “Moderately impacted” compared to watershed reference station (WR01); “Slightly impacted” compared to upstream reference station (LR02B)
Habitat: 85% comparable to watershed reference station (WR01); 100% comparable to upstream reference station (LR02B)

This was the most impaired biomonitoring station in the 2001 Westfield River watershed survey in terms of aquatic health. That impacts to the resident benthos were pronounced when compared to the upstream reference station, coupled with the fact that habitat quality was similar at LR02B and LR02C, strongly suggests that Cook Brook is the source of water quality degradation here. Sediment deposition in particular appears to pose the greatest threat to fish, and especially, benthic communities in this portion of the river—instream sedimentation was substantial throughout the LR02C sampling reach, and densities of macroinvertebrate taxa most-susceptible to sediment loads were greatly reduced. In addition, the effects of sedimentation may be more pronounced due to epifaunal habitat already compromised by reductions (anthropogenic and/or naturally occurring) in baseflow. A review of the filtration bed maintenance activities conducted by the West Parish Filtration Plant is highly recommended, as is the consideration of an appropriate Best Management Practice (BMP) at that facility.

Biomonitoring (fish, periphyton, and macroinvertebrates) is recommended here during the next DEP Westfield River watershed survey in 2006 to continue to assess potential impacts originating from Cook Brook, or to document biological status following remediation efforts (i.e., implementation of BMPs) by the West Parish Filtration Plant. DEP should consider conducting biomonitoring in Cook Brook itself, as this stream is no doubt more vulnerable to sedimentation effects than the Little River due to its small size (first-order) and inherently limited assimilative capacity.

Yokum Brook

YB01A - 50 m upstream from upper dam, downstream from Route 8, Becket, MA
Biota: Watershed reference for study stations in low-order streams.
Habitat: Watershed reference for study stations in low-order streams.

Despite a reduction in baseflow and the resulting limitations to instream habitat, YB01A was thought to represent the “best attainable” conditions in the watershed with respect to biological integrity, habitat quality, and water quality. As a reference condition for lower-order tributary stations, and as an upstream control for post dam-removal investigations of Yokum Brook, biomonitoring is recommended here during the next MA DEP Westfield River watershed survey in 2006. Fish population sampling should accompany the macroinvertebrate sampling effort. In addition, water quality monitoring here would help to establish baseline reference conditions while supplementing the biological data.

YB01B - 100 m upstream from Prentice Place, Becket, MA; **YB01C -** immediately upstream from confluence with the West Branch Westfield River, Becket, MA
Biota: “Non-impacted” compared to reference station (YB01A)
Habitat: 100%; 93% comparable to reference station (YB01A)

Despite the presence of dams immediately upstream from their respective sampling reaches, and low baseflows due to drought conditions, benthic communities at YB01B and YB01C were extremely diverse and well-balanced in terms of trophic structure. Sediment inputs do threaten biological potential at YB01C, however. An investigation into the source of sediment loads (sand deposition) observed at YB01C is recommended, as is the possibility of implementing BMPs at upstream road crossings or other impervious surfaces adjacent to the sampling reach. In addition, the restoration of an adequate riparian buffer along the left (west) bank of both the YB01C and YB01B biomonitoring stations would help to minimize the potential for runoff and other NPS pollution inputs. Environmentally sensitive lawn maintenance practices are recommended here as well.

The Becket dams did influence ichthyofaunal community composition, mostly due to impediments to fish passageway. The fish community observed at YB01C, which was afforded unrestricted access to the West Branch of the Westfield River, appeared different from YB01A and YB01B, which were located behind the dams. Native, cold-water fish species and fluvial specialists were more numerous at YB01C than both upstream stations, while warm-water (pond species) species and habitat/feeding generalists were observed at YB01A and YB01C but not at the mouth.

Biomonitoring is recommended at YB01B and YB01C during the next MA DEP Westfield River watershed survey in 2006 to document changes in the biota here following the removal of both dams. Fish population sampling should be made a higher priority than macroinvertebrate sampling in this portion of Yokum Brook during future biosurveys.

West Branch Walker Brook

WB01 - near Porcupine Road and downstream from Robin Hood Lake, Becket, MA
Biota: "Slightly impacted" compared to reference station (YB01A)
Habitat: 100% comparable to reference station (YB01A)

Impoundment effects strongly influence benthic and fish community composition in this portion of the West Branch Walker Brook. Robin Hood Lake, located immediately upstream from WB01 and subjected to heavy shorefront development (both seasonal and year-round homes are numerous here) may contribute the nutrient/organic loads that appear to shape benthic community composition and function at WB01. In addition, the effects of organic enrichment (e.g., FPOM deposits, instream turbidity, high Biotic Index) or other water quality effects (e.g., temperature increases and the displacement of cold-water fish with warm-water, pond species) observed at WB01 may have been exacerbated by reduced baseflow conditions during the 2001 biosurvey.

Potentially-failing septic systems should be inspected and/or tested (e.g., dye testing) to evaluate the potential for impacts to Robin Hood Lake. In addition, lake-abutting homeowners should be educated about low-impact landscaping options, the importance of maintaining a riparian buffer, and use of environmentally sensitive lawn care products (e.g., slow releasing fertilizers)—all of which would help to minimize the potential for nonpoint source pollution inputs to the lake. To determine the specific types of water quality degradation that may impact Robin Hood Lake and downstream lotic communities, DEP should consider additional water quality monitoring (nutrients, bacteria, dissolved oxygen, etc.) upstream and downstream from Robin Hood Lake, and in the lake itself (baseline lake survey and estimate of trophic status), as part of future watershed surveys.

Powdermill Brook

PB00 - downstream from Interstate 90, behind Westfield High School, Westfield, MA
Biota: "Slightly impacted" compared to reference station (YB01A)
Habitat: 91% comparable to reference station (YB01A)

PB00 received the lowest habitat assessment of any biomonitoring station in the 2001 survey. The sediment inputs responsible for instream habitat degradation at PB00 most certainly compromise biological potential here, at least for resident macroinvertebrate populations which are highly vulnerable to instream sedimentation. The fish community appeared relatively unaffected by the habitat constraints documented by DEP. The presence of numerous pollution sensitive forms (e.g., eastern brook trout, slimy sculpin) among the PB00 fish assemblage suggests that it is indeed habitat quality rather than water quality that is most responsible for the impacts observed in the resident biota (i.e., macroinvertebrates) here.

Potential sources of sediment loadings are numerous and include highway (I-90) runoff, a sand and gravel operation adjacent to the right (north) bank of the PB00 reach, and agricultural (livestock) runoff (streambank erosion and inadequate riparian buffer) at the Russellville Road crossing about 1.5 km upstream. An investigation into the need for BMPs at these or other potential nonpoint sources is strongly recommended. In addition, a stream clean-up—perhaps by students at the adjacent high school—would greatly improve the aesthetics of this portion of Powdermill Brook, as well as aid in the stabilization of the vulnerable and eroding right bank. The City of Westfield may wish to look into the possibility of removing the abandoned automobile located on the steep right bank of the PB00 sampling reach.

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APPENDIX

Macroinvertebrate and Fish Taxa Lists, Benthos Data Analysis, and Habitat Assessments

Table A1. Species-level taxa list and counts, functional feeding groups (FG), and tolerance values (TV) for macroinvertebrates collected from stream sites during the 2001 Westfield River watershed survey between 4 and 6 September 2001. Refer to Table 1 for a complete listing and description of sampling stations.

TAXON	FG [1]	TV [2]	PB00	LR02C	LR02B	LR02A	YB01C	YB01B	YB01A [3]	YB01A (dup) [4]	WB01	WR05	WR01 [3]	WR06A	WR06B
Ferrissia sp.	SC	6	1									2			2
Pisidiidae	FC	6					1				7				
Enchytraeidae	GC	10					1		1						
Nais behningi	GC	6	1				1			1					
Nais communis	GC	8						2							
Pristinella jenkinae	GC	10				1									
Slavina appendiculata	GC	6												2	
Tubificidae	GC	10									1				
Lumbriculidae	GC	7	2					1					2		1
Hydrachnidia	PR	6	1		1	1			1	2					
Baetidae	GC	4					2						4		1
Baetis sp. (cerci only)	GC	6					3		2				3		
Baetis sp. (short terminal filament)	GC	6											1		
Baetis sp. (subequal terminal filaments)	GC	6	1				1						4		
Baetidae (cerci only)	GC	6	2	1				1		4		9			
Baetidae (subequal terminal filaments)	GC	6		7				6			1	1			1
Ephemerellidae	GC	1	1		6	3	1				1	1		1	3
Serratella sp.	GC	2		7				4	7	5					
Heptageniidae	SC	4						4				12	8		
Epeorus sp.	SC	0					7	1	13	9	1		3		
Leucrocuta sp.	SC	1											1		
Rhithrogena sp.	GC	0					2	3	1	1					
Stenonema sp.	SC	3			11	3	4	1			1		1	6	9
Isonychia sp.	GC	2			4		4			6		2	9	1	3
Leptophlebiidae	GC	2	3			2	6	4					2		
Paraleptophlebia sp.	GC	1							7		6				
Gomphidae	PR	5							1						
Chloroperlidae	PR	1				1									
Sweltsa sp.	PR	0					3		1						
Leuctridae	SH	0					4								
Leuctra sp.	SH	0	1	2	2	1									
Leuctridae/Capniidae	SH	2				7		1	4		4				
Tallaperla sp.	SH	0					1								1
Perlidae	PR	1				1					1				
Acroneuria sp.	PR	0					1		1		2		1		
Agnetina sp.	PR	2						2							
Beloneuria sp.	PR	0	1												
Neoperla sp.	PR	3			1		3		2	3			1		
Paragnetina sp.	PR	1			1		1			1			2		1
Perlodidae	PR	2			1			3	2	3					
Corydalus sp.	PR	4											5		
Nigronia sp.	PR	0				1			1		1				
Micrasema sp.	SH	2		1				1							

Table A1 (cont.)

TAXON	FG[1]	TV[2]	PB00	LR02C	LR02B	LR02A	YB01C	YB01B	YB01A[3]	YB01A (dup)[4]	WB01	WR05	WR01[3]	WR06A	WR06B
Glossosoma sp.	SC	0		1				1	1	1					
Protoptila sp.	SC	1										2			
Helicopsyche borealis	SC	3					1								
Cheumatopsyche sp.	FC	5	2		14	9	2			4	5	1	2	10	16
Hydropsyche sp.	FC	4				2		8							
Hydropsyche morosa gr.	FC	6	10	29	8		10		7	6	2	20	9	16	12
Macrostemum zebratum	FC	3										3			1
Hydroptila sp.	GC	6			3										
Lepidostomatidae	SH	1											1		
Lepidostoma sp.	SH	1	1		3	4	4		1	1	1	1	1		
Limnephilidae	SH	4							2	1					
Psilotreta sp.	SC	0				2									
Chimarra sp.	FC	4			1						10	35	23		2
Dolophilodes sp.	FC	0	9	16	7	5	6	2	5	8					
Neureclipsis sp.	FC	7										1			1
Rhyacophila sp.	PR	1	2	2			4	4	4	2			1		
Elmidae	SC	4	1												
Optioservus sp.	SC	4								1					3
Optioservus ampliatus	SC	4	7												
Optioservus trivittatus	SC	4		1									1	1	
Oulimnius latiusculus	SC	4	10	1			6	2			2	1	1	3	1
Promoresia sp.	SC	2							1	1	1				
Promoresia tardella	SC	2	6			18		15							
Stenelmis sp.	SC	5			2		1	1	1		11	10	7	14	9
Psephenus herricki	SC	4			3		1	1	3		1		1		2
Ceratopogonidae	PR	6	1												
Probezzia sp.	PR	6					1						1		
Chironomidae	GC	6	10	2	2	9	3	4	2	4	6		1	2	3
Chironominae	GC	6			1										
Microtendipes pedellus gr.	FC	6							1		1			1	
Microtendipes rydalensis gr.	FC	6					1	1			1			3	
Nilothauma sp.	GC	6												2	
Phaenopsectra sp.	SC	7									1				
Polypedilum aviceps	SH	4	2	2	10		1	2	11	2	2				
Polypedilum flavum	SH	6							1	1			1	8	2
Polypedilum illinoense	SH	6												1	
Polypedilum tritum	SH	6					1			1	1				
Cladotanytarsus sp.	FC	5								1					
Micropsectra sp.	GC	7	3		1	1	5		2	3	8		1		
Micropsectra/*Tanytarsus* sp.	FC	7	5					1			1				1
Rheotanytarsus distinctissimus gr.	FC	6	1				1	3	1	5	1			7	4
Rheotanytarsus exiguus gr.	FC	6	1			2		1					1	3	4
Tanytarsus sp.	FC	6			1		1	1			1			12	1
Zavrelia sp.	FC	4									1				
Pagastia sp.	GC	1			1	1									
Orthocladiinae	GC	5		1		2									
Cardiocladius sp.	PR	5												2	
Corynoneura sp.	GC	4	1						2	1					
Cricotopus bicinctus	GC	7		1	2			1						2	1
Cricotopus tremulus gr.	SH	7		1											
Cricotopus vierriensis	SH	7		1											
Cricotopus/*Orthocladius* sp.	GC	7		1	1									2	1

Table A1 (cont.)

TAXON	FG[1]	TV[2]	PB00	LR02 C	LR02 B	LR02 A	YB01 C	YB01 B	YB01A[3]	YB01 A (dup)[4]	WB01	WR05	WR01[3]	WR06 A	WR06 B
Eukiefferiella sp.	GC	6		1				2							
Eukiefferiella brehmi gr.	GC	4				13		2							
Eukiefferiella claripennis gr.	GC	8					1								
Eukiefferiella devonica gr.	GC	4						2							
Eukiefferiella gracei gr.	GC	4						1							
Eukiefferiella pseudomontana gr.	GC	8						1							
Lopescladius sp.	GC	4					1	1	1	1			1		
Nanocladius parvulus gr.	GC	7												4	2
Orthocladius sp.	GC	6		4	1	2									
Parachaetocladius sp.	GC	2		1				1	1	2	1				
Parametriocnemus sp.	GC	5	5		4	1	2	1		6	1		1		
Rheocricotopus sp.	GC	6			1										
Symposiocladius lignicola	SH	5											1		
Synorthocladius sp.	GC	6							1	1				1	
Thienemanniella sp.	GC	6		1	2			1					1		
Tvetenia bavarica gr.	GC	5	2								5				
Tvetenia vitracies gr.	GC	5		1										2	5
Tanypodinae	PR	7				1									
Conchapelopia sp.	PR	6				1									1
Nilotanypus sp.	PR	6							1						
Thienemannimyia sp.	PR	6			1	1						1	1		
Trissopelopia sp.	PR	4				1									
Clinocera sp.	PR	6					1								
Hemerodromia sp.	PR	6		1							1		1		
Simuliidae	FC	6								1					
Simulium sp.	FC	5		3	1		1	1				2			
Tipulidae	SH	5	1												
Antocha sp.	GC	3	2	1										1	1
Dicranota sp.	PR	3		1			3	1		2					
Hexatoma sp.	PR	2	1		2			2	4	1					
Tipula sp.	SH	6	1	1							1				
TOTAL			98	92	99	96	104	98	97	92	92	104	105	107	95

[1]Functional Feeding Group (FG) lists the primary feeding habit of each species and follows the abbreviations: SH-Shredder; GC-Gathering Collector; FC-Filtering Collector; SC-Scraper; PR- Predator.
[2]Tolerance Value (TV) is an assigned value used in the calculation of the biotic index. Tolerance values range from 0 for organisms very intolerant of organic wastes to 10 for organisms very tolerant.
[3]Reference station
[4]Duplicate sample

Table A2. Summary of RBP III data analysis for macroinvertebrate communities sampled during the Westfield River watershed survey between 4 and 6 September 2001. Shown are the calculated metric values, metric scores (in italics) based on comparability to the watershed reference station (WR01), and the corresponding assessment designation for each biomonitoring station. Refer to Table 1 for a complete listing and description of sampling stations.

STATION	**WR01**		**WR05**		**WR06A**		**WR06B**		**LR02A**		**LR02B**		**LR02C**	
STREAM	Westfield River		Westfield River		Westfield River		Westfield River		Little River		Little River		Little River	
HABITAT SCORE	184		185		168		165		185		154		156	
TAXA RICHNESS	33	*6*	17	*2*	23	*4*	26	*4*	24	*4*	28	*6*	25	*4*
BIOTIC INDEX	4.10	*6*	4.61	*6*	5.46	*4*	4.82	*6*	3.30	*6*	3.80	*6*	4.10	*6*
EPT INDEX	17	*6*	12	*2*	5	*0*	11	*0*	11	*0*	13	*2*	9	*0*
EPT/CHIRONOMIDAE	8.56	*6*	88.0	*6*	0.65	*0*	2.04	*0*	1.14	*0*	2.21	*2*	3.88	*2*
SCRAPER/FILTERER	0.66	*6*	0.44	*6*	0.46	*6*	0.62	*6*	1.28	*6*	0.50	*6*	0.06	*0*
% DOMINANT TAXON	22%	*4*	34%	*2*	15%	*6*	17%	*6*	19%	*6*	14%	*6*	32%	*2*
REFERENCE AFFINITY	100%	*6*	74%	*6*	53%	*4*	76%	*6*	56%	*4*	78%	*6*	71%	*6*
TOTAL METRIC SCORE	*40*		*30*		*24*		*28*		*26*		*34*		*20*	
% COMPARABILITY TO REFERENCE			75%		60%		70%		65%		85%		50%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	***REFERENCE*** **(NON-IMPACTED)**		**SLIGHTLY IMPACTED**		**SLIGHTLY IMPACTED**		**SLIGHTLY IMPACTED**		**SLIGHTLY IMPACTED**		**NON-IMPACTED**		**MODERATELY IMPACTED**	

Table A3. Summary of RBP III data analysis for macroinvertebrate communities sampled during the Westfield River watershed survey between 4 and 6 September 2001. Shown are the calculated metric values, metric scores (in italics) based on comparability to the watershed reference station (YB01A), and the corresponding assessment designation for each biomonitoring station. Refer to Table 1 for a complete listing and description of sampling stations.

STATION	**YB01A***		**YB01B**		**YB01C**		**PB00**		**WB01**	
STREAM	Yokum Brook		Yokum Brook		Yokum Brook		Powder Mill Brook		West Br. Walker Brook	
HABITAT SCORE	151		168		140		138		165	
TAXA RICHNESS	33.5	*6*	38	*6*	39	*6*	29	*6*	33	*6*
BIOTIC INDEX	3.07	*6*	3.55	*6*	3.27	*6*	4.22	*4*	4.52	*2*
EPT INDEX	15.5	*6*	15	*6*	20	*6*	11	*2*	12	*2*
EPT/CHIRONOMIDAE	2.23	*6*	1.77	*6*	4.12	*6*	1.10	*2*	1.13	*4*
SCRAPERS/FILTERERS	0.92	*6*	1.44	*6*	0.87	*6*	0.89	*6*	0.60	*6*
% DOMINANT TAXON	12%	*6*	15%	*6*	10%	*6*	10%	*6*	12%	*6*
REFERENCE AFFINITY**	100%	*6*	82% 81%	*6*	89% 86%	*6*	68% 74%	*6*	76% 78%	*6*
TOTAL METRIC SCORE	*42*		*42*		*42*		*32*		*32*	
% COMPARABILITY TO REFERENCE STATION			100%		100%		76%		76%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	***REFERENCE*** **(NON-IMPACTED)**		**NON-IMPACTED**		**NON-IMPACTED**		**SLIGHTLY IMPACTED**		**SLIGHTLY IMPACTED**	

*Reference station; metric values represent mean of values for YB01A and YB01A duplicate sample
**Test stations receive two values for this metric because similarity is calculated against YB01A and YB01A duplicate sample.

Table A4. Summary of RBP III data analysis for macroinvertebrate communities sampled during the Westfield River watershed survey between 4 and 6 September 2001. Shown are the calculated metric values, metric scores (in italics) based on comparability to an upstream reference station (WR06B, LR02B, YB01A), and the corresponding assessment designation for each test station (WR06A, LR02C, YB01B, YB01C). Stations WR06B-WR06A bracket the Westfield WWTP discharge, stations LR02B-LR02C bracket the Cook Brook confluence, and stations YB01A-YB01B-YB01C bracket the Yokum Brook dams in Becket.

STATION	**WR06B**		**WR06A**		**LR02B**		**LR02C**		**YB01A***		**YB01B**		**YB01C**	
STREAM	Westfield River		Westfield River		Little River		Little River		Yokum Brook		Yokum Brook		Yokum Brook	
HABITAT SCORE	165		168		154		156		151		168		140	
TAXA RICHNESS	26	*6*	23	*6*	28	*6*	25	*6*	33.5	*6*	38	*6*	39	*6*
BIOTIC INDEX	4.82	*6*	5.46	*6*	3.80	*6*	4.10	*6*	3.07	*6*	3.55	*6*	3.27	*6*
EPT INDEX	11	*6*	5	*0*	13	*6*	9	*0*	15.5	*6*	15	*6*	20	*6*
EPT/CHIRONOMIDAE	2.04	*6*	0.65	*2*	2.21	*6*	3.88	*6*	2.23	*6*	1.77	*6*	4.12	*6*
SCRAPER/FILTERER	0.62	*6*	0.46	*6*	0.50	*6*	0.06	*0*	0.92	*6*	1.44	*6*	0.87	*6*
% DOMINANT TAXON	17%	*6*	15%	*6*	14%	*6*	32%	*2*	12%	*6*	15%	*6*	10%	*6*
REFERENCE AFFINITY**	100%	*6*	76%	*6*	100%	*6*	80%	*6*	100%	*6*	82% 81%	*6*	89% 86%	*6*
TOTAL METRIC SCORE	*42*		*32*		*42*		*26*		*42*		*42*		*42*	
% COMPARABILITY TO REFERENCE			76%				62%				100%		100%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	***REFERENCE (NON-IMPACTED)***		**SLIGHTLY IMPACTED**		***REFERENCE (NON-IMPACTED)***		**SLIGHTLY IMPACTED**		***REFERENCE (NON-IMPACTED)***		**NON-MPACTED**		**NON-IMPACTED**	

*Metric values represent mean of values for YB01A and YB01A duplicate sample
**YB01B and YB01C receive two values for this metric because similarity is calculated against YB01A and YB01A duplicate sample.

Table A5. Habitat assessment summary for biomonitoring stations sampled during the Westfield River watershed survey between 4 and 6 September 2001. For primary parameters, scores ranging from 16-20 = optimal; 11-15 = suboptimal; 6-10 = marginal; 0-5 = poor. For secondary parameters, scores ranging from 9-10 = optimal; 6-8 = suboptimal; 3-5 = marginal; 0-2 = poor. Refer to Table 1 for a complete listing and description of sampling stations.

STATION		WR01	WR06B	WR06A	WR05	LR02A	LR02B	LR02C	YB01A	YB01B	YB01C	PB00	WB01
PRIMARY PARAMETERS (range is 0-20)		**SCORE**											
INSTREAM COVER		20	16	6	18	18	12	14	10	18	17	15	15
EPIFAUNAL SUBSTRATE		20	18	20	19	18	14	18	16	18	18	15	18
EMBEDDEDNESS		18	16	13	20	20	20	17	16	20	18	12	19
CHANNEL ALTERATION		20	15	20	20	20	20	20	20	19	13	17	20
SEDIMENT DEPOSITION		17	17	19	19	20	20	11	18	18	13	6	16
VELOCITY-DEPTH COMBINATIONS		19	16	15	15	13	8	10	7	12	10	10	10
CHANNEL FLOW STATUS		18	16	15	14	13	8	8	8	16	15	15	8
SECONDARY PARAMETERS (range is 0-10 for each bank)		**SCORE**											
BANK VEGETATED PROTECTION	right	10	10	10	10	10	8	10	10	8	5	10	10
	left	8	10	10	10	10	10	10	10	9	7	8	10
BANK STABILITY	right	10	8	10	10	10	8	10	10	10	10	6	9
	left	8	10	10	10	10	10	10	7	9	10	5	10
RIPARIAN ZONE WIDTH	right	10	10	10	10	10	6	8	10	5	2	10	10
	left	6	3	10	10	10	10	10	9	6	2	9	10
TOTAL SCORE		**184**	**165**	**168**	**185**	**182**	**154**	**156**	**151**	**168**	**140**	**138**	**165**

Table A6. Fish population data collected by DWM at eight biomonitoring stations in the Westfield River watershed between 5 and 6 September 2001. Sampling stations were at: Powdermill Brook (PB00), West Branch Walker Brook (WB01), Westfield River (WR01), Little River upstream of Cook Brook (LR02B), Little River downstream of Cook Brook (LR02C), Yokum Brook upstream of Becket dams (YB01A), Yokum Brook between Becket dams (YB01B), and Yokum Brook downstream from Becket dams (YB01C). Refer to Table 1 for a complete listing and description of sampling stations.

TAXON		Habitat Class[1]	Trophic Class[2]	Tolerance Class[3]	PB00	WB01	WR01	LR02B	LR02C	YB01A	YB01B	YB01C
common shiner	*Luxilus cornutus*	FDR	GF	M	-	-	9	7	37	-	-	-
blacknose dace	*Rhinichthys atratulus*	FS	GF	T	-	85	-	147	149	59	11	60
longnose dace	*Rhinichthys cataractae*	FS	BI	M	-	-	8	44	31	6	-	43
creek chub	*Semotilus atromaculatus*	MG	GF	M	-	-	-	-	-	1	1	-
fallfish	*Semotilus corporalis*	RFS	GF	M	-	-	-	-	1	-	-	-
white sucker	*Catostomus commersoni*	FDR	GF	T	-	21	12	-	5	-	-	-
brown bullhead	*Ameirus nebulosus*	MG	GF	T	-	-	1	-	-	-	-	-
yellow perch	*Perca flavescens*	MG	TC	M	-	1	-	-	-	8	2	-
Atlantic salmon	*Salmo salar*	FS	BITC	I	-	-	-	-	2	76	35	16
brown trout	*Salmo trutta*	FS	TC	I	7	-	1	1	4	2	-	2
brook trout	*Salvelinus fontinalis*	FDR	TC	I	75	1	-	4	5	4	15	14
largemouth bass	*Micropterus salmoides*	MG	TC	M	1	1	-	-	-	-	-	-
smallmouth bass	*Micropterus dolomieu*	MG	TC	M	-	-	22	-	-	-	-	-
pumpkinseed	*Lepomis gibbosus*	MG	GF	M	-	-	1	-	-	-	-	-
American eel	*Anguilla rostrata*	MG	TC	T	-	-	1	1	-	-	-	-
slimy sculpin	*Cottus cognatus*	FS	BI	I	100	-	-	-	4	-	-	52
TOTAL					183	109	55	204	238	156	64	187

[1] Habitat Class – FS (fluvial specialist), FDR (fluvial dependent reproduction), MG (macrohabitat generalist), RFS (regional fluvial specialist). From Bain and Meixler (2000), modified for Massachusetts
[2] Trophic Class – GF (generalist feeder), BI (benthic invertivore), TC (top carnivore), WC (water column invertivore). From Halliwell et al. (1999)
[3] Tolerance Classification – I (intolerant), M (moderately tolerant), T (tolerant). From Halliwell et al. (1999)

APPENDIX C

TECHNICAL MEMORANDUM FOR THE RECORD

BY: **Gerald M. Szal, Aquatic Ecologist, and Division of Watershed Management, Worcester**

DATE: **March 17, 1998**

SUBJECT: **1996 Westfield River Macroinvertebrate Monitoring Results**

PROJECT OVERVIEW:

Over the summer of 1996, biologists from the Division of Watershed Management (DWM) collected riverine benthic macroinvertebrate samples from twelve stations in the Westfield River basin. These collections and subsequent analyses were conducted to evaluate potential impacts from a number of known or suspect pollutant sources. The survey included assessments of macroinvertebrate community effects from three wastewater discharges (Texxon in Huntington, Strathmore Paper in Russell, and the Westfield publicly-owned treatment works [POTW] in Westfield) to the mainstem Westfield River, from the Littleville Lake impoundment to the Middle Branch of the Westfield and from the town of Huntington to the West Branch of the Westfield. In addition to these upstream/downstream analyses of specific sites, comparisons of some of the mainstem reference stations were made to assess any large-scale benthic community changes in the Westfield River. Station locations and their placement with regard to pollutant sources are given in Table 1.

METHODS:

Field, laboratory and analytical methods used in these investigations followed procedures outlined by the U.S. Environmental Protection Agency (EPA) in a document entitled **Rapid Bioassessment Protocols** ("RBP") **for use in Wadeable Streams and Rivers** (EPA/444/4-89-001) with a few minor changes which are described here.

The basic format for this approach is as follows: 1) Potential sampling sites are investigated upstream and downstream of a suspected pollutant source. Hereafter in this report, these stations will be referred to as "reference" and "test" stations respectively. They are evaluated for habitat similarity based on a number of variables known to affect the composition of stream-dwelling macroinvertebrate communities. The original list of EPA habitat variables and their descriptions has been updated for DWM and can be obtained upon request. 2) Reference and test stations are positioned in areas that are as similar as possible to minimize the influence of habitat differences on invertebrate community composition between sites, other than those due to the pollution source being evaluated. 3) Investigators collect macroinvertebrate samples from riffle areas at reference and test stations. Researchers typically use their feet or hands (only one method is chosen for a station pair) to disturb substrates while holding a net immediately downstream of the substrates being disturbed to collect organisms that become dislodged. In the 1996 Westfield study, 2 square meters of substrates were sampled at each station. Benthic materials found in the net are bottled in alcohol and returned to the laboratory. 4) A subsample of approximately 100 organisms is selected from the benthic samples collected at each station using a randomization procedure. 5) The organisms in these subsamples are identified to the family level (EPA's RBPII methods) by DWM biologists and a taxonomic list is prepared for each station which shows the number of individuals found in each taxonomic group. 6) A number of biological metrics are calculated for each station using the information in the taxonomic list. These metrics are used to evaluate differences between communities sampled at reference and test stations with regard to structure, feeding function and tolerance to certain types of pollution. Six of the eight EPA RBP metrics are used by DWM; an additional metric, Community Similarity (described below) is also used. 7) Metric values from each reference/test station pair are compared and each metric is given a score. The value of the score (0, 3 or 6) awarded to a metric is based on a table prepared by EPA in the RBP document for the six EPA metrics. Scores used for Community Similarity were derived by DWM. Scores for each test station metric are summed and compared to the sum of the scores from the reference station. The ratio of test station to reference station scores is called the Percent Comparability of the Test Station to the Reference Station.

A high Percent Comparability value for a test station indicates that the benthic community sampled is similar to that at the reference station or that dissimilarities are not considered detrimental, and a judgment of "No Impact" is ascribed to the test station. A low Percent Comparability score indicates that there are differences in the structure and/or function of the community sampled at the two stations and that these differences are of a detrimental nature. Depending on both the degree and type of differences between reference and test stations, the level of impact ascribed to test stations will vary.

The RBP process also includes a comparison of habitat scores at reference and test stations. In general, we assume that minor differences (≤ 10%) in habitat scores do not affect the interpretation of the degree of impact at test stations. However, as major habitat differences are expected to alter the composition of invertebrate communities, large differences in habitat scores may alter the assessment of impact. The degree of allowable difference between reference and test stations and its effect on interpreting degree of impact between these stations is a sliding scale that is described in the EPA RBP document.

Community Similarity: This is an index that compares the community structures of test and reference stations. First, the number of individuals found in each taxa group common to both stations are converted to a proportion of the total number of individuals in the sample collected at each station. Second, for each taxon common to both stations, one chooses the lower of the two proportions. Third, one sums these values for all common taxa groups and multiplies the total by 100. The result is the percent similarity between the two stations. This can vary from 0 (no taxa common to both groups) to 100 (both stations having the same number of individuals in each taxon). For this metric, a value of 70% or greater received a Criterion Score of 6; metric values that were ≥ 25% but <70 received a 3; metric values of less than 25% received a zero.

RESULTS AND DISCUSSION

The macroinvertebrate taxonomic list for stations sampled in this study appears in Table 2. Tables 3a and 3b list habitat and metric scores for each station, the degree of biological degradation to the macroinvertebrate community at the test station, and a judgment whether or not this degradation can be considered an "impact" caused by the pollutant source being investigated. A discussion of RBPII results for each station pair is presented below.

MB01/MB02

Habitat: These two stations were located on the Middle Branch of the Westfield and were sampled to evaluate the effects of the Littleville Lake impoundment on the stream benthos. Samples were collected at both stations by disturbing sediments by hand rather than by kick sampling to lessen the chance of damaging diagnostic characteristics of the benthos. The two stations were similar in width (approx. 14 m at the reference station and 15 m at the test station) and depth (0.15-0.45 m in riffles at the reference station and 0.15-0.3 m in the test station riffles). The substrate composition of the two sampling stations was also fairly similar: boulders (>25 cm diameter) accounted for about 60-65% of the substrate at both stations; cobble (6.4-25 cm diameter) was more common at the reference station (30% compared to 15% at the test station); gravel (0.25-6.4 cm diameter) was observed, but not extensive at both stations (10% reference and 15% test); sand (0.06-2 mm and "gritty") was not observed at the reference station but accounted for about 5 or so percent of the test station substrates.

The habitat score at the test station was about 11% lower than that at the reference station which is slightly lower than we like to see in comparing stations. There were some obvious habitat differences between the two stations that may have influenced benthic community composition. The riparian zone at the reference station was primarily boulder and cobble and although the banks were steep, the potential for erosion at this station did not appear to be substantial due to the presence of glacial erratics and boulders. By comparison, the streambanks immediately upstream of the test station were soft, devoid of vegetation and had obviously eroded. Periphytic growth at the two stations was also different. At the reference station periphytic growth was minimal. At the test station most cobbles and boulders were coated with green filamentous algae. Riparian vegetation at the reference station was composed primarily of trees dominated by mixed hardwoods and hemlocks. Grasses and ferns were also found at the border of the stream. Riparian vegetation at the test station was about 50% trees and 50% shrubs. Dominant tree types at the test station were sycamore, willow, alder and maple.

Benthos: Non-Impaired The RBP II analysis yielded an impairment status that was between "Non-Impaired" and "Moderately Impaired". In this "gray" area, the researcher conducting the analysis is asked to make a professional judgment as to whether or not impacts appear evident. A more detailed analysis of the metrics and taxa list than that afforded by the RBPII is provided below for this purpose.

Differences in the benthic samples collected from these stations are apparent in the relative abundance of certain organisms and in differences in the relative abundance of certain functional feeding groups. Oligoneuriids, mayflies which in this area are restricted to the genus Isonychia, were relatively rare (3% of the sample) at the reference station, but quite abundant (22% of the sample) at the test station. Oligoneuriids function as filterer-collectors of primarily fine particulate organic matter (FPOM). Their increased abundance at the test station, and that of two other families of filterer-collectors, were responsible for a large shift in the major feeding functions of the two sampled communities. While only 27% of the reference station sample fell into the filterer-collector group, this feeding group, at 54%, dominated the test station sample.

FPOM is usually composed of decaying plants, the bacteria and fungus that colonize the latter, and phytoplankton. FPOM levels are expected to naturally increase as one moves from upland to lowland systems for a number of reasons including the fact that leafy inputs get ground up from biotic and abiotic factors as they move downstream, but stations well downstream of MB02, in the mainstem, had lower representation of filterer-collectors so we can't ascribe the increase seen at MB02 to a natural progression in the stream continuum.

In Massachusetts, one often sees a dramatic rise in the relative abundance of hydropsychid caddisflies, which are filterer-collectors, downstream of impoundments. It stands to reason that both the degree of this rise and the downstream extent of this community change would be influenced by the degree of eutrophication of the impoundment as this will influence the concentration of FPOM in the water column. However, we do not see a large change in the hydropsychid component of the sample at the test station, although there was an increase in the abundance of other filter-collectors. A sample closer to the dam (preferably in an area more similar to the reference station) might show more dramatic changes in the filtering-collecting component of the community and would be a good test of the hypothesis that the impoundment, and not the structural changes in habitats between the two stations, is causing the differences observed in the two sample collections.

One of the metrics contributing to a low Percent Comparability between the two stations is the EPT metric. The EPT taxa (Ephemeroptera - Mayflies, Plecoptera - Stoneflies, and Trichoptera - Caddisflies) are used in the RBP analyses as indicators of high biological integrity. Both the richness (# of taxa) and evenness (relative distribution of individuals across different taxa) of the EPT community, together called diversity, are often used as metrics for evaluating the complexity of the community structure. In general, high richness and evenness in the EPT community are often characteristics of natural lotic systems that are unimpacted by man. Systems that are highly stressed usually are unable to support a diverse EPT assemblage. The RBP II uses EPT Richness to evaluate the EPT community and also employs the Percent Contribution of the Dominant Family as an index of the overall evenness of the entire community, but a highly unbalanced distribution of individuals among taxa in the EPT complex may go unnoticed in the RBP II analysis unless the researcher also examines the taxa list directly.

There were eight EPT taxa in the reference station sample, but only six in the sample taken from the test station. RBPII protocols dictate that the test station EPT metric "lose" points as a result. In comparing data from these two stations, I am concerned that, with these particular samples, the EPT metric may not be a very robust indicator of the differences in EPT richness or of the importance of the EPT communities at the two stations. Of the eight EPT groups found in the reference station sample, only five were represented by more than one individual. By comparison, all six of the EPT taxa found in the test station sample were represented by three or more individuals. As the probability of encountering rare taxa is low, it is quite possible that some, or all, of the three reference station EPT taxa for which only one individual was encountered might not be found if a second sample were generated for this station. In addition, judging from the samples collected at the two stations, it appears that the relative importance of the EPT community at the test station is actually greater than that at the reference station: the relative proportion of individuals found in EPT groups is about 50% higher in the test station sample (64%) than that in the reference station sample

(about 40%). Both of these characteristics are indicators that the low EPT metric score at the test station should be interpreted with some caution.
One metric, the Percent Contribution of Dominant Family showed a dramatic improvement at the test station. This metric was about 50% better (lower) for the test station sample than for the reference station sample. This particular metric is used as an estimator of “Evenness”, the relative distribution of individuals across the different taxa in the sample. Unimpaired sites often exhibit much more even distributions of individuals across different taxa groups than sites undergoing some type of stress.

Because of the conflicting results outlined above, in my opinion a more detailed collection and analysis effort would have to be conducted in order to get a clear determination of presence/absence and extent of impacts from the impoundment at the test station. It is unclear to me whether or not incongruities in the two datasets were primarily a function of the impoundment or whether they were due to habitat differences between the two stations.

<u>WB01/WBO2</u>

Habitat: These two stations were established to evaluate inputs from the town of Huntington on the West Branch of the Westfield. Benthic samples were collected at both stations by hand-cleaning substrates rather than through kick sampling. Reviewers should note that the Huntington POTW discharges to the Westfield mainstem and was not evaluated by this station pair.

The reference station, WB01, was located less than 60 m downstream of a footbridge that crosses the West Branch of the Westfield. The footbridge is about midway between the U.S. Geological Survey gaging station on the river and the Rt. 112 crossing of the West Branch. There are some homes in this area but they are separated from the streambank on both sides of the river by roads.

WB01 was almost completely unshaded. The river is about 21 m across in this area; a small island dominated by willow trees was adjacent to the sampling area. River banks in this area are steep, but are naturally lined with boulders and do not appear to be prone to erosion. There were some obvious sources of road runoff (sand) upstream of the site (which the team may wish to look into) although this sand did not appear to be deposited in the streambed at the sampling site. Riparian zone vegetation was about half trees (locust, willow, sycamore) and half shrub. Benthic substrates at the site were primarily boulder (60%) and cobble (30%) with lesser components of gravel (5%) and sand (5%). The riffles sampled in this area ranged in depth from 0.15-0.46 m in depth. Substrates were thinly coated with green filamentous algae. The type of streambed described appeared to stretch well upstream of the sampling area.

WB02, the downstream station, was located adjacent to a pumping station (drinking water?) on Rt. 20, about two tenths of a mile downstream of the point where Rt. 112 crosses the West Branch of the Westfield. Our sampling site was located about 15-30 m downstream of a large pipe that runs through the streambed from the pumping station. This station was also almost completely unshaded. Stream width in this area was about 15 m. Stream banks in this section of the West Branch rise gradually from the streambed and were vegetated primarily by shrubs. Our sampling was conducted in a riffle section that stretched well upstream and was dominated by cobble (65%) and boulder (25%) with a smaller complement of gravel (10%). The riffles sampled ranged in depth from about 0.15-0.3 m. There were some potential sources of runoff, but as the stream slopes were fairly gradual, they did not appear to be of great concern. The water clarity was high, and there was a growth of green algae on the rocks in this area which appeared similar to that upstream.

Habitat scores for the upstream and downstream sites were very similar (less than 6% different). As a result, habitat differences are not expected to alter judgments of impact at the test station.

Benthos: Non-Impaired The benthic samples from these two stations were quite similar and a judgment of “Non Impaired” was awarded to the test station. There were some differences in the number of rare (2 or less individuals per taxon) groups in each sample as well as in the percentage of the sample composed of heptageniids. There were more rare groups in the reference station sample than there were in the test station sample, but this may simply be a factor of routine sampling error. Of the eight taxonomic groups that were represented by more than 2 individuals in the reference station sample, seven of these were found in the test station sample. This indicates that at least the major community components of the reference station sample were present at the test station. In addition, the community similarity metric was 76%, which demonstrates that the relative proportions of individuals in the major taxonomic groups in the two samples were quite similar. The difference in relative proportions of heptageniids found in the two samples did not affect the relative proportion of scrapers seen at the two sites, which was almost exactly the same (about 26%-WB01, 28%-WB02). Other functional feeding components were also quite similar.

WR02/WR03

Habitat: These two Westfield River mainstem stations were chosen to evaluate potential impacts from the Texxon wastewater discharge in Russell. Substrates were hand-cleaned at both reference and test stations to obtain benthic samples. The reference station, WR02, was located adjacent to a small roadside park near the Huntington Health center. The Westfield River is fairly wide (about 28 m across) at this spot and is dominated by riffles just about as far as one can see upstream and downstream. It was divided into two braids at this spot; we sampled the eastern braid. The depth of riffles sampled ranged from 9-30 cm. Cobble was abundant here accounting for about 60% of the surface area. Gravel (20% of the surface area) and sand (about 15%) were also common. Small boulders and glacial erratics accounted for about 5% of the substrate surface area in the stretch of river sampled. Water clarity was excellent at the time of sampling; substrate surfaces in this area were covered by a thin layer of green algae.

The area sampled at WR02 was relatively unshaded (90% open). The roadside park along the southwest bank of the stream was primarily vegetated by mixed hardwoods as was the northeast side of the stream. There was some erosion along the roadside park which the team might wish to take a look at in order to increase protection of the trees that border the roadside park.

WR03 was located downstream of the Texxon discharge by about 460 m. We attempted to get closer to the discharge, but stream channel characteristics and substrates were too dissimilar to the reference station until we traveled a fair distance downstream of the discharge. Although it is not reflected in the habitat scores (reference/test = 168/162) there were some habitat differences between the two stations that were greater than I would have liked. The substrates at WR03 were primarily boulder (60%), but had a substantial complement (30%) of cobble with some sand (10%), and although the canopy cover across the stream was only about 20%, the area sampled was only about 4.5-6 m from the shore and received much more shade than the reference station. In addition, the water velocity was substantially greater than that at the reference station. Periphytic growth on substrates was a brownish gray, quite different than the more natural-looking green algal growth at the reference station.

This area of the river has some enormous pools and smooth outcroppings which, during our August survey, appeared to be begging for a party of swimmers. However, the west bank of the stream in this area is quite steep and was littered with broken glass, old car parts and a lot of rusted metal as well as other trash, all of which made the area quite unsafe for walking. We also found broken glass and large pieces of industrial-sized metal items embedded in the streambed which swimmers probably would not appreciate.

Benthos: No Impacts The RBPII evaluation for the test station yielded a judgment of “No Impacts”. Although the metrics employed in the RBPII yielded similar scores for the two sites, the taxa lists for the two stations are quite different. Ancylids, gastropods with a cone-shaped shell that are in the scraper functional feeding group, are a major component (about 17%) of the test station sample, but are absent from the reference station sample. Philopotamids and hydropsychids, which together account for 20% of the reference station sample, were represented by only one specimen in the test station sample. Other, rarer groups were found at one station and not the other, but this is to be expected as routine sample variability. The distribution of functional feeding groups was quite different in samples collected at these two stations as well. In the reference station sample, scrapers and collector-filterers were about equally represented (23 vs 21 individuals respectively). By contrast, scrapers (approx. 33% of the sample) were about seven times more abundant than collector-filterers (5% of the sample) in the test station sample. As a result of the major differences in the taxa lists mentioned, the community similarity index was somewhat low (58%) for the two samples. Many of these differences may be related to the fact that the two habitats were not as similar as is preferred rather than due to any impact of the Texxon discharge. A more rigorous sampling program with better control over certain habitat variables would be needed to determine if the benthic community downstream of Texxon is being impaired by the discharge.

WR04/WR05

These stations were selected to evaluate the potential impacts from the Strathmore Paper Company, located on the mainstem Westfield in the village of Woronoco in Russell.

Habitat: WR04 was located in the mainstem Westfield, upstream of Strathmore and across from the Whippernon Golf Club which lies adjacent to Route 20 in Russell. A few hundred yards downstream of the sampling area, the stream slowed down due to a dam upstream of the Strathmore discharge. The mainstem Westfield at this station was fairly wide (about 25 m across) and upstream of the sampling area there was a long stretch of fairly fast riffles and runs. Substrates at WR04 were predominantly composed of cobble (about 60%) and boulder (about 30%) with the remainder (10%) as gravel, with small deposits of sand behind major obstructions in the stream. Depth in the riffles ranged from 0.15 to 0.3 m. Kick samples, rather than hand-cleaned samples, were taken at this station and at WR05.

The stream banks at WR04 were fairly steep and a railroad bed ran along the east side of the river. Although there was some potential for erosion, the stream was bordered by cobble and boulders and streambanks appeared stable. Riparian vegetation in this area was primarily composed of deciduous trees: birch, mountain ash, sycamore and cherry; there was a lot of standing deadwood in the area as well. The canopy at the sampling site was primarily open.

At the time of our survey, Strathmore had a heated discharge which entered the mainstem Westfield from the east bank as well as a second discharge of treated paper process wastewater which flowed through a diffuser pipe that stretched across the mainstream. The test station, WR05, was located about 250 m downstream of the diffuser pipe. The width of the river at this location was about 15-18 m. Boulders were common at this site and accounted for about 70% of the substrates; cobble covered most of the remaining bottom (near 30%) and small pockets of sand and gravel were seen behind major obstructions. Water clarity was good. Deciduous trees predominated in the riparian zone. Due to the width of the river at the sampling station, the canopy was almost completely open (95%). There was evidence of flooding along the banks which very gently rose from the river along the east side; slopes along the west side of the river were steep and vegetated with hardwoods and hemlocks. There did not appear to be a great potential for erosion on either bank due to an abundance of boulder and cobble.

Benthic substrates in the sampling area were covered with brownish-green periphyton. The latter was completely different than that at any other station sampled in the Westfield basin. In addition, we observed what appeared to be sewage fungus downstream of the discharge, although we did not take a sample back to the lab for verification. Aside from station WR07 (downstream of the Westfield WWTF), this is the only station where we observed gray periphyton of this sort.

The habitat score at the test station was higher than that at the reference station. As a result, other than those community changes expected due to the impoundment, habitat differences were not expected to be detrimental to the macroinvertebrate community at the test station.

Benthos: Severe Impacts WR05, the test station, received an RBPII rating of "Severe Impacts". All seven of the metrics used in the RBPII analysis at this station received either the lowest score possible or a less than optimal score. Macroinvertebrate samples from the reference (WR04) and test (WR05) stations exhibited a wide range of major differences: 1. the number of different taxonomic groups found in the WR05 sample was 40% lower than that found at the upstream station; 2. seventy-five percent of the organisms in the WR05 sample were from one family (Chironomidae - midges), which is highly unusual for the habitat (riffle) and type of sampling we were conducting; 3. due to the preponderance of midges, there was a substantial shift in the distribution of individuals across different functional feeding groups; 4. the organisms found in the WR05 sample had a much higher average biotic index value than those from the reference station.

The Biotic Index is a measure of the relative tolerance to organic waste of the sampled community as a whole. A "tolerance value" is ascribed to each of the taxa (primarily based on literature values), and the mean tolerance value of all individuals in the sample is recorded as the Biotic Index value for the sample. Tolerance values (listed in Table 2) run from 0-10. A value of 0 is given to taxa groups that are most intolerant of organic wastes; a value of 10 is given to organisms that can tolerate high concentrations of organic wastes. Since the concentration of organic waste in the water column is often positively correlated with the frequency of low-oxygen events in a waterbody, very high tolerance values are linked to the ability of individual taxa (e.g., sludge worms) to withstand periods of anoxia or near-anoxia.

There were a few individuals in the test station sample that had very low Biotic Index tolerance values, which may be an indication that oxygen concentrations at WR05 are not responsible for the dramatic community changes seen at this station. The high average Biotic Index value for the test station is primarily a function of the relatively high Biotic Index value (6) for the family Chironomidae. The reasons for their high relative abundance at the test station may be be related to increased temperatures or interactions among heat and other components of the waste streams from Strathmore.

I expected to see an increase in filterer-collectors at the downstream site due to the impoundment upstream of Strathmore. This was not observed which leads me to believe that the algal community in the impoundment was not overly productive. The filterer-collector group at the reference station accounted for about 24% of the sample but comprised only about 10% of the sample at the test station. This could have been due, in part, to the level of taxonomy used in RBPII: chironomids are lumped into the collector-gatherer group even though not all chironomids fall into this feeding group. However, DWM biologists examined a subset of the chironomids from this station, and collector-filtering genera were not observed. Perhaps the effluent characteristics rendered this site primarily hospitable to only a few taxa and the collector-filtering groups found upstream were not among these.

WR06/LR01/WR07:

These three stations were sampled to evaluate the effects of the Westfield Wastewater Treatment Facility on the benthic macroinvertebrate community. The Westfield mainstem and the Little River converge within 0.9 km upstream of the Westfield WWTF discharge to the mainstem. Because it appeared that the mainstem Westfield and the Little River were not completely mixed upstream of the Westfield discharge, reference stations were established on both waterbodies.

Habitat: LR01, the Little River station, was located approximately 90 m upstream of the point where Rt. 20 crosses over the Little River. The Little River converges with the Westfield mainstem another 90 m or so downstream of the Rt. 20 bridge. Substrates in the sampling area, a run rather than a riffle, were 50% cobble, 30% gravel and 20% sand. The stream width was about 14 m across and the canopy was about 50% open in this area. The run that we sampled ranged in depth from about 0.2-0.3 m. Green periphyton was fairly abundant at this station. Deciduous trees were the primary form of riparian vegetation on both banks; there was a lawn on the south bank of the stream near the sampling area which stretched nearly to the streambank.

Surface water velocity measurements were taken at each of the three stations by recording the float-time of similar-sized sticks over a measured distance. Velocity in the areas sampled at LR01 ranged from 0.26-0.3 m/second. (A note for the team: both streambanks were covered with trash and the south bank of the little river had areas where lawn clippings and leaves had been dumped.)

WR06 was located in the Westfield mainstem, on the east side of the streambed and slightly upstream of the point where the Little River converges with the Westfield from the west. Substrates sampled were in a run (similar to LR01) and were composed of about 60% cobble, 20% gravel and 20% sand. Sample depth at this station was 0.3-0.6 m. Estimated stream width was about 28 m. The mainstem, due to its width, is only about 10% shaded in this area. Water clarity was good; water velocity in the area sampled ranged from 0.24-0.26 m/second (fairly similar to the Little River station). Deciduous trees lined the banks and there was an extensive understory of herbaceous plants as well.

Our test station, WR07, was located on the mainstem Westfield River, about 335 m downstream of the Westfield WWTF discharge. We observed what appeared to be sewage fungus which was fairly dense directly downstream of the discharge and which extended past the area where we sampled at WR07, athough its abundance diminished substantially by the time we were at WR07. Periphyton at this station also included some filamentous green algae, not seen at the two reference stations.

We sampled a run at this station as we did at the two reference stations. Kick sampling was employed as a collection method here as well as at the other two stations. Cobble dominated the substrates at WR07 and accounted for about 75% of the benthic surface area; the rest of the substrates were about equally divided between gravel and sand. Depth at the sampling sites ranged from 0.3-0.46 m. The water velocity at this station was greater than that at the two reference stations and ranged from 0.37-0.46 m/second. Canopy cover was about 10%, similar to that at WR06. Sandy floodplains, with an abundance of trash, bordered the mainstem on the east side of the sampling area; they were vegetated primarily by herbaceous plants and shrubs. The west side of the Westfield was bordered by deciduous trees.

The habitat score for WR07 was higher those for WR06 or LR01. As a result, we might expect that the habitat at the test station might provide that station a greater potential for supporting a benthic community of high integrity than was available at either reference station.

Benthos: Moderate Impacts WR07, the test station, received a judgment of "Moderate Impacts" when compared to either the Little River reference station or to the Westfield mainstem reference station. The test station benthic sample was dominated by midges (Chironomidae) which accounted for 73% of the total sample. In contrast, the most abundant groups at the Little River and Westfield reference stations accounted for only 24% and 32% of the total, respectively. Although there were (surprisingly) 10 other families represented by at least one individual in the test station taxa list, the distribution of abundance across different taxa was quite lopsided due to the high number of midges. By comparison, benthic samples from the two reference stations had four taxa groups with ten or more individuals in each and had a much more even distribution of individuals across all taxa. A highly skewed distribution of individuals across the different taxa groups is often a sign of stress and is seldom observed at pristine sites. A shift in functional feeding groups was another result of the dominance of midges at the test station: although scrapers were present at the test station, they only comprised about 8% of the total number of individuals in that sample whereas they accounted for 50% and 38% of the total sample at LR01 and WR06, respectively.

WR01/WR02:

These two stations were compared to provide an evaluation of macroinvertebrate communities in the Westfield mainstem upstream and downstream of its confluence with the Middle and West Branches.

Habitat: WR01 was our most upstream station on the Westfield River mainstem. It was located approximately 3.2 km downstream of the Knightville dam, and was upstream of the confluence of the Middle Branch of the Westfield River with the mainstem. The stream width at this site was about 27 m. Boulders comprised about 45% of the benthic substrate; cobble accounted for 30%, gravel for 15% and sand for about 10%. Riffle depth was 0.3-0.6 m. The canopy was almost completely open in this area. Water clarity was very good. The predominant land use was forest with some residential directly adjacent to and downstream of the sampling area; mixed hardwoods and evergreens were the predominant riparian vegetation.

WR02 was located another 3.5 km or so downstream of WR01 and was downstream of both the Middle and West Branches of the Westfield. A description of the Habitat for this station is given above. Habitat scores for WR01 and WR02 were similar (173 and 168 respectively) and other than the differences in substrate composition, the sites appeared fairly similar. Benthic organisms were dislodged from substrates at both stations by hand rather than through kick sampling.

Benthos: No Impacts The RBP II analysis classified the downstream station in-between "No Impacts" and "Moderate Impacts" (see Table 3b). The metric that scored the lowest in the RBPII analysis was EPT. The reference station had 10 EPT taxa, and the test station had only 6. Although the reference station sample had a large number of EPT taxa, only half (5) of these taxa were represented by more than 1 individual. Five EPT taxa in the test station sample were also well represented (6-17 individuals per taxon). As a result, since half the EPT score at the reference station is due to rare taxa, the apparently wide difference in EPT between the two stations could be primarily due to sampling error rather than an expression of the relative importance of EPT taxa to the total sample.

The relative abundance of EPT taxa was quite similar at the two sites: 54% of all individuals at the test station were EPT taxa, with a fairly even distribution across the five groups. This compares well with the reference station sample in which 50% of all individuals were EPT taxa. Other community characteristics appear similar at the two stations including the relative abundance of scrapers in the two samples (26% at WR01 and 23% at WR02). For these reasons, judging from the two samples taken at these stations, I would say that there were no observable "impacts" in the macroinvertebrate assemblage at the test station.

WR04/WR06

These two stations were compared to determine if there were any substantial differences in the macroinvertebrate community upstream and downstream of the city of Westfield. This comparison was added to this report upon request of those working on the Section 305b (Federal Clean Water Act) report to the U.S. congress. It was not part of the original study design or the two stations would have been placed closer together (they were about 14.5 km apart).

Habitat: Habitat descriptions are given above for both stations. WR04 was located well above the Strathmore discharge and WR06 was downstream of the city of Westfield. Kick samples were collected at both stations. Although there were some notable differences in the habitats sampled at the two stations, Habitat Scores for the two stations were comparable (WR04:WR06 = 158:148). WR04 samples were taken in a riffle while those at WR06 were taken in a run. In addition, WR04 substrates were primarily boulder (30%) and cobble (60%) with some areas of gravel (10%) with very little embeddedness (about 10-15%). By comparison, boulders were rare at WR06; substrates here were primarily cobble with a good proportion of gravel (20%) and sand (20%) and a higher degree of embeddedness (about 50%). Even with these differences, Habitat Scores were comparable

Benthos: Moderate Impacts The RBP II analysis for these two stations indicates that some degradation has taken place in the macroinvertebrate community between these two stations. The most obvious differences are the change in the biotic index and the presence/absence and relative abundance of the EPT taxa.

The Biotic Index of the test station sample averaged much higher (indicating greater tolerance for low dissolved oxygen) than that at the reference station. All but one of the individuals found in the test station sample had a Biotic Index tolerance value of 4 or greater. By comparison, a major portion - over 20%, of the reference community had a tolerance value of zero. The absence of low tolerance groups in the test station sample is notable, and may suggest that the community at the test station is subjected to more organic waste and lower oxygen concentrations than the reference station. Biotic Index values worsen at the next station downstream (WR07) after the Westfield mainstem receives a discharge from the Westfield WWTF, although one fairly intolerant group (ephemerellids) accounts for about 6% of the sample at that station. The EPT complex was a much more important component of the reference station sample than of the test station sample. In addition to the difference between the stations in EPT Richness (8:4, reference:test), the reference station sample had a more even distribution of individuals among the EPT taxa present: of the 8 EPT taxa found in the reference station sample, six were represented by five or more individuals. By comparison, of the four EPT taxa found in the test station sample, only two such groups were found.

In summary, the taxa in the test station sample were more tolerant of organic waste and low oxygen concentrations than those found in the reference station sample and the test station EPT complex was much less diverse than that at the reference station.

RECOMMENDATIONS:

Notes regarding small areas of erosion and stream segments where trash collection or debris removal are needed can be found in the text. Two NPDES wastestreams appeared to be responsible for substantial degradation of macroinvertebrate communities downstream of their discharges to the Westfield mainstem and are noted below.

Strathmore: While we were conducting reconnaissance in the Westfield, two passers-by expressed concerns about the Strathmore discharges. These individuals claimed that they fished in the area and that the water temperature downstream of Strathmore was substantially higher than that upstream of the discharge at certain times. In addition, when we visited the treatment plant at this site, one of the operators told us that toxicity testing had been conducted and that the discharge had been shown not to be toxic. When we asked to see the reports, we were shown one report that clearly indicated that the wastewater discharge was toxic at the time of sampling. To my knowledge, DEP has not received copies of these reports.

Due to the fact that invertebrate samples downstream of this discharge indicate a severe problem at this site, and based on the concerns over stream temperatures and toxicity, I recommend that DEP start gathering information on toxicity and temperature well in advance of the next NPDES permit reissuance. I suggest that we communicate with EPA and representatives from Strathmore to see how this might best be done. If toxicity tests have been conducted, we should ask that copies of all such reports be forwarded to DEP and attempt to determine how we can be certain that all reports are forwarded to the regulators. Furthermore, I recommend that additional toxicity tests be run and provided for regulatory review. I also recommend that a series of temperature evaluations be conducted to determine if there is the potential for Water Quality criteria violations and suggest that we attempt to determine how the permit will address temperature monitoring such that Water Quality criteria violations will be documented.

Westfield POTW: Two of the three times we visited this facility, the discharge was extremely turbid. On one of these occasions we asked about this apparent violation of MA Water Quality Criteria, and we were told that one of the clarifiers was being cleaned, but we were unable to determine what might have been the cause of the other incident of high turbidity.

The facility was experiencing some toxicity problems in1994 and 1995, but none of the three samples tested in 1996 were acutely toxic; chronic toxicity during 1996 was evident, though not strongly so. Chronic No-Effect concentrations ranged from 25-50% over the 1994-95 period and were in the range of 25% for 1996. Judging from the amount of dilution apparently available at the time we conducted our invertebrate studies at this site, this degree of toxicity should not have affected the test station community. Although ammonia concentrations were fairly high in earlier years (38 mg/L in the winter of 1994), most of the chemical evaluations conducted as part of the NPDES effluent toxicity assessments were not reported for some reason and there are no data for ammonia in the 1996 dataset. Unfortunately, compliance evaluations were not conducted along with invertebrate community evaluations during the 1996 survey, so we have no explanations for the impacts observed at the test station. I suggest that the team attempt to identify the cause of the impacts to the macroinvertebrate community observed downstream of the Westfield POTW. It is not apparent from the data collected through the NPDES toxicity testing program in 1996.

Table 1
1996 Westfield River Macroinvertebrate Study, Station Descriptions

Station	Description
WR01	Westfield River, downstream of Knightville Dam, off Rocky Road near Rt. 112, Huntington
MB01	Middle Branch of the Westfield, upstream of Littleville Lake, off East River Road and upstream of the Dayville fairgrounds, Chester
MB02	Middle Branch of the Westfield, downstream of Littleville Lake, downstream of Goss Hill Rd., Huntington
WB01	West Branch of the Westfield, upstream of the town of Huntington, downstream of footbridge which is located 0.8 km downstream of USGS gage, Huntington
WB02	West Branch of the Westfield, downstream of the town of Huntington, near confluence with Westfield River, Huntington
WR02	Westfield River, upstream from Texon plant, at roadside park near Huntington Health Center, Huntington
WR03	Westfield River, approx. 450 m downstream of Texxon discharge, Russell, MA
WR04	Westfield River, upstream of Strathmore and across from Whippernon Golf Club, adjacent to Rt. 20, Russell
WR05	Westfield River, approx. 250 m downstream of Strathmore diffuser pipe for wastewater discharge, Russell.
WR06	Westfield River, upstream of the Westfield WWTP discharge, and about 15-20 m upstream of the confluence of the Little and Westfield rivers, Westfield
LR01	Little River, approx. 90 m upstream of the Rt. 20 overpass, near the confluence of the Little and Westfield rivers, Westfield
WR07	Westfield River, approx. 340 m downstream of Westfield WWTP discharge, Westfield

Table 2. Family-level taxa list and counts, functional feeding groups, and tolerance values for macroinvertebrates collected from 12 stream sites in the Westfield River watershed between August 20 and August 28, 1996.

TAXON	FFG[1]	TV[2]	WR01	MB01	MB02	WB01	WB02	WR02	WR03	WR04	WR05	WR06	LR01	WR07
Gastropoda	SC	8										1		
Physidae	GC	8											1	
Ancylidae	SC	7	1		2				17				26	1
Pisidiidae	FC	6										1	1	1
Lumbricina	GC	8			1									
Naididae	GC	9		4	3				6	1	8		2	
Lumbriculidae	GC	7	1		1		1	7	1	2			2	
Erpobdellidae	PR	8											1	
Hydracarina	PR	6			1			1				2	2	3
Ephemeroptera	GC	2				1								
Baetidae	GC	4	1	2	5	4	6	17	22	6	2	33	11	4
Oligoneuriidae	FC	4	2	3	22	6	5		4	4				1
Heptageniidae	SC	4	17	9	3	16	25	10	12	5		20	24	4
Ephemerellidae	GC	1	1	1					1	1			3	6
Tricorythidae	GC	5				2							4	
Leptophlebiidae	GC	2		1										
Potamanthidae	GC	2				2								
Gomphidae	PR	5		2										
Calopterygidae	PR	5				1								
Coenagrionidae	PR	9			1							1		
Peltoperlidae	SH	0					1							
Perlidae	PR	1	2		2	1	2	6	3	1	1			
Corydalidae	PR	5		7	6	1			4	1			1	
Philopotamidae	FC	3	13	4	9	7	4	10		5	7	1		
Hydropsychidae	FC	4	12	18	23	9	10	10	1	14	4	2	18	5
Rhyacophilidae	PR	0				2			1		1			
Glossosomatidae	SC	0								22				
Hydroptilidae	GC	4	1											
Brachycentridae	FC	1	1	1										
Lepidostomatidae	SH	1	1					1	1					
Pyralidae	SH	5	1						1		1			
Psephenidae	SC	4	4	1	1	4	1	2	1	3		2	2	
Elmidae	SC	4	5	6	1	4		11	4	10	2	16	4	3
Tipulidae	SH	5				1		1						
Ceratopogonidae	PR	6		1								2		
Simuliidae	FC	6	1			1		1		2				
Chironomidae	GC	6	36	38	19	31	38	23	25	29	79	20	6	79
Empididae	PR	6	2			1						1		1
TOTALS			102	98	100	94	93	100	104	106	105	102	108	108

[1] Functional Feeding Group (FFG) lists the primary feeding habit of each taxon and follows the abbreviations: SH-Shredder; GC-Gathering Collector; FC-Filtering Collector; SC-Scraper; PR-Predator.
[2] Tolerance Value (TV) is an assigned value used in the calculation of the biotic index, tolerance values range from 0 for organisms very intolerant of organic wastes to 10 for organisms very tolerant.

Table 3a. Summary of RBP II data analysis for macroinvertebrate communities sampled at 12 stream sites in the Westfield River watershed. Stations were located upstream (reference) and downstream (test) of potential pollution sources. Seven biological metrics were calculated for taxa collected at each station and scored (in parentheses). Scores for each test station were totaled and compared to scores from each reference station. The percent comparability of test to reference station yields a final impairment score for each test station.

STATION #	MB01	MB02	WB01	WB02	WR02	WR03	WR04	WR05	WR06	WR07	LR01	WR07
STREAM	Middle Branch Westfield River (upst Littleville Lake)	Middle Branch Westfield River (dnst Littleville Lake)	West Branch Westfield River (upst of Huntington)	West Branch Westfield River (dnst of Huntington)	Westfield River (upst of Texxon)	Westfield River (dnst of Texxon)	Westfield River (upst of Strathmore)	Westfield River (dnst of Strathmore)	Westfield River (upst of Westfield WWTP)	Westfield River (dnst of Westfield WWTP)	Little River (upst of Westfield WWTP)	Westfield River (dnst of Westfield WWTP)
HABITAT SCORE	183	164	160	169	168	162	158	169	148	159	140	159
TAXA RICHNESS	15 (6)	16 (6)	18 (6)	10 (3)	13 (6)	16 (6)	15 (6)	9 (3)	13 (6)	11 (6)	16 (6)	11 (3)
BIOTIC INDEX	4.97 (6)	4.64 (6)	4.50 (6)	4.70 (6)	4.41 (6)	4.98 (6)	3.75 (6)	5.76 (3)	4.59 (6)	5.36 (6)	5.07 (6)	5.36 (6)
EPT INDEX	8 (6)	6 (3)	10 (6)	7 (3)	6 (6)	8 (6)	8 (6)	5 (0)	4 (6)	5 (6)	5 (6)	5 (6)
EPT/CHIRONOMIDAE	1.03 (6)	3.37 6)	1.61 (6)	1.39 (6)	2.35 (6)	1.80 (6)	1.93 (6)	0.19 (0)	2.80 (6)	0.25 (0)	10.0 (6)	0.25 (0)
RIFFLE COMMUNITY: SCRAPERS/FILTERERS	0.62 (6)	0.13 (0)	1.04 (6)	1.37 (6)	1.10 (6)	6.80 (6)	1.60 (6)	0.18 (0)	9.75 (6)	1.14 (0)	2.95 (6)	1.14 (3)
% CONTRIBUTION DOMINANT FAMILY	39% (3)	23% (6)	33% (3)	41% (3)	23% (6)	24% (6)	27% (6)	75% (0)	32% (3)	73% (0)	24% (6)	73% (0)
COMMUNITY SIMILARITY	100% (6)	60% (3)	100% (6)	76% (6)	100% (6)	58% (3)	100% (6)	42% (3)	100% (6)	37% (3)	100% (6)	37% (3)
TOTAL METRIC SCORE	39	30	39	33	42	39	42	9	39	24	42	21
% COMPARABILITY TO REFERENCE STATION		77%		85%		93%		21%		62%		50%
BIOLOGICAL STATUS - DEGREE IMPAIRMENT	upstream reference	moderate/ non	upstream reference	non	upstream reference	non	upstream reference	severe	upstream reference	moderate	upstream reference	moderate

Table 3b. Summary of modified RBP II analysis for macroinvertebrate communities sampled in the Westfield Basin. Location of reference and test stations and general method used to calculate Degree Impairment as in Table 2. Some of the metrics used in this table are different than those used in Table 2. An explanation of reasons for using different metrics appears in the text.

STATION #	**WR01**	**WR02**	**WR04**	**WR06**
STREAM	Westfield River (off Rocky Hill Rd, Near Rt 112, Huntington)	Westfield River (upst of Texxon)	Westfield River (upst of Strathmore)	Westfield River (upst of Westfield WWTP)
HABITAT SCORE	173	168	158	148
TAXA RICHNESS	18 (6)	13 (3)	15 (6)	13 (6)
BIOTIC INDEX	4.56 (6)	4.41 (6)	3.75 (6)	4.59 (3)
EPT	10 (6)	6 (0)	8 (6)	4 (0)
EPT/CHIRONOMIDS	1.36 (6)	2.35 (6)	1.93 (6)	2.80 (6)
RIFFLE COMMUNITY: SCRAPERS/FILTERERS	0.93 (6)	1.10 (6)	1.6 (6)	9.75 (6)
% CONTRIBUTION OF DOMINANT FAMILY	35% (3)	23% (6)	27% (6)	32% (3)
COMMUNITY SIMILARITY	100% (6)	66% (3)	100% (6)	44% (3)
TOTAL METRIC SCORE	39	30	42	27
% COMPARABILITY TO REFERENCE STATION		77%		64%
BIOLOGICAL STATUS -DEGREE IMPAIRMENT		Moderate/non		Moderate

APPENDIX D

Technical Memorandum

WESTFIELD RIVER BASIN 2001 PERIPHYTON DATA

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March 2004

During the summer of 2001, Massachusetts Department of Environmental Protection (MA DEP) personnel collected periphyton samples from stations in the Westfield River basin. This was part of the biological assessment of the Westfield River that included macroinvertebrate identifications, habitat assessment and fish community analysis. The objectives of the periphyton sampling were to document areas with nuisance algal growth, to examine community changes over time, as well as spatially, and to provide a record of the taxa that are found in Massachusetts. The periphyton identifications and estimates of percent algal cover are used along with the percent canopy cover to determine if Aesthetics and Aquatic life uses are supported or threatened (Barbour, 1999). Nuisance levels of algal biomass are defined as >100 mg/m^2 chlorophyll a and/or >40 % cover by macroalgae (Barbour, 1999) (Biggs, 1996). This amount of algal growth indicates nutrient or organic enrichment in-stream. Reaches exhibiting these levels are typically placed on "alert status" in watershed assessments since Aesthetics or Aquatic Life uses may be compromised.

The stations chosen for biological examination were located on major tributaries as well as the mainstem of the Westfield River and offer a wide spatial coverage of the basin. The locations where "alert status" may be necessary are described.

MATERIALS and METHODS

Periphyton Identifications and Relative Abundance

Field Methods

Table 1 lists the stations that were included in this study with descriptions of their locations as well as the percent algal cover, percent canopy cover and dominant algal type. The stations are listed beginning with the headwaters and continuing downstream. The periphyton taxonomic identifications and relative abundance are included in Appendix A. The habitat information is based on visual determinations of parameters including both riparian and instream conditions. Habitat assessment and the biological collections were primarily done by John Fiorentino or Robert Nuzzo. Periphyton grab samples from the riffle zone were gathered along with the macroinvertebrate samples and habitat information using methods described in Barbour (1999). Algae on boulder or cobble substrates in the riffle were scraped with a knife or gathered by hand (MA DEP, 2001). The material was collected in labeled glass vials and transported to the lab at DEP-DWM-Worcester without refrigeration. Samples were held in plastic containers that were partially filled with *insitu* water to keep them cool. Once at the lab they were refrigerated until identifications were completed or they were preserved using M3 (Reinke, 1984).
At the laboratory, the vials were logged in and assigned lab numbers. The vial was shaken to get a uniform sample before subsampling. If clumps of filamentous algae were present in the sample they were removed first, identified separately and then the remainder of the sample was examined. If moss or other macrophytes were present they were shaken in the sample container to dislodge epiphytic algae and then a sample was extracted. An Olympus BH2 compound microscope with Nomarski optics and equipped with a Whipple grid was used for the identifications following a modified method for periphyton analysis developed by L. Bahls (1993). Slides were typically examined under 200 power. The scheme (Bahls, 1993) for determining the relative abundance of the soft-bodied algae 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.

Typically, 10 fields are examined per slide. If just R and C type abundance is found, then a second slide is prepared and examined. This determination of abundance provides a relative approximation of the phyla that contribute the most to the cell count in the riffle, run or pool habitats.

Table 1: Westfield River Periphyton-2001
Station Locations, % Canopy Cover, % Algal Cover and Dominant Algal Type

Station #	Location	Date	% Canopy Cover	% Algal Cover	Dominant algal type
YB01A	Yokum Brook, upstream from large dam, approximately 270 m upstream from the most downstream Route 8 crossing, Becket.	5 Sept.	65	<1	Green (Chlorophyceae)
YB01B	Yokum Brook, approximately 100 m upstream from Prentice Place, Becket.	5 Sept.	75	<1	Green (Chlorophyceae)
YB01C	Yokum Brook, near mouth, Becket.	5 Sept.	75	* no visible accumulation of algae present-not sampled	
WR01	Westfield River downstream from Knightville Dam, Huntington.	6 Sept.	0	<1	Green (Chlorophyceae)
WR05	Westfield River, 250 m downstream from Strathmore Paper, Russell.	5 Sept.	0	* no visible accumulation of algae present-not sampled	
PB00	Powdermill Brook, downstream from I-90, behind high school, Westfield.	4 Sept.	60	40	Yellow-green (Xanthophyceae)
LR02A	Little River between Cobble Mountain Reservoir and power tunnel, approximately 750 m downstream from power lines.	4 Sept.	50	25	Green (Chlorophyceae)
LR02B	Little River, upstream from Cook Brook, Westfield.	4 Sept.	0	100	Green (Chlorophyceae)
LR02C	Little River, downstream from Cook Brook, Westfield.	4 Sept.	0	40	Green (Chlorophyceae) Diatoms (Bacillariophyceae)
WR06B	Westfield River, downstream from Westfield WWTF discharge, approx 15 m, near south bank, Westfield-control for WR06A.	6 Sept.	30	100	Green (Chlorophyceae)
WR06A	Westfield River downstream from Westfield WWTF mixing zone.	6 Sept.	20	100	Green (Chlorophyceae)

RESULTS and CONCLUSIONS

Algal growth was conspicuous at several stations in the Westfield River. **At five of the Westfield River stations (PB00, LR02C, LR02B, WR06B, WR06A)** macroalgal growth (does not require a microscope to see) covered 40 % or more of the bottom substrates. This percentage of macroalgae is likely to be having a harmful effect on the invertebrate community particularly when they decompose and fill the interstitial spaces thereby eliminating space used by the meiofauna (invertebrates that dwell in the interstitial spaces). Algal growth of this magnitude may impair Aquatic Life uses and Aesthetics as well (Biggs, 1996). In contrast, the algal coverage was low at Yokum Brook (YB01A) <1%, a reference station established for macroinvertebrate community comparisons, and at WR01, a mainstem reference station which also had <1% macroalgal growth.

Szal (2001), mentions that the Strathmore Paper Company, Russell (WR05) was still discharging in 1996 when the river was previously sampled. Green, filamentous algal growth was observed to be quite prolific in this reach. The filamentous bacteria, *Sphaerotilus* sp. which thrives on organic carbon sources, was also present. Yet, in contrast to 1996, in 2001 when the paper company no longer was discharging, no algal growth or aquatic vegetation was observed at this location. No explanation is offered for this change. The invertebrate sampling indicated that in 2001 the river impairment at WR05 improved from severely impaired (1996) to slightly impaired (Fiorentino and Mitchell, 2004).

The green, filamentous alga *Oedogonium* sp. covered approximately 100% of the substrates in the riffle zone of the Little River upstream from Cook Brook, Russell (LR02B). ***The reach including LR02B should be considered for alert status for Aesthetics and Aquatic Life.***

Oedogonium sp. was not part of the algal assemblage found in the riffle zone of LR02C although this site is located approximately 100 m downstream from Cook Brook. It was abundant, however, in the pool sample collected at the same station. Any impacts which resulted from Cook Brook entering the Little River could not be distinguished by the algae sampling done here. Although a change in the algal community would be a way of determining if a particular source has impacted the community structure, the sampling at this location was not rigorous enough to determine this. No explanation can be given for this change in community at this time.

Westfield River station WR06B was located approximately 400 m downstream from Little River in Westfield. This stretch of the river was 50 % forest and 50% commercial/industrial. The water column was slightly turbid, but the light penetration was good and even with 30% canopy cover, algal growth of primarily the green filamentous algae *Ulothrix zonata* covered an estimated 100% of the reach. ***This reach should be considered for alert status for Aesthetics and Aquatic Life because of nuisance, algal growth*** (Barbour, 1999).

WR06A is located approximately 375 m downstream of the Westfield Wastewater Treatment Facility (WWTF) and was determined to be moderately impacted in 1996 (Szal, 2001). In 2001, Fiorentino and Mitchell (2004) found that it was still impaired, but with increased taxonomic resolution - from family to species level identifications - the determination changed so that now it is considered “slightly impaired”. This is not necessarily a reflection of any major community improvements at the site. However, the algal growth both “above” and below the wastewater treatment facility was marked by excessive (100% cover) amounts of green filamentous algae. The green alga *Ulothrix* grows to prolific amounts in areas with high nutrient concentrations and low water temperatures (Biggs, 1996). This genus was found downstream of the Westfield WWTF in open canopy conditions. This excess growth is deleterious to aesthetic enjoyment. ***Part of this reach should be considered for alert status for both Aquatic Life and Aesthetic uses.***

At PB00, on the Powdermill Brook downstream of the Westfield High School, the yellow-green alga Vaucheria sp. covered approximately 40% of the substrates. This filamentous alga responds to enriched nutrient conditions, so although canopy cover was relatively high at 60%, areas of suitable substrates, light and stable flow conditions allowed the development of a relatively high percent cover of algae. ***Further changes in the riparian zone without accompanying reductions in in-stream nutrients could lead to increased nuisance algal growth that would diminish Aquatic Life and Aesthetic uses.***

The upper and lower parts of the Westfield River basin vary considerably in their benthic algal coverage. The tributary and mainstem stations down to approximately river mile 18.1 (WR05) on the Westfield River mainstem (by Strathmore Paper) had <1% cover of benthic algae. Below this station, the Little River in Westfield had prodigious filamentous algal growth as did the mainstem stations sampled starting just above the Westfield WWTF. The opening of the forest canopy as the river widened increased light availability compared to the more closed canopy areas upstream. This combination of available light and nutrients likely led to the several areas (Table 1) with excessive or nuisance algal growth.

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Appendix

Periphyton Westfield River 2001

Date	Habitat	Class	Genus	Abundance
Location: Yokum Brook (YB01A) upstream from large dam and approximately 270 meters upstream from the most downstream Rte 8 crossing, Becket.				
5 September 2001	riffle	Bacillariophyceae	*Melosira* sp.	R
		Chlorophyceae	*Mougeotia* sp.	A
		Chlorophyceae	*Spirogyra* sp.	C
		Chlorophyceae	ui green filament	R
Location: Yokum Brook (YB01B) upstream from Prentice Place, Becket.				
5 September 2001	riffle	Chlorophyceae	*Spirogyra* sp.	VA
		Chlorophyceae	*Ulothrix* sp.	A
Location: Westfield River (WR01) downstream from Knightville Dam, Huntington.				
6 September 2001	riffle	Chlorophyceae	*Spirogyra* sp.	VA
Location: Powdermill Brook (PB00) approximately 800 meters downstream from I-90, behind high school, Westfield.				
4 September 2001	riffle-run	Bacillariophyceae	*Melosira* sp.	R
		Chlorophyceae	*Closterium* sp.	R
		Cyanophyceae	*Lyngbya* sp.	R
		Xanthophyceae	*Vaucheria* sp.	VA
	pool	Bacillariophyceae	*Fragilaria* sp.	C
		Bacillariophyceae	*Melosira varians*	R
		Bacillariophyceae	*Navicula* sp.	C
		Bacillariophyceae	ui pennate diatoms	C
		Chlorophyceae	*Closterium* sp.	R
		Chlorophyceae	ui desmid	C
		Xanthophyceae	*Vaucheria* sp.	C
Location: Little River (LR02A) between Cobble Mountain Reservoir and power tunnel, approximately 750 meters downstream from power lines, Russell.				
4 September 2001	riffle	Bacillariophyceae	*Navicula* sp.	C
		Bacillariophyceae	*Synedra* sp.	C
		Chlorophyceae	*Mougeotia* sp.	A
		Chlorophyceae	*Sirogonium* sp.	A
		Chlorophyceae	*Spirogyra* sp.	C
Location: Little River (LR02B) upstream from Cook Brook, Westfield.				
4 September 2001	riffle	Bacillariophyceae	*Meridion* sp.	R
		Bacillariophyceae	*Tabellaria* sp.	R
		Chlorophyceae	*Cosmarium* sp.	C
		Chlorophyceae	*Oedogonium* sp.	VA
		Chlorophyceae	ui green filament	A
Location: Little River (LR02C) downstream from Cook Brook, Westfield.				
4 September 2001	riffle	Bacillariophyceae	*Tabellaria* sp.	A
		Chlorophyceae	placcoderm desmid	VA
		Chlorophyceae	ui green filaments	VA
	pool	Bacillariophyceae	*Cymbella* sp.	R
		Bacillariophyceae	*Synedra* sp.	R
		Bacillariophyceae	*Tabellaria* sp.	A
		Chlorophyceae	*Cosmarium* sp.	C
		Chlorophyceae	*Oedogonium* sp.	VA
		Chlorophyceae	*Zygnema* sp.	A

Appendix

Periphyton Westfield River 2001 continued

Location: Westfield River (WR06A) downstream from Westfield WWTF mixing zone, Westfield.				
6 September 2001	riffle	Bacillariophyceae	*Cocconeis* sp.	C
		Bacillariophyceae	*Melosira* sp.	C
		Bacillariophyceae	*Synedra* sp.	R
		Chlorophyceae	saccoderm desmid	R
		Chlorophyceae	*Scenedesmus* sp.	R
		Chlorophyceae	*Ulothix zonata*	VA
	pool	Bacillariophyceae	*Cyclotella* sp.	C
		Bacillariophyceae	*Navicula* sp.	A
		Bacillariophyceae	pennate diatoms	A
		Chlorophyceae	*Euastrum* sp.	C
		Chlorophyceae	*Hydrodictyon* sp.	A
		Chlorophyceae	saccoderm desmid	A
		Chlorophyceae	*Scenedesmus* sp.	C
		Chlorophyceae	Ulothix zonata	C
Location: Westfield River (WR06B) approximately 15 meters downstream from Westfield WWTP discharge, near south bank, Westfield.				
6 September 2001	riffle	Chlorophyceae	*Ulothix zonata*	VA

APPENDIX E

MA DEP DWM 2001 FISH TOXICS MONITORING IN THE WESTFIELD RIVER WATERSHED

INTRODUCTION

Fish contaminant monitoring is a cooperative effort between three MA DEP Divisions/Offices, (Watershed Management (DWM), Environmental Analysis, Research and Standards), the Department of Fish and Game, 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.

During the summer of 2001 fish from Congamond Lake and Pequot Pond were collected and analyzed for selected metals, PCB and organochlorine pesticides. The objective of the 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), PCB, and organochlorine pesticides. These data are used by the Massachusetts Department of Public Health in assessing human health risks associated with the consumption of freshwater fishes.

Project Objectives

Fish tissue monitoring is typically conducted to assess the levels of toxic contaminants in freshwater fish, identify waterbodies where those levels may impact human health, and identify waters where toxic chemicals may impact fish and other aquatic life. Nonetheless, human health concerns have received higher priority and, therefore, fish tissue analysis has been restricted to edible fillets. The fish toxics monitoring was designed to screen the edible fillets of several species of fish representing different feeding groups (i.e., bottom dwelling omnivores, top-level predators, etc.) for the presence of heavy metals, Polychlorinated biphenyls (PCBs) and chlorinated pesticides. In 2001, MA DEP DWM Fish Toxics Monitoring was conducted under an EPA-approved Fish Toxics Quality Assurance Project Plan (MA DEP 2001). Data Quality Objectives are presented in the above-mentioned QAPP. There were no deviations from the QAPP.

METHODS

Details related to the collection, handling, and processing of samples were excerpted from the report entitled *2001 Fish Toxics Monitoring Public Request and Year 2 Watershed Surveys* (Maietta and Colonna-Romano 2002).

Field Methods

Waterbodies were sampled using an electrofishing boat. Electrofishing was performed by maneuvering the boat through the littoral zone and shallow water habitat of a given waterbody and collecting most fish shocked. Fish collected by electrofishing were stored in a live-well filled with site water until the completion of sampling. In all cases live fish, that were not included as part of the sample, were released. Fish that were included in the sample were stored on ice. Table E1 contains the results of the fish tissue analyses.

The following samples were retained and subsequently submitted for analysis:

Waterbody	Date Sampled	Fish Species (number of fish)
Congamond Lake	06/18/01	largemouth bass *Micropterus salmoides* (3) brown bullhead *Ameiurus nebulosus* (3) bluegill and pumpkinseed *Lepomis* spp. (3)
Pequot Pond	06/19/01	largemouth bass *Micropterus salmoides* (3) brown bullhead *Ameiurus nebulosus* (3) bluegill *Lepomis macrochirus* sp. (3)

Laboratory Methods

Fish were placed on ice and brought to MA DEP's Division of Watershed Management in Worcester where lengths and weights were measured and fish were visually inspected for tumors, lesions, or other indications of stress or disease. Scale samples or pectoral fin spines were obtained from each fish to determine the approximate age of the fish. Species, length, and weight data can be found in Table E1.

All equipment used in the filleting process was rinsed in tap water and then rinsed twice in de-ionized water before and or after each sample. Samples (individual or composite) targeted for % lipids, PCBs and organochlorine pesticide analysis were wrapped in aluminum foil. Samples targeted for metals analysis were placed in VWR high-density polyethylene (HDPE) cups with covers. Composite samples were composed of three fillets from like-sized individuals of the same species (occasionally the same genus). Two bluegill and one pumpkinseed from Congamond Lake (analysis # 2001003) that were composited prior to analysis. Samples were tagged and frozen for subsequent delivery to the Department's Wall Experiment Station (WES).

Methods used at WES for metals analysis include the following:
Mercury is analyzed by a cold vapor method using a Perkin Elmer, FIMS (Flow Injection Mercury System), which uses Flow Injection Atomic Absorption Spectroscopy. Cadmium and lead are analyzed using a Perkin Elmer, Optima 3000 XL ICP - Optical Emission Spectrophotometer. Arsenic and selenium are analyzed using a Perkin Elmer, Zeeman 5100 PC, Platform Graphite Furnace, Atomic Absorption Spectrophotometer.

PCB Arochlor, PCB congener, and organochlorine pesticide analysis was performed on a gas chromatograph equipped with an electron capture detector "according to the modified AOAC 983.21 procedure for the analysis of PCB Arochlors, Congeners, and Organochlorine Pesticides." Additional information on analytical technique used at WES is available from the laboratory. According to standard practice, all laboratory analytical results were forwarded to the Massachusetts Department of Public Health.

RESULTS

The results of MA DEP Westfield River Watershed fish toxics monitoring surveys are described below for each sampling event (Maietta and Colonna-Romano 2002). Data for these surveys are presented in Table E1. All raw data files, field sheets, lab reports, chain of custody forms, and other metadata are maintained in databases at the MA DEP Division of Watershed Management office in Worcester. Quality assurance data are available in a data validation report (MA DEP 2004).

Congamond Lakes (North, Middle, and South Basins): Congamond Lake is composed of three interconnected basins located in the town of Southwick. Congamond Lake (Middle Basin) is a 267-acre eutrophic pond located in between the 48-acre North and 135-acre South basins. The watershed surrounding the lake is a 50/50 mix of medium density residential and croplands. Approximately 95% of the shoreline area is developed with seasonal and year round residences. Dense beds of submerged/emergent and floating aquatic macrophytes cover much of the littoral area.

Mercury concentrations were below the MDPH trigger level of 0.5 mg/kg in the three samples analyzed. Arsenic, lead, and selenium were either below method detection limits (MDLs) or at concentrations that do not appear to be of concern. Cadmium was slightly elevated (0.94 mg/kg) in the largemouth bass sample. PCB and most pesticides were below method detection limits. The largemouth bass sample contained a trace amount of a DDE (0.020 mg/kg). The USFDA Action Level for DDT and its metabolites (DDE and DDD) is 5.0 mg/kg.

Pequot Pond (Hampton Pond): Pequot Pond is a 154-acre mesotrophic pond located in Westfield/ Southampton. The immediate watershed is a mix of medium density residential and forest. The shoreline is approximately 40% developed with seasonal and year-round homes. Hampton Ponds State Park is located in the southeastern corner of the pond.

Mercury concentrations were below the MDPH trigger level of 0.5 mg/kg in the three samples analyzed. Arsenic, cadmium, lead, and selenium were either below MDLs or at concentrations that do not appear to be of concern. PCB and organochlorine pesticides were below method detection limits (MDLs) in all samples analyzed from Pequot Pond.

Table E1. 2001 Westfield River Watershed Fish Contaminant Survey. Fish contaminant data (mg/kg wet wt. unless otherwise specified) for Congamond Lake, Southwick, and Pequot Pond, Southhampton.

Analysis #	Sample ID	Collection Date	Species Code [1]	Length (cm)	Weight (g)	Sample Type [2]	Cd	Pb	Hg	As	Se	% Lipids	PCB (ug/g)	Pesticides (ug/g)
Congamond Lake														
2001001	CLF01-01	06/18/01	LMB	35.0	600	Composite	0.94	<0.80	0.47*	<0.060	0.16	0.27	ND[3]	ND
	CLF01-02	06/18/01	LMB	35.8	600									
	CLF01-03	06/18/01	LMB	35.0	680									
2001002	CLF01-04	06/18/01	BB	30.0	420	Composite	<0.08	<0.80	<0.010	<0.060	0.15	0.29	ND	ND
	CLF01-05	06/18/01	BB	32.2	420									
	CLF01-06	06/18/01	BB	32.2	430									
2001003	CLF01-07	06/18/01	B	19.0	120	Composite	<0.08	<0.80	0.090*	<0.060	0.21	0.11	ND	ND
	CLF01-08	06/18/01	B	18.0	120									
	CLF01-09	06/18/01	P	18.0	120									
Pequot Pond														
2001004	PLF01-01	06/19/01	LMB	30.0	300	Composite	<0.08	<0.80	0.32	<0.060	0.15	0.05	ND	ND
	PLF01-02	06/19/01	LMB	28.6	280									
	PLF01-03	06/19/01	LMB	28.7	290									
2001005	PLF01-04	06/19/01	B	20.0	180	Composite	<0.08	<0.80	0.14	<0.060	0.22	0.30	ND	ND
	PLF01-05	06/19/01	B	21.0	180									
	PLF01-06	06/19/01	B	20.2	160									
2001006	PLF01-07	06/19/01	BB	32.4	460	Composite	<0.08	<0.80	0.040	<0.060	0.10	0.19	ND	ND
	PLF01-08	06/19/01	BB	31.5	440									
	PLF01-09	06/19/01	BB	31.5	400									

[1]Species Code:
- largemouth bass (LMB) *Micropterus salmoides*
- brown bullhead (BB) *Ameiurus nebulosus*
- bluegill (B) *Lepomis macrochirus*
- pumpkinseed (P) *Lepomis gibbous*

[2]Sample Type (All samples were fillets with skin off.)
[3]ND = Not Detected
*Analyzed beyond EPA recommended holding time of 28 days.

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32wqar.doc *DWM CN 090.0*

REFERENCES

MA DEP. 2001. *Quality Assurance Project Plan for 2001 Fish Toxics Monitoring*. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MA DEP. 2004. CN 149.0. *Data Validation Report for Year 2001 Project Data.* Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

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APPENDIX F
MA DEP DWM 1996 AND 2001 LAKES SURVEY DATA
WESTFIELD RIVER WATERSHED

1996

In the Westfield River Watershed DWM conducted synoptic surveys at 30 lakes during the 1996 field season. Observations, from at least one access point on each lake (multiple access points on larger lakes) were recorded on standardized field sheets. 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 areal 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 (on site 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 meters (the bathing beach guideline). 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 F1. 1996 Westfield River Watershed lake observations and trophic status estimates.

Lake Name, Location	Waterbody Identification Code (WBID)	Trophic Status Estimate	Survey Observations
Ashley Cutoff*, Holyoke	MA32001	M	Clear; little turbidity; slight brown silt on rocks and vegetation; few patches of floating leaf plants and very dense submergent (well below surface) on northwest side, very dense floating and submergent plants in southeast cove
Ashley Pond*, Holyoke	MA32002	M	Slight to moderate green/gray to brown turbidity; black staining on rocks and orange floc at some shore locations; occasional algae on rocks and white foam on shore; moderate density of submergents and some very dense patches on northeast side, sparse plant cover throughout most of pond
Blair Pond*, Blandford	MA32009	M	Slight stain; little turbidity; moderate brown silt over rock and gravel bottom; very dense submergent and floating leaf plants in southern cove, remainder is open water; non-native aquatic species (Cc)
Borden Brook Reservoir*, Granville/Blandford	MA32011	U	Dark stain; slight turbidity; white foam on shore; moss present on rocks; sparse plant cover
Buck Pond, Westfield	MA32012	E	Slight stain; slight turbidity; brown powdery scum; brown silt over sandy bottom; very dense floating leaf, submergent and encroaching emergents around perimeter and band across center of pond (about 50% of the pond affected); non-native aquatic species (Mh)
Center Pond, Becket	MA32015	U	No stain; little turbidity; slight brown silt and some green algae on sand and rock bottom; sparse floating vegetation, possibly denser submergent cover next to beach and at southern end of the pond
Clear Pond*, Holyoke	MA32077	M	No stain; slight turbidity, slight brown silt on rock and vegetation bottom; very dense submergent plants and nearly to the surface; non-native wetland species (Ls)

* Indicates Class A (water supply) water body; all others are Class B.
Trophic Status Estimate: O = Oligotrophic, M = Mesotrophic, E = Eutrophic, H = Hypereutrophic, U = Undetermined.
Non-native Aquatic Plants: Cc = *Cabomba caroliniana*, Mh = *Myriophyllum heterophyllum* , Ms = *Myriophyllum spicatum*
Non-native Wetland Plants: Pa = *Phragmites australs*, Ls = *Lythrum salicaria*

Table F1 (cont). 1996 Westfield River Watershed lake observations and trophic status estimates.

Lake Name, Location	Waterbody Identification Code (WBID)	Trophic Status Estimate	Survey Observations
Cobble Mountain Reservoir*, Blandford/ Granville/Russell	MA32018	U	Clear to slight stain; slight turbidity; moderate brown silt and much undecomposed matter over rock and muck bottom; sparse plant cover
Conqamond Lake (Middle Basin), Southwick	MA32021	M	No stain; moderate green turbidity; slight brown silt over sand and gravel bottom; periphyton on vegetation; very dense floating and submerged plant life along both shores, north of access (northeast end of lake) and along east shore to south of access (< 5 acres affected), very dense floating leaf and submergent plants in cove next to access (SW end of lake) and along east shore, dense patches along west shore (about 10 acres total affected area); non-native aquatic species (Ms)
Congamond Lake (North Basin), Southwick	MA32022	U	No water quality observations; very dense submergent plant cover along both banks of southern cove (about 5 acres affected), remainder of the pond is not visible; non-native aquatic species (Ms)
Congamond Lake (South Basin), Southwick	MA32023	U	No water quality observations; non-native aquatic species (Ms) based on local observer's comments
Connor Reservoir*, Holyoke	MA32024	E	Clear; little turbidity; much vegetation, perimeter is dense with floating leaf plants along south shore, very dense submergent plants, but not reaching the surface, southwest area very dense with floating leaf plants
Crooked Pond, Plainfield	MA32028	U	Dense submergent and floating leaf plants in northeast cove and around much of the shore (about 25% of the pond affected)
Damon Pond, Chesterfield/ Goshen	MA32029	E	Moderate tea stain; slight turbidity (> 1.2 m SD, est.); slight fine muck over rock and gravel bottom at the outlet; about a third of the lower cove covered by dense submergent plants, most of the open water dense with clusters of yellow flowers indicating dense submergent plant growth, some patches of floating leaf plants, moderate cover on north end
Garnet Lake, Peru	MA32037	U	Clear; slight turbidity; slight silt over sand, rock, and vegetation bottom; powdery brown scum on surface at outlet; patches of moderate emergent and floating leaf plant cover frequent around the pond, overall moderate cover
Granville Reservoir*, Granville	MA32038	U	Very little stain; very little turbidity; brown silt over vegetated bottom; plant cover sparse in lower area of the lake
Hammond Pond, Goshen	MA32040	U	Moderate tea stain; moderate brown turbidity (likely > 1.2 m SD, est.); slight brown muck over sand and gravel bottom; plant cover sparse throughout pond, except moderate floating leaf patch at north end
Horse Pond, Westfield	MA32043	E	Very slight stain; slight turbidity; vegetation on bottom; north end has islands of emergent plants surrounded by very dense floating leaf and submergent plants, west shore very dense, east shore mostly open water, southeast and south shores with very dense floating leaf plants along perimeter (about a third of the pond covered with very dense plants); non-native aquatic species (Mh, Ms)

* Indicates Class A (water supply) water body; all others are Class B.
Trophic Status Estimate: O = Oligotrophic, M = Mesotrophic, E = Eutrophic, H = Hypereutrophic, U = Undetermined.
Non-native Aquatic Plants: Cc = *Cabomba caroliniana*, Mh = *Myriophyllum heterophyllum*, Ms = *Myriophyllum spicatum*
Non-native Wetland Plants: Pa = *Phragmites australs*, Ls = *Lythrum salicaria*

Table F1 (cont). 1996 Westfield River Watershed lake observations and trophic status estimates.

Lake Name, Location	Waterbody Identification Code (WBID)	Trophic Status Estimate	Survey Observations
Littleville Lake*, Chester/ Huntington	MA32046	U	Slight stain; very little turbidity; sandy silt and some undecomposed matter over rock bottom; sparse vegetation throughout the pond. Non-native species observed (Ls)
McLean Reservoir*, Holyoke	MA32050	U	No stain; slight turbidity; moderate brown silt over rocks, muck and decomposed matter on bottom; sparse plant cover over entire pond
North Railroad Pond*, Holyoke	MA32053	E	Little open water to observe; heavy brown turbidity observed from a distance (likely < 1.2 m SD, est.); nearly 100% covered with floating leaf plants
Norwich Pond, Huntington	MA32054	U	Clear; little turbidity; little silt on sand and gravel bottom; white foam on windward shore; some orange staining along shore north of ramp; sparse plant cover throughout pond
Robin Hood Lake, Becket	MA32057	U	Slight to moderate stain; moderate turbidity; large amounts of undecomposed matter on bottom, slight brown silt over sand at beach areas; some orange stain and oily scums near beaches on northeast "arm" and along east shore; sparse aquatic plant cover throughout pond; pond likely treated chemically; many lawns in the area and densely developed shoreline; non-native wetland plant (Pa)
Rudd Pond, Becket	MA32060	U	Slight stain; slight turbidity; slight brown silt on rocks, undecomposed debris on bottom; sparse plant cover throughout the pond
Russell Pond, Russell	MA32061	U	Clear; little turbidity; slight brown silt over vegetation and some partly decomposed matter on bottom; sparse plant cover throughout; shallow at dam end, leaking under spillway
Scout Pond, Chesterfield	MA32063	M	Slight stain; slight turbidity; bottom mainly undecomposed organic matter; band of dense emergents around much of pond, moderate submerged plant cover with floating leaf plants in patches (< 10% of the pond affected)
Westfield Reservoir, Montgomery	MA32074	U	Slight stain; slight turbidity; moderate brown silt/floc on rocks and partly to undecomposed matter on bottom; sparse plant cover throughout the reservoir
Windsor Pond, Windsor	MA32076	U	Very slight stain; very slight turbidity; slight brown silt over rock and muck bottom; occasional patches of emergent and floating leaf plants around shore (< 10% of the pond affected); non-native aquatic species (Ms)
Wright Pond*, Holyoke	MA32078	M	Clear; slight turbidity, green/gray turbidity in small cove on south side; slight brown silt on rocks and green algae on some rocks throughout most of the pond; sparse plant cover in northeast corner, very dense submergent plantss in most of the north basin and cove on south side; non-native wetland species (Ls)
Yokum Pond, Becket	MA32079	U	Clear; little turbidity; slight brown over stone, gravel, and sand bottom; sparse plant cover throughout most of the lake with a few moderate beds of emergent plants

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

Trophic Status Estimate: O = Oligotrophic, M = Mesotrophic, E = Eutrophic, H = Hypereutrophic, U = Undetermined.

Non-native Aquatic Plants: Cc = *Cabomba caroliniana*, Mh = *Myriophyllum heterophyllum*, Ms = *Myriophyllum spicatum*

Non-native Wetland Plants: Pa = *Phragmites australs*, Ls = *Lythrum salicaria*

2001

In the Westfield River Watershed a baseline lake survey was conducted for Congamond Lakes (North, Middle, and South basins). Data were collected on 19 June, 18 July, and 22 August 2001 to coincide with maximum growth of aquatic vegetation, highest recreational use, and highest lake productivity. A technical memorandum (CN167.0) entitled *Baseline Lake Survey 2001 Technical Memo* provides details of sample collection methods, results, data, and weed maps for the lakes surveyed in the Westfield, Taunton, South Coastal, and SuAsCo Watersheds in 2001 (Mattson and Haque 2004).

In situ measurements using a Hydrolab® multiprobe (measuring dissolved oxygen, water temperature, pH, specific conductivity, and depth and calculating total dissolved solids and % oxygen saturation) were recorded at deep hole stations and 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 WES Standard Operating Procedures (SOPs). 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 available in the 2001 Data Validation Report (MA DEP 2004). Apparent color and chlorophyll *a* were measured according to standard procedures at the MA DEP 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 TMDL Baseline Lakes Survey 2001 (Mattson and Haque 2004). Data were excerpted from the Baseline Lake Survey 2001 Technical Memo and presented in Tables F2, F3 and F4. Data qualifiers were excerpted from the Data Validation Report for Year 2001 Project Data and can be found in Table F5 (MA DEP 2004).

Table F2. 2001 Congamond Lake (Middle Basin) Hydrolab® and Water Quality Data (see any data qualifiers in Table F5).

Congamond Lakes (Palis: 32021)

Unique ID: W0923, Station: A, Description: Deep hole, center of Middle Basin, Southwick

Date	OWMID	Time	Depth	Temp	pH	Conductivity at 25°C	TDS	DO	Saturation
		(24hr)	(m)	©	(SU)	(uS/cm)	(mg/l)	(mg/l)	(%)
06/19/01	LB-1208	10:40	0.5	25.8u	7.6cu	163	105	9.1u	109u
		10:55	1.5	25.2u	7.6cu	163	104	8.9	106
		11:02	2.5	24.7u	7.5c	163	104	8.1u	95u
		11:07	3.5	21.1u	7.6c	165	106	9.4u	103u
		11:14	4.5	17.7u	7.5cu	167	107	9.5u	97u
		11:21	5.4	14.5u	7.4cu	167	107	9.2u	88u
		11:29	6.4	12.7u	7.1cu	168	108	6.5u	60u
		11:37	7.4	10.6	6.8u	169	108	0.9u	8u
		11:43	8.5	9.1	6.6u	170	109	<0.2	<2
		11:48	9.2	8.7	6.6	177	113	<0.2	<2
07/18/01	LB-1301	11:05	0.5	24.3	8.1c	167	107	9.6	112
		11:20	1.5	24.0	8.1c	168	107	9.7	113
		11:25	3.4	23.9	8.0c	167	107	9.5	110
		11:32	4.5	22.9u	7.5c	168	108	7.9u	90u
		11:40	5.5	19.2u	7.0cu	170	109	6.3u	66u
		11:47	6.5	14.8u	6.7	169	108	3.6	35
		11:53	7.5	12.0	6.6	167	107	2.8u	25u
		11:59	8.5	10.2	6.5	172	110	<0.2	<2
		12:04	10.0	8.8	6.5	187	120	<0.2	<2
		12:09	11.5	8.0u	6.4	224u	144u	<0.2	<2
08/22/01	LB-1394	11:26	0.5	26.4	8.6c	168	108	9.9	120
		11:37	2.5	26.0	8.6c	168	107	9.9	119
		11:44	4.0	25.8	8.4c	168	108	9.1u	109u
		11:53	5.0	23.1	6.7	172	110	##u	##u
		11:59	6.0	19.8u	6.5	173	110	0.6u	6u
		12:05	7.0	15.9u	6.4	171	109	<0.2	<2
		12:13	8.0	11.7u	6.4	174u	111u	<0.2	<2
		12:19	9.5	9.5u	6.4	195	125	<0.2	<2
		12:29	11.4	8.3	6.2	232u	148u	<0.2	<2

Congamond Lakes (Palis: 32021)

Unique ID: W0923, Station: A, Description: Deep hole, center of Middle Basin, Southwick

Date	Secchi Depth	Secchi Time	Station Depth	OWMID	QAQC	Time	Sample Depth	Relative Depth	Alkalinity	TP	Apparent Color	Chloro-phyll a
	m	24 hr	m			24hr	m		mg/l	mg/l	PCU	mg/m3
06/19/01	3.0	10:37	9.8	LB-1204	LB-1203	**	0.5	Surface	20d	0.021	22	--
				LB-1203	LB-1204	11:55	0.5	Surface	11d	0.021	16	--
				LB-1205	--	**	9.3	Bottom	48	0.046	24	--
				LB-1206	LB-1207	**	0 - **	Integrated	--	--	--	8.6
				LB-1207	LB-1206	**	0 - **	Integrated	--	--	--	10.4
07/18/01	2.7	11:00	12.0	LB-1296	LB-1297	11:30	0.5	Surface	43	0.017	<15h	
				LB-1297	LB-1296	11:35	0.5	Surface	43	0.016	<15h	
				LB-1298	--	12:30	11.5	Bottom	73	0.19	65h	
				LB-1299	LB-1300	12:24	0 – 8.1	Integrated				12.9
				LB-1300	LB-1299	12:26	0 – 8.1	Integrated				12.1
08/22/01	2.4	11:50	12.0	LB-1390	LB-1389	12:15	0.5	Surface	44	0.019b	22	
				LB-1389	LB-1390	12:15	0.5	Surface	43	0.020b	18	
				LB-1391	--	12:30	11.4	Bottom	85	0.34b	75	
				LB-1392	LB-1393	12:45	0 – 7.2	Integrated				16.7
				LB-1393	LB-1392	12:50	0 - 7.2	Integrated				15.6

Table F3. 2001 Congamond Lake (North Basin) Hydrolab® and water quality data

Congamond Lakes (Palis: 32022)
Unique ID: W0924, Station: B, Description: Deep hole, center of North Pond, Southwick

Date	OWMID	Time	Depth	Temp	pH	Conductivity at 25°C	TDS	DO	Saturation
		(24hr)	(m)	(C)	(SU)	(uS/cm)	(mg/l)	(mg/l)	(%)
06/19/01	LB-1213	13:49	0.5	26.5	7.3cu	119	76.2	8.6u	105u
		13:54	1.5	25.5u	7.4cu	119	76.0	8.6	102
		13:59	2.5	24.7u	7.7cu	119	76.0u	9.2u	107u
		14:05	3.5	21.5u	7.9c	118	75.6	10.0u	111u
		14:09	4.4	17.1u	7.9cu	118	75.8u	11.5u	116u
		14:15	5.4	13.0u	7.7cu	121	77.6u	11.6u	107u
		14:21	6.4	10.0u	7.4cu	124	79.5	11.1u	96u
		14:27	7.4	8.1	7.4c	126	80.7	12.0u	99u
		14:32	8.4	6.6u	6.9cu	129	82.3	1.4u	11u
		14:37	10.4	5.6u	6.7u	136	86.8	<0.2u	<2u
07/18/01	LB-1305	14:12	0.5	25.1	8.1c	122u	78.1u	8.9u	106u
		14:22	2.5	24.3u	8.2c	121	77.7	9.1	107
		14:27	4.5	23.2u	8.3c	121u	77.3u	10.3u	118u
		14:33	5.5	17.4u	7.6cu	121	77.4	11.9	122
		14:38	6.5	13.6u	7.1cu	123	78.9	11.0u	103u
		14:43	7.5	10.6	7.0cu	125u	79.9u	10.5u	92u
		14:48	8.5	8.8	6.7u	126	80.8	##u	##u
		14:55	10.0	6.8u	6.3u	129u	82.7u	<0.2	<2
		14:59	11.5	5.8	6.2	141u	90.2u	<0.2	<2
		15:06	12.2	5.7u	6.2	144u	91.8u	<0.2	<2
08/22/01	LB-1398	14:44	0.5	27.4u	8.3cu	126	80.4	9.2u	113u
		14:56	2.5	26.8u	8.3c	126	80.3	9.2u	113u
		15:01	4.0	26.5	8.2c	125	80.3	9.2u	112u
		15:06	5.0	23.6	8.9c	123	79.0	13.8	159
		15:13	6.0	17.9u	7.2cu	124	79.3	##u	##u
		15:18	7.0	14.3u	6.7u	126	80.3	8.3u	79u
		15:24	8.0	##u	6.4	127	81.2	##u	##u
		15:30	9.0	9.4u	6.2u	127	81.3	1.9u	16u
		15:35	10.5	7.2	6.0	137u	87.8u	<0.2	<2
		15:42	12.0	6.2	6.0	148	94.9	<0.2	<2

Congamond Lakes (Palis: 32022)
Unique ID: W0924, Station: B, Description: Deep hole, center of North Pond, Southwick

Date	Secchi	Secchi Time	Station Depth	OWMID	Time	Sample Depth	Relative Depth	Alkalinity	TP	Apparent Color	Chloro-phyll a
	m	24hr	m		24hr	m		mg/l	mg/l	PCU	mg/m3
06/19/01	4.6	13:45	13.4	LB-1210	**	0.5	Surface	11	0.017b	<15	--
				LB-1211	**	10.8	Bottom	34	0.068b	24	--
				LB-1212	**	0 - **	Integrated	--	--	--	2.6
07/18/01	3.3	14:00	13.5	LB-1302	14:45	0.5	Surface	30	0.013b	<15h	--
				LB-1303	15:05	12.2	Bottom	41	0.083b	40h	--
				LB-1304	14:55	0 - 8.1	Integrated	--	--	--	3.3
08/22/01	3.7	15:10	12.5	LB-1395	15:00	0.5	Surface	30	0.012	<15	--
				LB-1396	16:00	12.0	Bottom	44	0.083	43	--
				LB-1397	15:50	0 - 11.1	Integrated	--	--	--	11.3

Table F4. 2001 Congamond Lake (South Basin) Water Quality Data

Congamond Lakes (Palis: 32023)

Unique ID: W0925, Station: C, Description: Deep hole, center of South Pond, Southwick

Date	Secchi	Secchi Time	Station Depth	OWMID	Time	Sample Depth	Relative Depth	Alkalinity	TP	Apparent Color	Chloro-phyll a
	m	24hr	m		24hr	m		mg/l	mg/l	PCU	mg/m3
06/19/01	**	13:00	7.3	LB-1209	**	0.5	Surface	--	0.025b	--	--
07/18/01	1.5	13:15	**	LB-1306	13:15	0.5	Surface	--	0.028b	--	--
08/22/01	2.0	13:40	6.1	LB-1399	13:40	0.5	Surface	--	0.027b	--	--

Table F5. Data Symbols and Qualifiers. (These are used in the MA DEP 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) (MA DEP 2004).

General Symbols (applicable to all types):

" ## " = Censored data (i.e., data that has been discarded for some reason)

" ** " = 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).

Multiprobe-Specific Qualifiers:

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

" **c** " = greater than **c**alibration 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).

Sample-specific Qualifiers:

" **b** " = **b**lank Contamination in lab reagent blanks and/or field blank samples (indicating possible bias high and false positives).

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

" **h** " = **h**olding time violation (usually indicating possible bias low)

REFERENCES

MA DEP. 1995 January Draft. *Laboratory Quality Assurance Plan and Standard Operating Procedures.* Massachusetts Department of Environmental Protection, Division of Environmental Analysis. Wall Experiment Station, Lawrence, MA.

MA DEP. 1999a. CN 1.0 *Grab Collection Techniques for DWM Water Quality Sampling, Standard Operating Procedure*. October 25, 1999. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MA DEP. 1999b. CN 4.0 *Hydrolab® Series 3 Multiprobe, Standard Operating Procedure*. September 23, 1999. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

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APPENDIX G
1996/1997 MA DEP DWM WATER QUALITY MONITORING IN THE WESTFIELD RIVER WATERSHED

A preliminary monitoring plan for the Westfield River Watershed was developed by the MA DEP DWM office based on a review of past water quality reports, input from MA DEP Western Regional office staff in Springfield, the watershed association, and local input received during public information gathering meetings held throughout the basin. The following general objectives were initially identified for the 1996 Westfield River Watershed survey:

1) to quantitatively characterize ambient aluminum concentrations in the Westfield River to facilitate review of NPDES permits,
2) to determine the existence and extent of sedimentation impacts from known and suspected nonpoint sources in the basin,
3) to identify areas impacted by bacterial contamination that may impair recreational use and threaten public health,
4) to determine the extent to which macrophytes impact the recreational use of lakes and ponds;
5) to identify lakes and ponds containing exotic plant species,
6) to assess the degree of impact from point source discharges via biological monitoring above and below selected NPDES discharges,
7) to assess the habitat in the Little River with regards to flow management,
8) to evaluate the water quality in the Westfield River during wet weather conditions, and
9) to assess the degree to which waters of the Westfield River Watershed support their designated uses.

It became necessary to make modifications to the monitoring plan during the 1996 sampling period. Ultimately, the revised 1996 monitoring plan concentrated on objectives 3, 4, 5, 6, 7 and 9 above. The water quality sampling matrix for the DWM 1996 Westfield River Watershed survey is summarized in Table G1. Bacteria samples were collected from the Main, Middle, and West branches of the Westfield River and numerous tributaries to these subwatersheds. Samples were collected twice at most stations in the spring and summer at a variety of flow conditions. Many of the tributary stream stations were established near their confluences with the larger branches. If fecal coliform contamination was detected at these locations, upstream investigative sampling was recommended.

Additionally, water quality monitoring was conducted by DWM in eight streams in 1997 as part of the 104(b)(3) Numeric Biocriteria Development Project surveys. Water quality sampling was restricted to in-situ Hydrolab® measurements of depth, pH, dissolved oxygen, conductivity, temperature, total dissolved solids, and turbidity. The surveyed streams were: Little River, Kinne Brook, Sanderson Brook, Roaring Brook, Bradley Brook, Moose Meadow Brook, Bedlam Brook, and Dickerson Brook. Sampling of these streams was completed during the week of 22-26 September 1997. In addition to characterizing the stream biota in the Berkshire Transition subecoregion, physical characteristics and habitat assessments were performed by Division of Watershed Management biologists at each 100-meter sampling reach.

Table G1: Westfield River Watershed Sampling Summary for Water Quality – 1996-1997 Segment Numbers, Station IDs, and Parameters

Station ID	Unique ID[1]	8 May 1996	9 May 1996	22 May 1996	23 May 1996	30 July 1996	5 Aug 1996	6 Aug 1996	12 Aug 1996	13 Aug 1996	Sept 1997
WSFR56.8	W0215		B				B				
SWFR50.6	W0216		B				B				
WSFR48.1	W0217		B				B				
WSFR42.7	W0218		B				B				
WSFR38.0	W0219						B				
WSFR26.8	W0220	B				B	B				
MEDB00.2	W0273		B				B				
SWFT00.2	W0272		B				B				
WBWC00.1	W0271						B				

[1]Unique ID = unique station identification number, B = Fecal coliform bacteria, H = Hydrolab® meter (pH, temperature, dissolved oxygen, percent saturation, specific conductance), O = Dissolved oxygen YSI meter

* This data collection effort was conducted as part of the numeric biocriteria development project

Table G1 (continued)

Station ID	Unique ID[1]	8 May 1996	9 May 1996	22 May 1996	23 May 1996	30 July 1996	5 Aug 1996	6 Aug 1996	12 Aug 1996	13 Aug 1996	Sept 1997
WATS00.1	W0269		B				B				
WRDS00.0	W0270		B			B	B				
LRWT00.1	W0268		B			B	B				
BT08LIT	W0267										H
MBWF16.4	W0258					B					
MBWF14.4	W0259					B					
MBWF09.3	W0260					B					
MBWF07.5	W0261					B					
MBWF05.2	W0262					B					
MBWF04.0	W0263					B					
MBWF00.4	W0264	B				B					
GDBR00.4	W0266					B					
BT05KIN	W0265										H
WSFR23.5	W0221	B		B			B			B	
WSFR20.3	W0222			B						B	
WSRF17.3	W0223		B							B	
WBWF16.1	W0248	B						B			
WBWF13.2	W0249							B			
WBWF08.9	W0250	B						B			
WBWF05.4	W0251	B						B			
WBWF01.4	W0252	B						B			
DPOB02.3	W0256	B						B			
SKMB00.4	W0257	B						B			
YKMB00.2	W0255	B						B			
WLKB00.4	W0254	B						B			
BT04SAN	W0253										H
BT07ROA	W0247										H
BDLB00.1	W0246			B						B	
BT03BRA	W0245										H
PTAB00.1	W0244									B	
MMBR01.0	W0243				B					B	
BT06MOO	W0242										H
LITR04.7	W0237		B						B		
BT02BED	W0241										H
LITR00.2	W0238			B					B		
LITRPIPE	W0239			B	B				B		
BT01DIC	W0240										H
PDMB03.8	W0234				B					B	
PDMB01.1	W0235			B	B					B	
PNDB0.1	W0236	B			B		B			B	
GRTB08.6	W0231			B					B		
GRTB03.1	W0232			B					B		
GRTB00.3	W0233			B					B		
WSFR07.2	W0224						O				
WSFR01.5	W0225				B				B		
WSFR03.2	W0226						O				
WSFR00.2	W0227				B		O, B		B		
PCTB00.3	W0230				B		B			B	
MILB00.2	W0228	B					B				
WHTB000	W0229				B				B		
TTYB00.0	W0214	B									
MUNB00.1	W0346								B		

[1]Unique ID = unique station identification number, B = Fecal coliform bacteria, H = Hydrolab® meter (pH, temperature, dissolved oxygen, percent saturation, specific conductance), O = Dissolved oxygen YSI meter
* This data collection effort was conducted as part of the numeric biocriteria development project

Materials and Methods
Procedures followed in 1996 are detailed in MA DEP's *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 1995). Samples were preserved in the field as necessary, transported on ice to WES, and analyzed according to WES standard operating procedures. Quality control samples generally included field blanks, field replicates, and sample splits. In 1996 water temperature, dissolved oxygen, and pH measurements were made *in-situ* at each station using a pre-calibrated YSI® multi-parameter meter. *In-situ* measurements made in 1997 were obtained using a pre-calibrated Hydrolab® multi-probe meter.

Quality Assurance and Quality Control
In general, monitoring surveys in the Westfield River Watershed in 1996 were performed with attention to maintaining quality assurance and control of field samples and field-generated data. For the majority of the water quality surveys quality control samples (field blanks and sample splits) 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.

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). Data validation for the 1996 surveys is available in a memorandum, *1994, 95 & 96 QA/QC Assessment Report* (MA DEP 2000). Specific notes regarding the Westfield River Watershed were excerpted and appear in Table G2. All YSI® and Hydrolab® multi-probe data were validated using multi-staff review. Data symbols (e.g., ** for censored/missing data) were applied to Hydrolab® data as necessary.

Results
Quality control data decisions appear in Table G2 (MA DEP 2000). *In-situ* Hydrolab® data from the 1997 Biocriteria numerical development in the Westfield Watershed surveys are presented in Table G3. Fecal Coliform bacteria data appear in Table G4. *In-situ* YSI® data from the 1996 watershed survey appear in Table G5.

Table G2. 1995/1996 DWM Data Decisions for Westfield River Watershed Discrete Sample Data (excerpted from MA DEP 2000).

OWMID	Description / Suggested Action
32-0061-107	No field blank had been collected for Fecal Coliform analysis for the following Westfield surveys: 8/13/96, 8/12/96, 8/6/96, 8/5/96 and 5/22/96 (see note 1).
32-0073/74 **32-0058/59** **32-0019/20**	Replicate results are at or below the ideal counting range of 20 CFU for Fecal Coliform analysis (see note 2).

Notes:
1. The DWM QA Program was not fully established during the 1994, 95 and 96 sampling surveys. In addition, DWM relied on WES to supply the reagent water for field blanks. DWM staff members were not always supplied with contaminant-free reagent water. If the field blank objective was violated the associated survey data are not necessarily suspect unless a trend is found or there is documented evidence that aberrant collection, handling or analysis procedures were used. If, however, two or more data quality objectives were violated than all associated data by that sampling crew on that day are to be censored.

2. Individual analytes can not have > 20% of their replicate population outside the established data quality objectives. Analytes that exceed the 20% limit will be reviewed independently against other quality control factors (i.e. laboratory duplicate data) and decision made on their validity. The percentages are calculated and presented below in the replicate summary.

Table G3. 1997 *In-situ* Hydrolab® Data at Biocriteria Development Project Stations in the Westfield River Watershed.

OWMID[1]	Date	Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Conductivity (µS/cm)	TDS (mg/L)	DO (mg/L)	Saturation (%)	Turbidity (NTU)
DICKINSON BROOK										
Station: BT01DIC, Mile Point: 3.2, Unique ID[2]: W0240										
Description: Approximately 100 meters west (upstream) of Water Street crossing, Granville.										
BC-0044	09/23/97	09:30	**i	11.2	6.8	46.3	30.0	10.5	93	5.9i
BEDLAM BROOK										
Station: BT02BED, Mile Point: 0.5, Unique ID[2]: W0241										
Description: Approximately 800 meters north (upstream) of Route 23, Blandford.										
BC-0045	09/23/97	11:31	**i	11.5	7.1	311	199	9.9	88	4.4i
MOOSE MEADOW BROOK										
Station: BT06MOO, Mile Point: 3, Unique ID[2]: W0242										
Description: Approximately 400 meters north (upstream) of Tekoa Reservoir, Westfield.										
BC-0048	09/24/97	09:17	**i	9.8	6.7	41.6	27.0	11.0	94	2.1i
BRADLEY BROOK										
Station: BT03BRA, Mile Point: 0.7, Unique ID[2]: W0245										
Description: Behind #54 Moss Hill Road, approximately 400 meters west (upstream) of Route 20, Montgomery.										
BC-0046	09/23/97	14:17	**i	12.1	7.4	102	65.0	10.8	98	6.3i
ROARING BROOK										
Station: BT07ROA, Mile Point: 0.9, Unique ID[2]: W0247										
Description: Approximately 100 meters northwest (upstream) of second Carrington Road crossing of Roaring Brook, Montgomery.										
BC-0049	09/24/97	11:25	**i	9.5	7.0	72.8	47.0	11.0	93	4.5i
SANDERSON BROOK										
Station: BT04SAN, Mile Point: 0.7, Unique ID[2]: W0253										
Description: Off the west side of Sanderson Brook Road approximately 1000 meters south (upstream) of Route 20, Chester.										
BC-0047	09/23/97	16:13	**i	11.7	7.2	57.4	37.0	10.5	94	2.6i
KINNE BROOK										
Station: BT05KIN, Mile Point: 1.7, Unique ID[2]: W0265										
Description: Approximately 250 meters south (downstream) of confluence of Skunk Brook off the west side of Kinne Brook Road, Chester.										
BC-0050	09/24/97	13:01	**i	10.0	7.5	71.4	46.0	11.1	95	5.0i
LITTLE RIVER										
Station: BT08LIT, Mile Point: 1.9, Unique ID[2]: W0267										
Description: Off the north side of Route 112 approximately 1900 meters southeast (downstream) of Ireland Street crossing, Huntington.										
BC-0051	09/24/97	15:13	**i	11.7	7.6	127	81.0	10.8	96	3.9i

[1] OWMID = sample tracking number, [2] Unique ID = unique station identification number.
** = Censored Data, i = Inaccurate Data

Table G4. 1996 Westfield River Watershed fecal coliform bacteria

OWMID[1]	QA/QC	Date	Time	Fecal Coliform Bacteria (colonies/100mL)
Pipe/Discharge to Unnamed Tributary to Yokum Brook				
Station: TTYB00.0, Mile Point: 0.01, Unique ID[2]: W0214				
Description: pipe located upstream, right hand side of Route 8 bridge, Becket.				
32-0005		05/08/96	11:04	<10
WESTFIELD RIVER				
Station: WSFR56.8, Mile Point: 61.4, Unique ID[2]: W0215				
Description: River Road bridge, Windsor. .				
32-0024		05/09/96	11:56	<10
32-0066		08/05/96	10:08	120
WESTFIELD RIVER				
Station: WSFR50.6, Mile Point: 54.8, Unique ID[2]: W0216				
Description: West Main Street bridge, Cummington.				
32-0023		05/09/96	11:31	<10
32-0067		08/05/96	10:30	40
WESTFIELD RIVER				
Station: WSFR48.1, Mile Point: 52.2, Unique ID[2]: W0217				
Description: Route 9 bridge near Stage Road, Cummington.				
32-0022		05/09/96	11:19	<10
32-0068		08/05/96	10:41	140
WESTFIELD RIVER				
Station: WSFR42.7, Mile Point: 46.7, Unique ID[2]: W0218				
Description: Route 9/112 at roadside park upstream of Swift River confluence, Cummington.				
32-0019	32-0020	05/09/96	10:43	20
32-0020	32-0019	05/09/96	10:43	50
32-0070		08/05/96	11:15	180
WESTFIELD RIVER				
Station: WSFR38.0, Mile Point: 41, Unique ID[2]: W0219				
Description: Base of Chesterfield Gorge just upstream confluence with Whitside Brook, Chesterfield.				
32-0073	32-0074	08/05/96	12:00	80
32-0074	32-0073	08/05/96	12:00	<20
WESTFIELD RIVER				
Station: WSFR26.8, Mile Point: 29.4, Unique ID[2]: W0220				
Description: Gardner State Park, Route 112, Huntington.				
32-0011	32-0012	05/08/96	12:52	<10
32-0012	32-0011	05/08/96	12:52	<10
32-0058	32-0059	07/30/96	11:16	20
32-0059	32-0058	07/30/96	11:16	40
32-0062		08/05/96	09:00	640
WESTFIELD RIVER				
Station: WSFR23.5, Mile Point: 25.9, Unique ID[2]: W0221				
Description: Route 20 at roadside park downstream from confluence with West Branch Westfield River, Huntington.				
32-0013		05/08/96	13:06	<10
32-0026		05/22/96	09:34	10
32-0061		08/05/96	08:40	160
32-0097		08/13/96	09:10	120
WESTFIELD RIVER				
Station: WSFR20.3, Mile Point: 21.4, Unique ID[2]: W0222				
Description: Route 20, near Whippernon Golf Course, downstream from confluence with Bradley Brook and Westfield River Paper Company Dam, Russell.				
32-0028		05/22/96	10:03	180
32-0099		08/13/96	09:31	40

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

Table G4 (continued). 1996 Westfield River Watershed fecal coliform bacteria

OWMID[1]	QA/QC	Date	Time	Fecal Coliform Bacteria (colonies/100mL)
WESTFIELD RIVER				
Station: WSFR17.3, Mile Point: 18.3, Unique ID[2]: W0223				
Description: Route 20, at Route 90 overpass, Russell.				
32-0030		05/22/96	10:24	60
32-0101		08/13/96	09:54	120
WESTFIELD RIVER				
Station: WSFR01.5, Mile Point: 6.5, Unique ID[2]: W0225				
Description: Robinson State Park, upstream of confluence with Miller Brook, Agawam/West Springfield.				
32-0045	32-0046	05/23/96	12:04	140
32-0046	32-0045	05/23/96	12:04	140
32-0094		08/12/96	11:40	40
WESTFIELD RIVER				
Station: WSFR00.2, Mile Point: 0.3, Unique ID[2]: W0227				
Description: Route 5 bridge, Agawam.				
32-0047		05/23/96	12:35	70
32-0095	32-0096	08/12/96	12:10	60
32-0096	32-0095	08/12/96	12:10	60
WHITE BROOK				
Station: WHTB00.0, Mile Point: 0.01, Unique ID[2]: W0229				
Description: Robinson State Park entrance road bridge, Agawam.				
32-0043		05/23/96	11:45	150
32-0092		08/12/96	11:25	280
MILLER BROOK				
Station: MILB00.2, Mile Point: 0.3, Unique ID[2]: W0228				
Description: Robinson State Park entrance road bridge, Agawam.				
32-0044		05/23/96	11:48	40
32-0093		08/12/96	11:30	60
PAUCATUCK BROOK				
Station: PCTB00.3, Mile Point: 0.2, Unique ID[2]: W0230				
Description: Sikes Avenue bridge, West Springfield.				
32-0042		05/23/96	11:23	<10
32-0106	32-0107	08/13/96	12:04	2,600
32-0107	32-0106	08/13/96	12:04	2,500
GREAT BROOK				
Station: GRTB08.6, Mile Point: 10.8, Unique ID[2]: W0231				
Description: Sheep Pasture Road bridge, Southwick.				
32-0032		05/22/96	11:17	50
32-0089		08/12/96	10:43	40
GREAT BROOK				
Station: GRTB03.1, Mile Point: 7.3, Unique ID[2]: W0232				
Description: Route 57 bridge, Southwick.				
32-0033		05/22/96	11:51	170
32-0090		08/12/96	10:58	80
GREAT BROOK				
Station: GRTB00.3, Mile Point: 0.2, Unique ID[2]: W0233				
Description: Little River Road bridge, Westfield.				
32-0034		05/22/96	12:02	180
32-0091		08/12/96	11:10	20

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

Table G4 (continued). 1996 Westfield River Watershed fecal coliform bacteria

OWMID[1]	QA/QC	Date	Time	Fecal Coliform Bacteria (colonies/100mL)
POWDERMILL BROOK				
Station: PDMB03.8, Mile Point: 5.4, Unique ID[2]: W0234				
Description: Russellville Road bridge, Westfield.				
32-0039		05/23/96	10:48	320
32-0102		08/13/96	10:46	960
POWDERMILL BROOK				
Station: PDMB01.1, Mile Point: 1.2, Unique ID[2]: W0235				
Description: Union Street bridge, Westfield.				
32-0029		05/22/96	10:09	10
32-0040		05/23/96	11:11	220
32-0104		08/13/96	11:48	680
POND BROOK				
Station: PNDB00.1, Mile Point: 0.1, Unique ID[2]: W0236				
Description: Union Street bridge, Westfield.				
32-0041		05/23/96	11:15	10
32-0105		08/13/96	11:52	120
LITTLE RIVER				
Station: LITR04.7, Mile Point: 5, Unique ID[2]: W0237				
Description: Horton's Bridge on Granville Road, Westfield.				
32-0031		05/22/96	10:45	90
32-0087		08/12/96	08:47	480
LITTLE RIVER				
Station: LITR00.2, Mile Point: 0.3, Unique ID[2]: W0238				
Description: Upstream of stormdrain discharge at end of South Street, Westfield.				
32-0035		05/22/96	12:28	90
32-0085		08/12/96	08:27	40
Pipe/Discharge to LITTLE RIVER				
Station: LITRPIPE, Mile Point: 0.29, Unique ID[2]: W0239				
Description: stormdrain discharge to Little River located at the end of South Street, Westfield.				
32-0036		05/22/96	12:28	500,000
32-0037		05/23/96	10:15	900,000
32-0086		08/12/96	08:30	5,000
MUNN BROOK				
Station: MUNB00.1, Mile Point: 0.4, Unique ID[2]: W0346				
Description: Granville Road bridge, Westfield.				
32-0088		08/12/96	08:53	220
MOOSE MEADOW BROOK				
Station: MMBR01.1, Mile Point: 1.2, Unique ID[2]: W0243				
Description: Pochassic Road bridge, Westfield.				
32-0038		05/23/96	10:36	370
32-0103		08/13/96	11:01	68,000
POTASH BROOK				
Station: PTAB00.1, Mile Point: 0.01, Unique ID[2]: W0244				
Description: Woronoco Road bridge, Russell.				
32-0100		08/13/96	09:42	40
BRADLEY BROOK				
Station: BDLB00.1, Mile Point: 0.1, Unique ID[2]: W0246				
Description: Upstream of unnamed tributary southwest of Lincoln Avenue, behind ball park, Russell.				
32-0027		05/22/96	09:50	20
32-0098		08/13/96	09:21	440

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

Table G4 (continued). 1996 Westfield River Watershed fecal coliform bacteria

OWMID[1]	QA/QC	Date	Time	Fecal Coliform Bacteria (colonies/100mL)
WEST BRANCH WESTFIELD RIVER				
Station: WBWF16.1, Mile Point: 17.4, Unique ID[2]: W0248				
Description: Off Pleasant Street, downstream from confluence with Yokum Brook, Becket.				
32-0003		05/08/96	10:47	50
32-0076		08/06/96	09:53	100
WEST BRANCH WESTFIELD RIVER				
Station: WBWF13.2, Mile Point: 13.9, Unique ID[2]: W0249				
Description: Bancroft Road/Town Hill Road bridge, Becket/Middlefield.				
32-0079		08/06/96	10:29	120
WEST BRANCH WESTFIELD RIVER				
Station: WBWF08.9, Mile Point: 9.6, Unique ID[2]: W0250				
Description: Middlefield Road bridge, Chester.				
32-0007		05/08/96	11:46	<10
32-0081		08/06/96	11:01	340
WEST BRANCH WESTFIELD RIVER				
Station: WBWF05.4, Mile Point: 6, Unique ID[2]: W0251				
Description: Unnamed bridge off Route 20, upstream of confluence of Abbott Brook, Chester.				
32-0008		05/08/96	12:00	<10
32-0082	32-0083	08/06/96	11:18	240
32-0083	32-0082	08/06/96	11:18	360
WEST BRANCH WESTFIELD RIVER				
Station: WBWF01.4, Mile Point: 1.5, Unique ID[2]: W0252				
Description: At USGS gaging station #01181000 near Fiske Avenue, Huntington.				
32-0009		05/08/96	12:30	<10
32-0084		08/06/96	12:02	240
WALKER BROOK				
Station: WLKB00.4, Mile Point: 0.5, Unique ID[2]: W0254				
Description: Hampton Street bridge, Chester				
32-0006		05/08/96	11:34	<10
32-0080		08/06/96	10:46	40
YOKUM BROOK				
Station: YKMB00.2, Mile Point: 0.6, Unique ID[2]: W0255				
Description: Route 8 bridge near Carter Road, Becket.				
32-0004		05/08/96	11:03	<10
32-0078		08/06/96	**	140
DEPOT BROOK				
Station: DPOB02.3, Mile Point: 2.5, Unique ID[2]: W0256				
Description: Cross Place Road bridge, Washington.				
32-0001		05/08/96	10:15	20
32-0075		08/06/96	09:38	420
SHAKER MILL BROOK				
Station: SKMB00.4, Mile Point: 0.5, Unique ID[2]: W0257				
Description: Lovers Lane bridge, Becket.				
32-0002		05/08/96	10:33	<10
32-0077		08/06/96	10:02	20
MIDDLE BRANCH WESTFIELD RIVER				
Station: MBWF16.4, Mile Point: 15.6, Unique ID[2]: W0258				
Description: Parish Road bridge nearest Route 143, Worthington.				
32-0055		07/30/96	10:23	40

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

Table G4 (continued). 1996 Westfield River Watershed fecal coliform bacteria

OWMID[1]	QA/QC	Date	Time	Fecal Coliform Bacteria (colonies/100mL)
MIDDLE BRANCH WESTFIELD RIVER				
Station: MBWF14.4, Mile Point: 13.5, Unique ID[2]: W0259				
Description: River Road bridge upstream of confluence with Fuller Brook, Worthington.				
32-0054		07/30/96	10:11	<20
MIDDLE BRANCH WESTFIELD RIVER				
Station: MBWF09.3, Mile Point: 9.3, Unique ID[2]: W0260				
Description: Off East River Road upstream of confluence with Glendale Brook, Middlefield/Worthington.				
32-0052		07/30/96	09:43	<20
MIDDLE BRANCH WESTFIELD RIVER				
Station: MBWF07.5, Mile Point: 7.4, Unique ID[2]: W0261				
Description: Herring Road bridge, Chester.				
32-0051		07/30/96	09:33	<20
MIDDLE BRANCH WESTFIELD RIVER				
Station: MBWF05.2, Mile Point: 5.1, Unique ID[2]: W0262				
Description: Off East River Road, approximately 1 mile upstream of confluence with Kinne Brook, Chester.				
32-0050		07/30/96	09:21	80
MIDDLE BRANCH WESTFIELD RIVER				
Station: MBWF04.0, Mile Point: 3.8, Unique ID[2]: W0263				
Description: Kinne Brook Road bridge, Chester.				
32-0049		07/30/96	09:10	20
MIDDLE BRANCH WESTFIELD RIVER				
Station: MBWF00.4, Mile Point: 0.3, Unique ID[2]: W0264				
Description: Goss Hill Road bridge at USGS gage # 01180500, Huntington.				
32-0010		05/08/96	12:44	<10
32-0060		07/30/96	11:32	<20
GLENDALE BROOK				
Station: GDBR00.4, Mile Point: 0.3, Unique ID[2]: W0266				
Description: Clark Wright Road bridge, Middlefield.				
32-0053		07/30/96	09:55	140
LITTLE RIVER				
Station: LRWT00.1, Mile Point: 1.1, Unique ID[2]: W0268				
Description: Off Route 112, just above flood pool of Knightville Dam, Huntington.				
32-0015		05/09/96	09:55	660
32-0056		07/30/96	10:48	<20
32-0063		08/05/96	09:14	100
WATTS STREAM				
Station: WATS00.1, Mile Point: 0.1, Unique ID[2]: W0269				
Description: Prentice Road bridge, Worthington.				
32-0016		05/09/96	09:32	50
32-0065		08/05/96	09:31	160
WARDS STREAM				
Station: WRDS00.0, Mile Point: 0.01, Unique ID[2]: W0270				
Description: Route 112 bridge, Worthington.				
32-0017		05/09/96	09:44	<10
32-0064		08/05/96	09:23	180
WEST BRANCH				
Station: WBWC00.1, Mile Point: 0.1, Unique ID[2]: W0271				
Description: Ireland Street bridge, Chesterfield.				
32-0072		08/05/96	11:45	120

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

Table G4 (continued). 1996 Westfield River Watershed fecal coliform bacteria

OWMID[1]	QA/QC	Date	Time	Fecal Coliform Bacteria (colonies/100mL)
SWIFT RIVER				
Station: SWFT00.2, Mile Point: 0.3, Unique ID[2]: W0272				
Description: Route 9/112 bridge, Cummington.				
32-0018		05/09/96	10:27	10
32-0071		08/05/96	11:28	<20
MEADOW BROOK				
Station: MEDB00.2, Mile Point: 0.2, Unique ID[2]: W0273				
Description: Nash Road bridge, Cummington.				
32-0021		05/09/96	11:00	20
32-0069		08/05/96	11:02	1,800

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

Table G5. 1996 YSI® Data

Date	OWMID[1]	Time (24hr)	Temp (C)	DO (mg/L)
WESTFIELD RIVER				
Station: WSFR07.2, Unique ID[2]: W0224				
Description: Route 20 and Dewey Street, downstream confluence with Paucatuck Brook, West Springfield/Agawam.				
08/28/96	32-0110	**	17.0is	7.7is
WESTFIELD RIVER				
Station: WSFR03.2, Unique ID: W0226				
Description: Mittineague Bridge Road/Bridge Street bridge, West Springfield/Agawam.				
08/28/96	32-0109	**	18.0is	10.0is
WESTFIELD RIVER				
Station: WSFR00.2, Unique ID: W0227				
Description: Route 5 bridge, Agawam.				
08/28/96	32-0108	**	19.0is	7.7is

[1] OWMID = sample tracking number, [2] Unique ID = unique station identification number.
** = Censored Data
i = inaccurate data
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.

REFERENCES

MA DEP 1990. *BASINS PROGRAM Standard Operating Procedures River and Stream Monitoring. Massachusetts Department of Environmental Protection, Division of Water Pollution Control, Technical Services Branch. Westborough, MA.*

MA DEP. 1995, January Draft. *Laboratory Quality Assurance Plan and Standard Operating Procedures.* Massachusetts Department of Environmental Protection, Division of Environmental Analysis. Wall Experiment Station, Lawrence, MA.

MA DEP. 2000. Memorandum to Rick McVoy, Laurie Kennedy, Tom Dallaire, Arthur Johson and Mollie Weinstein from Mark Guilmain dated February 2000. *1994, 95 & 96 QA/QC Assessment Report.* CN 36.0. Division of Watershed Management Department of Environmental Protection. Worcester, MA

APPENDIX H
SUMMARY OF NPDES AND WMA PERMITTING INFORMATION FOR THE WESTFIELD RIVER WATERSHED

Information from open permit files located in MA DEP Boston, Worcester, and Springfield Offices.

Table H1. Westfield River Watershed Municipal and Sanitary Wastewater Surface Discharges.

Permitee	NPDES #	Issuance	Flow (MGD)	Receiving Water (Segment)
Huntington WWTP, Huntington	MA0101265	28 September 1998	0.2	Westfield River Segment MA32-05
Russell Village POTW, Russell	MA0100960	29 September 1998	0.24	Westfield River Segment MA32-05
Woronoco Village POTW, Russell	MA0103233	30 September 1998	0.02	Westfield River Segment MA32-05
Westfield WWTP[1], Westfield	MA0101800	14 November 2001	6.1	Westfield River Segment MA32-05
The Maples, Worthington	MA0027871	22 September 1995	0.0023	Wards Stream Segment MA32-15
Renaissance Manor, Westfield	Under DEP (WRO) ACO	To be issued	0.01	Westfield River Segment MA32-06

WWTP = waste water treatment plant, POTW = publicly owned treatment works
Note: There are many past wastewater dischargers no longer operating, or discharging to the watershed: Massachusetts Turnpike Authority Sewage Disposal Pond, Western Massachusetts Hospital, Combined Sewer Overflow permits for Westfield, Agawam, and West Springfield.

[1]**Details on the status of upgrades at the Westfield WWTP and summary of permit limits**:
The Westfield WWTP is an activated sludge secondary treatment facility, currently under a construction upgrade to increase its wastewater collection system service area to provide treatment for increased wastewater flows. According to the MA DEP Western Regional Office all the upgrades were expected to be completed by November 2004. The permit was reissued 27 September 2000 by MA DEP and USEPA and substantially modified 14 November 2001 to reflect permit limits once the upgrades are on- line. The cost of this upgrade project is between 14 and 15 million dollars. The existing WWTP is being upgraded from a 4.0 MGD to a 6.1 MGD rated capacity treatment plant. The proposed expansion includes: construction of a new aerated grit chamber and aeration tank, new primary and secondary settling tanks, new chlorine contact tank, new blower and sludge processing buildings, new effluent pump station, modifications to various existing facilities such as chemical storage, and work platforms. A special note here regarding the existing facility is that it consists of one grit chamber, two primaries, two aeration tanks, two secondary tanks, chlorine contact chamber with dechlorination. The two existing aeration systems (currently mechanically aerated) will be converted to fine bubble diffusers. Additionally, a third backup aeration system (fine bubble diffuser) will be constructed.

Effluent permit limits before upgrade completion include: an average monthly flow of 4.0 MGD; average monthly/weekly/daily limitations, BOD and TSS, in mg/l; 30/45/report, and lbs/day, 1000/1500; Fecal Coliform, cfu/100ml, 200 (average monthly)/ 400 (maximum daily); Total Residual Chlorine in mg/l, 0.12 (average monthly)/ 0.20 (maximum daily); Total Copper in mg/l, 0.035 (average monthly)/ 0.05 (maximum daily); Total Nickel in mg/l, 0.20 (average monthly)/ 1.81 (maximum daily). Phosphorous, NH3, Nitrite + Nitrate, and TKN are all report in mg/l (average monthly).

Effluent permit limits after the upgrades are on-line include: an average monthly flow of 6.1 MGD; average monthly/weekly/daily limitations, BOD and TSS, November 1 to May 31 each year, in mg/l: 30/45/report, and lbs/day, 1530/2290, June 1 to October 31 each year, in mg/l, 20/30/report, and lbs/day, 1000/1500/report; Fecal Coliform, cfu/100ml, 200 (average monthly)/ 400 (maximum daily); Total Residual Chlorine in mg/l, .055 (average monthly)/ .095 (maximum daily); Total Copper in mg/l, .0167 (average monthly), .0225 (maximum daily); Total Nickel in mg/l, .094 (average monthly), report (maximum daily); Cadmium in mg/l, .0006 (average monthly), .0031 (maximum daily); Total Aluminum in mg/l, report (average monthly); Total Ammonia Nitrogen, as N, June 1st to October 31st , in mg/l, 3 (average monthly), 5 (average weekly), report (daily maximum). Total ammonia-nitrogen as N (November 1st to May 31st report in mg/l (average monthly). Total phosphorus (June 1st to October 31st (1.0 mg/l average monthly) and report (maximum daily). Chlorination is utilized at a minimum, yet adequate level, as a disinfection process. Whole Effluent Modified Acute, and Whole Effluent Chronic Toxicity Testing is required 4 times per year with daphnid (Ceriodaphnia dubia), with maximum Modified Acute allowable limits of $LC_{50}\geq$100% effluent, and maximum Chronic allowable limits of CNOEC$\geq$20% maximum daily. Chlorination/dechlorination will continue to be utilized as a disinfection process.

Table H2. Westfield River Watershed NPDES Industrial Wastewater Discharge Facilities.

Permitee	NPDES #	Issuance	Flow (MGD)	Type of Discharge	Receiving Water (Segment)
Northeast Utilities	MA0035556	29 September 1998	Report Quarterly	Turbine and Thrust Bearing cooling water, trench/drain, NCCW	Little River MA32-36
Texon USA	MA0005282	12 November 1999	0.8	Process Wastewater, Floor drainage, NCCW	Westfield River MA32-05
NPDES General Permits:					
Austin Brook Reservoir Slow Sand Water Filtration Plant	MAG640035	13 December 1995	N/A	Sand media filtered water	Austin Brook Reservoir, Walker Brook MA32-20
City of Springfield, Water Treatment Plant	MAG640023	30 January 2001	0.991 maximum	Filter backwash (West Parish Filters)	Cooks Brook to the Little River MA32-36
City of Westfield, Water Treatment Plant	MAG640001	22 November 2001	0.33 maximum	Effluent	Jack's Brook to the Little River MA32-08
Fiber Mark DSI, Inc.	MAG250966	30 July 2000	Ceased operation June 2002	Non Contact Cooling Water (NCCW)	Westfield River MA32-07
Jen-Coat Inc.	MAG250856	18 June 2001	0.028 monthly	NCCW	Westfield River MA32-05

Note: There are many industrial dischargers (both major and minor) who are not currently operating, or discharging to the watershed. This list includes: Columbia Manufacturing Co., Decorative Specialties Inc., General Abrasive Division, Inc., Micro Abrasives, Inc., Strathmore Paper Co., Stevens Paper Mills Inc., Upper Mill, Lower Mill, and Westfield River Paper Co.

Table H3. Westfield River Watershed NPDES Phase II Stormwater Communities.
All permits expire 1 May 2008.

Town	NPDES Permit Number	Permit Issued Date	Mapped Regulated Area in Community
Agawam	MAR041001	08/22/2003	Partial
Holyoke	MAR041011	10/02/2003	Total
Southampton	MAR041021	10/03/2003	Partial
Southwick	MAR041022	01/08/2004	Partial
West Springfield	MAR041024	09/18/2003	Total
Westfield	MAR041236	09/26/2003	Total

Table H4. Westfield River Watershed FERC Projects.

Project Name	Project Number	Owner Name / Issuance date	Receiving Water (Segment)	Kilowatts
Woronoco	2631	Woronoco Hydro LLC/ Permit issued 4/30/02	Westfield River Segment MA32-05	2,700 KWh
West Springfield Hydroelectric	2608	A & D Hydro, Inc./Permit issued 24 October 1994	Westfield River Segment MA32-07	1.4 MWh

Table H5. Westfield River Watershed FERC-exempt Projects.

Project Name	Project Number	Owner Name / Issuance date	Receiving Water (Segment)	Kilowatts
Crescent Hydroelectric Project (Texon Project)	2986A	Littleville Power Company Inc.	Westfield River Segment MA32-05	1500 KWh
Knightville Dam	9895X	U.S. Army Corps of Engineers/ applied for FERC 1986, denied 25 February 1986	Westfield River Segment MA32-04	963 KWh (potential)
Littleville (Dam) Lake	8350X	U.S. Army Corps of Engineers/ issued as FERC 24 March 1986, surrendered 15 June 1988	Westfield River Segment MA32-03	1060 KWh (potential)

Table H6. Westfield River Watershed NPDES Industrial Storm Water Permits.

Note: All towns identified (except Russell) are only partially located in the Westfield River Watershed; therefore receiving waters from these facilities may not be located in the Westfield River Watershed.

Permitee	NPDES #	Issuance	Location
Atlas Founders	MAR05B956	01/25/2001	Agawam
Berkshire Power LLC	MAR05C154	01/31/2001	Agawam
HP Hood Inc	MAR05C091	01/29/2001	Agawam
Pioneer Valley Resource Recovery	MAR05B972	01/27/2001	Agawam
Roberts Bros Lumber Co Inc	MAR05B951	01/25/2001	Ashfield
Becket Transfer Station	MAR05C472	03/07/2003	Becket
Berkshire Hardwoods Inc	MAR05B820	01/17/2001	Chesterfield
Highway Department Garage	MAR05C459	03/04/2003	Granville
Transfer Station	MAR05C460	03/04/2003	Granville
City of Holyoke WWTP	MAR05C561	07/02/2003	Holyoke
Hampden Papers Inc	MAR05C229	04/09/2001	Holyoke
Hampden Papers Inc	MAR05C230	04/09/2001	Holyoke
Hazen Paper Company	MAR05B689	12/27/2000	Holyoke
Holyoke Gas & Electric Department	MAR05B765	01/11/2001	Holyoke
Kodak Polychrome Graphics	MAR05B851	01/22/2001	Holyoke
Marox Corporation	MAR05C584	10/17/2003	Holyoke
William F Sullivan Co Inc	MAR05B799	01/19/2001	Holyoke
Texon Usa	MAR05B679	12/20/2000	Russell
Bob's Auto Salvage	MAR05B754	01/09/2001	Southampton
The Lane Construction Corp	MAR05C242	04/24/2001	Southwick
Tolland DPN	MAR05C482	03/06/2003	Tolland
Barnes Air National Guard Base	MAR05C225	02/01/2001	Westfield
Cersosimo Lumber Co Inc	MAR05B916	01/24/2001	Westfield
Columbia Manufacturing Inc	MAR05C251	05/02/2001	Westfield
Day Lumber Corp	MAR05C218	03/14/2001	Westfield
International Paper	MAR05B904	01/24/2001	Westfield
Jen Coat Inc	MAR05B629	12/07/2000	Westfield
Mestek Inc	MAR05C002	01/26/2001	Westfield
Mestek Inc	MAR05C159	02/01/2001	Westfield
Son Inc., Plant No 1	MAR05C356	03/15/2002	Westfield
Stone Container Corp	MAR05B775	01/04/2001	Westfield
The Lane Construction Corp	MAR05C239	04/24/2001	Westfield
The Lane Construction Corp	MAR05C243	04/24/2001	Westfield
Westfield Coatings Corp	MAR05B678	12/20/2000	Westfield

Table H7. List of WMA registered and permitted average annual water withdrawals in the Westfield River Watershed (LeVangie 2002).

Permit	Registration	PWSID	System Name	Registered Volume (MGD)	20 Year Permitted Volume (MGD)	Source (G = ground S = surface)	Well/Source Name	Withdrawal Location Segment
9P10427902	N/A	N/A	Old Farm Golf Club, Inc	N/A	0.15		Lake A Lake D Well #2 Well #4	MA32-08
9P210432901	N/A	N/A	John S. Lane & Son Inc.	N/A	0.65		Westfield River	MA32-05
9P210425603	N/A	N/A	Texon USA	N/A	0.72		Intake on Westfield River	MA32-05
N/A	10413701	1137000	Holyoke Water Works	1.01	N/A	1137000-01G	Driven Wells	MA32-24
						1137000-03S 1137000-01S	McLean Reservoir Ashley Pond Reservoir	MA32-29
N/A	10414301	1143000	Huntington Water Department	0.12	N/A	1143000-01S 1143000-01G 1143000-02G	Cold Brook Reservoir Well #1 Well #2	MA32-01
9P210425602	10425601	1256000	Russell Water Department	0.29	N/A	1256000-01S 1256000-01G 1256000-02G	Black Brook Reservoir Well #1 Well #2	MA32-21 MA32-21 MA32-05
9P10427901	10427905	1279000	Southwick Water Department	0.45	0.28	1279000-01G	Well #1 Great Brook	MA32-25
N/A	10428101	1281000	Springfield Water and Sewer Commission	37.2	N/A	281-03S	Littleville Lake Reservoir	MA32046 and MA32-03
						281-02S	Cobble Mountain Reservoir	MA32018 and MA32-35
						281-04S	Borden Brook Reservoir	MA32011
N/A	10432501		Southworth Company	0.15	N/A		Westfield River	MA32-07
N/A	10432502		DSI - West Springfield	0.11	N/A		Westfield River - Canal	MA32-07
9P10432501	10432503	1325000	West Springfield Water Department	3.89	2.82	1325000-01S	Bearhole Reservoir	MA32-29
						1325000-01G 1325000-02G 1325000-03G 1325000-04G	Southwick Well #1 Southwick Well #2 Southwick Well #3 Southwick Well #4	MA32-25
N/A	10432901	1329000	Westfield Water Department	6.11	N/A	1329000-01G 1329000-07G 1329000-08G	Well #1 Well #7 Well #8	MA32-24
						1329000-01S	Montgomery Reservoir	MA32-23
						1329000-05G 1329000-06G 1329000-02S	Well #5 Well #6 Granville Reservoir	MA32-36
						1329000-02G	Well #2	MA32-05
						1329000-03G 1329000-04G	Well #3 Well #4	MA32-25

APPENDIX I

MA DEP GRANT AND LOAN PROGRAMS

Excerpted from MA DEP's World Wide Web site http://www.mass.gov/dep/brp/wm/projsums.htm.

604(b) WATER QUALITY MANAGEMENT PLANNING GRANT PROGRAM

This grant program is authorized under the federal Clean Water Act Section 604(b) for water quality assessment and management planning.

No recent 604(b) grants have been awarded within the Westfield River 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. 104(b)(3) projects in the Westfield River Watershed include the following.

- 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 subecoregion difference in stream biota, if any, and to 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.

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. 319 projects in the Westfield River Watershed include the following.

- 00-14/319 *Forestry BMP implementation monitoring Protocol Project*. The purpose of this project is to develop a forestry BMP monitoring protocol for use in evaluating and monitoring the effectiveness of BMPs in controlling NPS pollution, in conjunction with forest harvesting operations conducted under the state's Forest Cutting Practices Act, Ch. 132 s. 40-48. Tasks include development of assessment methods to evaluate the effectiveness of BMPs contained in the Massachusetts BMP Manual, which are required in the MA Forest Cutting Practices Regulations. This will result in the development of performance standards for forestry BMPs. A draft field manual will be developed explaining the measurement and interpretation procedures. Field surveys on completed harvests in the Westfield watershed will be conducted to test the monitoring protocol, and the manual will be adjusted based on those findings.

  The project is consistent with Forestry Actions/Implementation efforts outlined in the Massachusetts Nonpoint Source Management Plan, Volume 1, p. 46. As forestry activity is generally regarded to be a source of nonpoint source pollution, particularly phosphorous, the development of performance standards and rigorous investigation into the effectiveness of forestry BMPs will greatly enhance efforts to implement TMDLs in forested watersheds.

- 02-03/319 *Stormwater Management on the Middle Pond of the Congamond Lakes*.
  The purpose of this project is to address the quality of street runoff entering Middle Pond of the Congamond Lakes from the Berkshire Avenue sub-basin drainage area. A diagnostic / feasibility study conducted in 1983 recommended stormwater management measures, including structural BMPs as well as watershed controls for source reduction of pollutants.

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. Source Water Protection projects in the Westfield River Watershed include the following.

- 99-05/SWT *Granville Reservoir Source Water Protection Project*. This project will develop a Surface Water Supply Protection Plan for the Granville Reservoir, which provides approximately 60% of the water requirements for Westfield. As development encroaches on crucial areas in the watershed, a completed plan will provide guidance and implementation tools for the Town of Granville to use in protecting its water supply.

- 00-04/SWT *Granville Source Water Protection Project.* This project will conduct a Household Hazardous Waste and Hard to Dispose of Materials Collection (HHW/HDMC), update the Town of Granville's Open Space Plan, and coordinate area aquifer protection efforts. An updated Open Space Plan and the coordination of protection efforts will permit the Massachusetts communities of Granville, Springfield, and Westfield, and the Connecticut Metropolitan District to formally exchange information on potential threats to water supplies as well as current efforts to acquire open space and conservation lands.

- 00-05/SWT *Austin Brook Reservoir Source Water Protection Project*. The project will develop a comprehensive Surface Water Supply Protection Plan, land use inventory, and education program for the Town of Chester. The Plan will inventory and assess potential threats and existing impacts in the Austin Brook Reservoir and Horn Pond watersheds, and provide strategic planning guidance and implementation tools for use in protecting these water supplies. The Plan also will include provisions for watershed areas in the adjacent town of Becket, parcel-based land use GIS maps, and an emergency response component. This project will be conducted in concert with the Department's SWAP program.

- 01-05/SWT *Westfield Source Water Protection Project*. This project will develop a Forest Management Plan for the city of Westfield's Granville Reservoir watershed. This project will inventory forested watershed lands and incorporate forestry management strategies to ensure safe water supplies for the future. The maintenance of a diverse, healthy forest cover throughout the watershed can help protect reservoir water quality.

- 01-09/SWT *West Springfield Source Water Protection Project*. This project will inventory forested watershed lands, prescribe management of the protection/infiltration forest, and develop a public education brochure for the town of West Springfield's Bear Hole Reservoir watershed. The maintenance of a diverse, healthy forest cover throughout the watershed can help protect reservoir water quality. The educational brochure will improve the water consumer's understanding of the importance of watershed management for water quality protection and will be distributed to water consumers, schools, garden clubs, and town government offices. This project will be conducted in concert with the Department's Source Water Assessment Program.

- 02-09/SWT *West Springfield Source Water Protection Project.* This project will develop an Interior Roadway Improvement Plan for West Springfield's Bear Hole Reservoir. This project will identify nonpublic roadway problem areas that may compromise the quality of drinking water, located in the watershed within ½ mile of the reservoir and Paucatuck Brook and provide recommendations for roadway improvements relative to watershed patrolling (e.g., restricting public access while improving roadway conditions for routine inspections and patrolling of watershed area).

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. Wellhead Protection projects in the Westfield River Watershed include the following.

- 99-02/WHP *Huntington Wellhead Protection Project*. This project will develop a Wellhead Protection Plan and construct a new storage facility for water treatment chemicals in the Zone I of wells #1 and #2. Relocating and upgrading the storage facility will ensure that liquid chemicals cannot contaminate the nearby wells in the event of a spill. Development of a Wellhead Protection Plan will also include an Emergency Response component for potential or accidental spills on nearby state Route 20 and an adjacent railroad line.

- 01-13/WHP *Russell Wellhead Protection Project*. This project will develop a comprehensive Wellhead Protection Plan as per Department guidance, and install fencing around the pump house for the town of Russell water supply. Wellhead protection efforts will include a public education and outreach program.

- 02-08/WHP *Cummington Wellhead Protection Project*. This project will develop a Wellhead Protection plan for the four drinking water wells operated by the two water departments in the town of Cummington, install security systems for West Cummington pump house and Center Well pump house, and install chain-link fencing around the West Cummington pump house.

MASSACHUSETTS WATERSHED INITIATIVE PROJECTS

The Massachusetts Watershed Initiative (MWI) was a broad partnership of state and federal agencies, conservation organizations, businesses, municipal officials and individuals that protects and restores natural resources and ecosystems on a watershed basis. The primary goals of the Watershed Initiative was to: improve water quality; restore natural flows to rivers; protect and restore habitats; improve public access and balanced resource use; improve local capacity to protect water resources; and, promote shared responsibility for watershed protection and management. Projects funded under the MWI included hydrologic and water quality monitoring and assessment, habitat assessment, nonpoint source assessment, hydrologic modeling, open space and growth planning, technical assistance and outreach. MWI projects in the Westfield River Watershed include the following.

- 99-14 MWI *An Assessment of Water Quality Impairment in the Westfield River*. The purpose of this project is to identify and assess the causes and sources of water quality impairment in the Westfield River. This will include water quality sampling during dry and wet weather conditions and aquatic macroinvertebrate and periphyton assessments.

- 02-15 MWI *Pequot Pond Pollution Survey*. This project will identify the sources contributing to water quality impairment at Pequot Pond.

- 02-16 MWI *Pond Brook Nonpoint Source Remediation Project*. This project will implement structural and non-structural best management practices (BMPs) in the East Mountain Country Club areas of Pond Brook to remediate identified nonpoint source pollution contributing to water quality impairment.

- 03-27 MWI *Westfield Vegetative Buffer Implementation*. This project will work with landowners to implement buffer protection/restoration at selected sites in the Great Brook sub-watershed of the Westfield River Watershed.

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 SRF Program is jointly administered by the Division of Municipal Services of the MA DEP and the Massachusetts Water Pollution Abatement Trust. Each year the MA DEP solicits projects from the Massachusetts municipalities and wastewater districts to be considered for subsidized loans, which are currently offered at 50% grant equivalency (approximates a two percent interest loan). The SRF Program now provides increased emphasis on watershed management priorities. A major goal 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. Recent SRF projects specific to the Westfield Watershed include:

- 00-46 CW SRF Westfield WWTP upgrade and Expansion. The cost of this project is between 14 and 15 million dollars. The existing WWTP is being upgraded from a 4.0 MGD to a 6.1 MGD rated capacity treatment plant. The proposed expansion includes: construction of a new aerated grit chamber and aeration tank, new primary and secondary settling tanks, new chlorine contact tank, new blower and sludge processing buildings, new effluent pump station, modifications to various existing facilities such as chemical storage, and work platforms. A special note here regarding aeration is that the two current aerations (currently mechanical aerated) will be converted to fine bubble diffusers along with a third aeration tank.

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