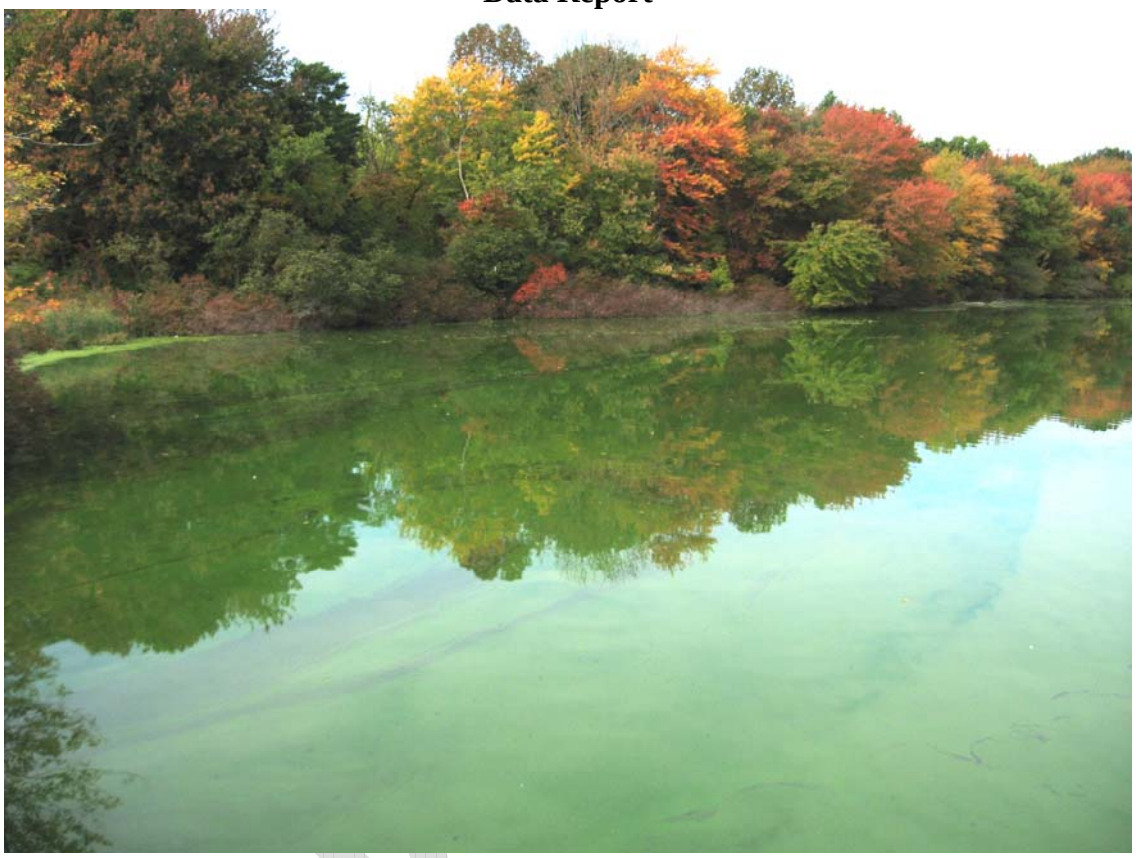
Surface Water Monitoring in the Ten Mile River Watershed

Data Report



Blue-green algae bloom in Central Pond. Photo taken on July 24, 2007.

State of Rhode Island
Department of Environmental Management
Office of Water Resources
Surface Water Protection Section

Draft Report

April 2011 (revised March 25, 2013)

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ABSTRACT
The Ten Mile River and its impoundments- Slater Park Pond, Central Pond, Turner Reservoir, and Omega Pond are all identified on the State of Rhode Island's 2008 303(d) list as being impaired for numerous parameters including cadmium (Cd), copper (Cu), lead (Pb), Total Phosphorus, fecal coliform bacteria dissolved oxygen, as well as impairments to the benthic macroinvertibrate community. As such, Total Maximum Daily Loads (TMDLs) are required for these waters under Section 303(d) of the Clean Water Act and USEPA's Water Quality Planning and Management Regulations (40 CFR Part 130).

Water quality monitoring was conducted in 2007 and 2008 in the Ten Mile River watershed to evaluate the existing water quality conditions under a range of hydrologic and atmospheric conditions. The goals of this monitoring were to: 1) document water quality conditions specific to the 303(d) pollutants of concern under varying hydrologic conditions, 2) utilize the information to assist with RIDEM's 2010 305(b) water quality assessments, and 3) collect sufficient data to develop TMDLs for specific waterbody segments within the Ten Mile River watershed.

This report summarizes water quality data collection activities carried out in the Ten Mile River watershed during 2007 and 2008. Water chemistry and bacteria data were collected at eight (8) stations throughout the mainstem and impoundments during seven (7) surveys in 2007 and two (2) surveys in 2008. Sampling was conducted under a variety of flow regimes including periods of low and high flow, as well as periods of rising and falling flows. Water samples were analyzed for nutrients (nitrate, nitrite, ammonia, TKN, total phosphorus), fecal coliform bacteria, and dissolved and total metals. In-situ measurements of dissolved oxygen (in mg/l and % saturation), specific conductance, and temperature were made at all stations during each survey. Streamflow and stage height were measured or estimated at a single station near the RI/MA border.

Ancillary monitoring activities included the collection of continuous dissolved oxygen, chlorophyll, and temperature data in 2007 with YSI 6600 multi-parameter water quality sondes. A single sonde was deployed at a fixed depth in Central Pond and two sondes were deployed at surface and depth stations in the Turner Reservoir. In addition, macroinvertebrate bioassessments were conducted at a single location in the Ten Mile River using EPA's Rapid Bioassessment Protocol (RBP).

An extensive and persistent cyanobacteria bloom occurred in Central Pond, Turner Reservoir, and Omega Pond during portions of the study (July through Nov 2007). Elevated levels of microcystin, a toxin produced by cyanobacteria, prompted DEM and the RI Dept. of Health to issue a temporary advisory warning people to avoid any recreational activities that would include contact with water. Details of this bloom are discussed in this report.

INTRODUCTION

The Ten Mile River, Slater Park Pond, Turner Reservoir, and Omega Pond are on the State of Rhode Island's 2008 303(d) List of Impaired Waters for several parameters (Table 1). These listings are based on historic data collected by numerous agencies including the US Geological Survey and RIDEM in 1998, University of Rhode Island Watershed Watch in 2000, and the Narragansett Bay Commission in 2000 and 2001.

Table 1. 2008 303(d) Listings in the Ten Mile River Watershed.

Waterbody	Waterbody Segment ID	2008 303d Listings
Ten Mile River	RI0004009-10A	Cd, Cu, Pb, non-native aquatic plants
Slater Park Pond	RI0004009L-02	TP, fecal coliform
Turner Reservoir (Central Pond)	RI0004009L-01A	Cu, Pb, dissolved oxygen, TP, fecal coliform
Turner Reservoir	RI0004009L-01B	Cu, Pb, dissolved oxygen, TP, fecal coliform
Ten Mile River	RI0004009-01B	Cu, Pb, benthic-macroinvertebrate, bioassessments
Omega Pond	RI0004009L-03	Cu, Pb, TP

Purpose and Scope

To supplement existing water quality data and aid in the development of TMDLs for these waterbodies several data collection activities were scheduled for 2007 and 2008. The primary objectives of these activities were to document water quality conditions under varying hydrologic conditions and confirm or refute the present (2008) 303d listings. Targeting wet weather events and sampling during the "first flush" was not an objective of this monitoring program. Specific objectives include:

- Evaluating waterbodies for support of designated uses, determine if State surface water quality standards are being met for specific pollutants, and evaluate the level of waterbody impairment.

- Providing quality-assured data for the purposes of developing TMDLs for dissolved metals, nutrients, and pathogen-impaired waterbody segments within the watershed.

Data collection activities included:

- Collection of chemical and physical data from surface waters at eight (8) locations during nine (9) separate surveys.

- Continuous monitoring of dissolved oxygen, temperature, and chlorophyll in surface and bottom waters of the Turner Reservoir and in surface waters of Central Pond and,

Watershed Characteristics

The Ten Mile River watershed is located in southeastern Massachusetts and a small portion of northeastern Rhode Island (Figure 1). It is the smallest of the 27 major watersheds in Massachusetts with a total drainage area of approximately 54 square miles (140 km^2). Originating in Savage's Pond in Plainville, Mass, the stream flows generally southwest through North Attleborough, Attleboro, and Seekonk to Pawtucket and East Providence, Rhode Island where it turns northwest and empties into the Seekonk River. The total length of the river is 22 miles (35.4 km), of which 15 miles (24 km) are in Massachusetts. The elevation of the riverbed drops from 230 feet (70 m) above mean sea level at the source to approximately thirteen feet (4 m) prior to flowing over the Omega Pond Dam.

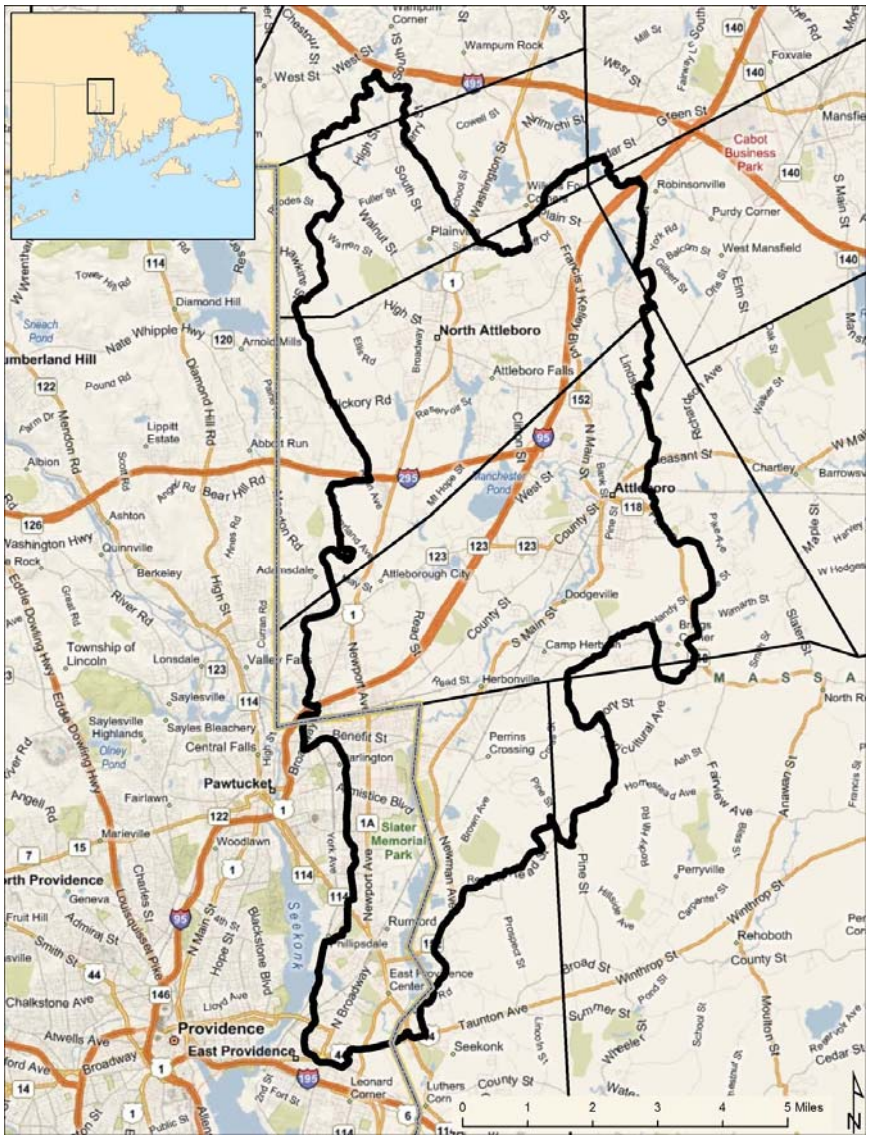

Figure 1. Ten Mile River watershed.

Land Use and Historic Water Quality Issues

Land Use in the basin is shown in Figure 2. Land use in the Massachusetts portion of the watershed is predominantly residential and forestland with some commercial uses. Within the Rhode Island portion, land use is primarily high density residential and commercial/industrial uses.

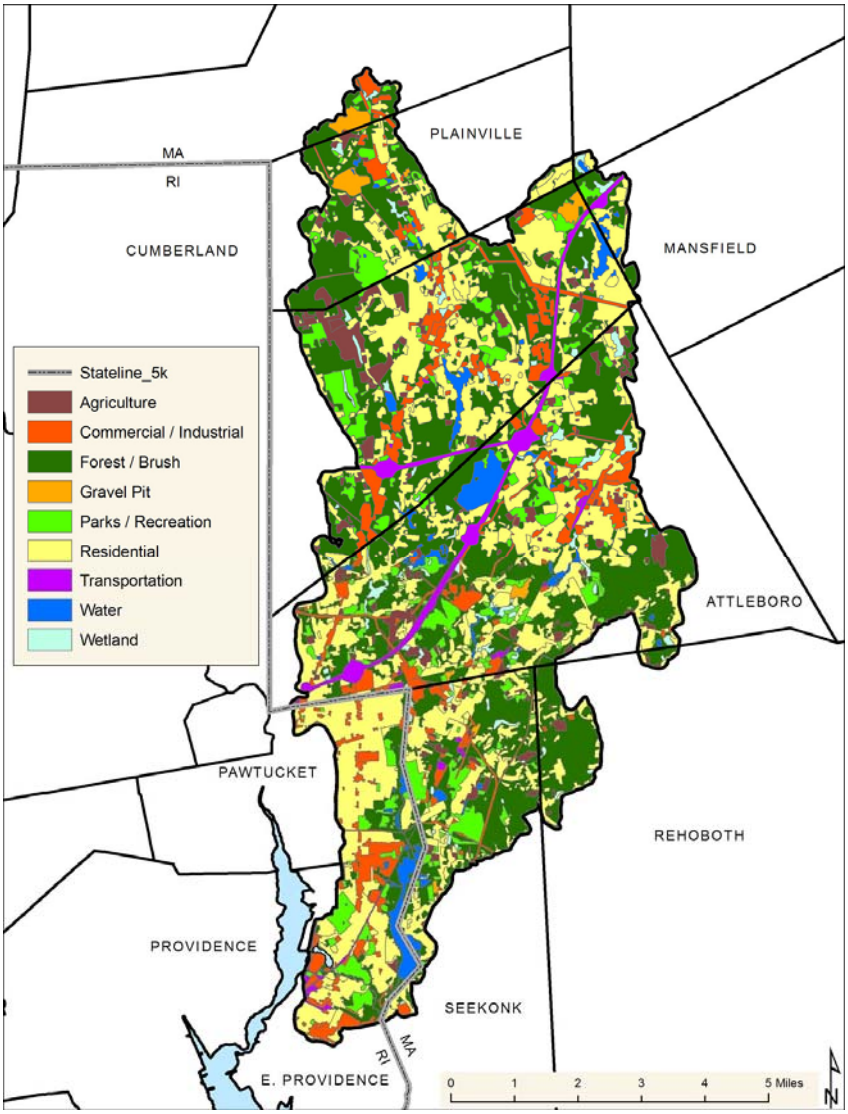

Figure 2 Land Use in the Ten Mile River watershed.

Water quality problems in the Ten Mile River watershed date back at least to the early twentieth century. During the period of colonial settlement and industrialization, the river was used as a prime energy source for manufacturing industries. This resulted in severe pollution in many parts of the river by the 1900's. Sewage treatment plants constructed after the Clean Water Act of 1972 have helped clean the river to some extent. Attleboro and North Attleboro comprise the urban core of the watershed that, at the turn of the century, supported a diversified mix of industries led by jewelry, plating and textiles. As a result of the increased levels of industrial use and residential development, the Ten Mile River was grossly polluted by the mid 1900s.

The communities in the watershed have long been manufacturing centers, with many industries which use water for process and for waste disposal. Because of the water-oriented industry, the development of the basin has followed the course of the river. Most of the population centers in the communities in the basin are located along the river. As a result of this development, several types of wastes, including sewage, industrial wastes, and urban runoff, are produced in concentrated areas of the river.

Water quality in the river has improved since the construction of two wastewater treatment plants- North Attleboro WWTF and Attleboro WWTF. However, the nutrient enrichment and elevated levels of metals in the water column and sediments continue to impact the basin's biological communities and diminish its recreational potential. In Massachusetts, The Ten Mile River and nearly all its tributaries are designated as Class B waters (fishable, swimmable). Only the Four Mile Brook and the upper reach of the Seven Mile River are designated as Class A "outstanding resource" waters (ORWs). The entire Seven Mile River is listed on the state impaired waters list as not meeting surface water quality standards. Also included on the list is the entire length of the Ten Mile River, Speedway Brook, Dodgeville Pond, and four other ponds pending confirmation. Overall, the watershed is largely urbanized and densely developed, however parts of the upper Seven Mile, the Bungay and Chartley Brook sub-watersheds remain sparsely developed and contain significant amounts of forest and open space.

Hydrology

The Ten Mile River's headwaters begin in Plainville and the river flows south through many impoundments before flowing into the Seekonk and Providence Rivers and ultimately Narragansett Bay. The Ten Mile River has two major tributaries, the Sevenmile River and the Bungay River. The Sevenmile River begins in North Attleborough, flows south through Attleboro and joins the Ten Mile River in Seekonk. Unnamed tributaries to the Bungay River originate in the Town of Foxborough and flow south into Greenwood Lake located in Mansfield and North Attleborough. The Bungay River originates at the outlet of Greenwood Lake and flows south to join the Ten Mile River in Attleboro.

The Ten Mile River picks up flow from two major tributaries, the Seven Mile River and the Bungay River, both located in Attleboro. Flow is highly restricted, with various dams creating a total of 15 impoundments. These impoundments comprise almost half the length of the river. During periods of low flow, wastewater discharge flows can

significantly alter the flow rate and water quality of the Ten Mile River and its impoundments.

The watershed contains 50 lakes and ponds, many of which are along the main channel of the Ten Mile River. Twenty seven of the lakes in the basin have areas of 10 acres or more. The principal aquifers in the Ten Mile River Basin are stratified-drift deposits in valleys and lowlands. These aquifers are hydraulically connected to surface-water bodies and underlie about one-half of the basin. Many dams were built along the river, and, for much of its length, the river flows through impoundments or is confined by concrete or masonry retaining walls (Simcox, 1992). The river altitude in the basin decreases mostly at the dams

The US Geological Survey (USGS) operates a single gaging station (01109403) in the Ten Mile River (http://waterdata.usgs.gov/nwis/uv?01109403). The gage is located downstream of the Turner Reservoir and at the same location as station TM6 (Pawtucket Avenue- East Providence, RI). The period of record is from October 1986 to the current year. The calculated mean daily flow for the Ten Mile River at station 01109403 is 109 cfs and the 7Q10 flow is 19 cfs. Historical discharge, expressed as daily mean flow, is presented in Figure 3.

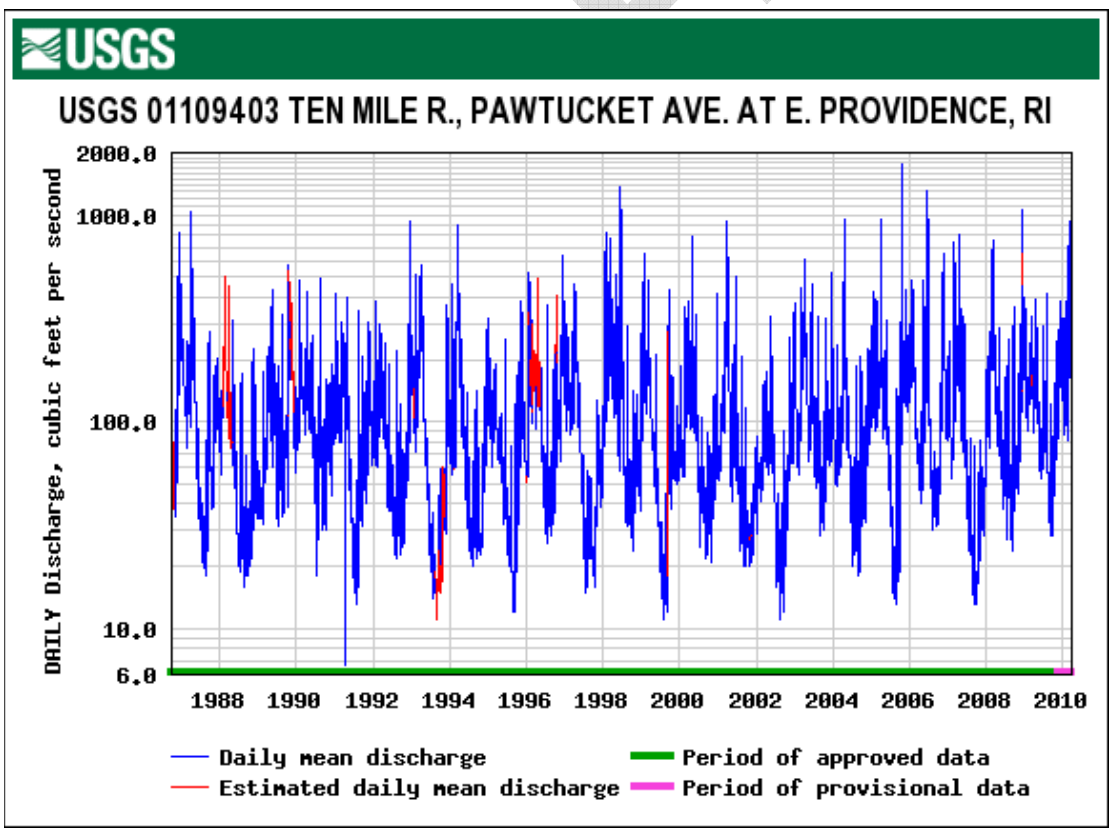

Figure 3. Historical discharge at USGS gage 01109403 on the Ten Mile River.

Wastewater Treatment Plants

Two wastewater treatment facilities, both located in Massachusetts, discharge directly to the Ten Mile River. The North Attleborough Wastewater Treatment Facility (WWTF) is located on Cedar Road in North Attleborough, Massachusetts. The facility collects and treats an average of 3.1 million gallon per day of industrial and domestic wastewater from the Town as well as the Town of Plainville. It has a permitted annual average capacity of 4.61 mgd. Treatment facilities at the plant include screening, aerated grit chambers, primary clarifiers, first-stage aeration tanks and clarifiers, second-stage aeration tanks and clarifiers, gravity sand filters, chlorine contact tanks, dechlorination facilities, and post aeration tanks. Sludge handling facilities include flotation thickeners and centrifuges.

Flow to the facility includes wastewater from two influent sewers and septage. The headwork's of the facility provides screening, grit removal, commutation and chemical addition for phosphorous removal in the primary clarifiers. Two-stage mechanical aeration provides for biological treatment of Biochemical Oxygen Demand (BOD) and nitrogenous wastes. The gravity sand filters provide final polishing of the effluent. Chlorine is injected into the effluent to destroy pathogens. The effluent is then de-chlorinated to eliminate any chlorine by products that could have a toxic effect on organisms that inhabit the river. The post aeration tank is provided to maintain adequate dissolved oxygen levels in the effluent to support aquatic life in the river. Sludge handling is accomplished by thickening the sludge in the thickeners to approximately 5% solids and is then trucked off site for further treatment and disposal. Seasonal and annual average maximum month data from 2004 through 2006 are summarized in Table 2.

The Attleboro Water Pollution Control Facility (WPCF) is located at 27 Pond Street North in Attleboro, Massachusetts. The Attleboro WPCF discharges to the Ten Mile River about 200 yards from the Rhode Island border. It has a permitted annual average capacity of 8.6 mgd and serves the City of Attleboro with some septage collected from portions of North Seekonk and Attleboro. Seasonal and annual average maximum month data from 2004 through 2006 are summarized in Table 3.

Table 2. North Attleboro WWTF 2004-2006 monthly average discharge data.

NORTH ATTLEBOROUGH WWTF
North Attleborough, Massachusetts
Monthly Averages 2004-2006

GENERAL		INFLUENT							EFFLUENT						
DATE		INF	pH	BOD	TSS	TN	NH3	Temp	DO	pH	BOD	TSS	F. COLI	NH3	TN
Month	Year	MGD		mg/L	mg/L	mg/L	mg/L	Deg C	mg/L		mg/L	mg/L	# / 100ml	mg/L	mg/L
January	2004	4.406516	7.06	101	118	17.6	14.4	11.2	7.0	6.92	10.75	5.06	8	5.75	9.6
February	2004	3.514828	7.04	125	154	29.2	15.7	10.3	7.1	6.94	9.09	2.87	10	7.69	15.7
March	2004	3.467968	7.13	111	145	25.5	14.5	10.7	7.1	7.02	8.23	2.37	0	8.40	18.50
April	2004	6.5454	6.70	57	102	14.1	7.4	11.1	7.7	6.74	15.59	19	410.0	1.03	6.30
May	2004	4.187645	6.88	83	136	14.8	10.7	13.9	7.8	6.83	9.08	10.96	2.4	0.35	5.90
June	2004	3.1083	7.06	128	187	21.0	13.0	16.2	7.6	6.75	4.90	5.77	0.9	0.20	9.40
July	2004	2.797419	7.10	120	189	21.3	14.7	18.3	7.4	6.89	3.25	3.08	0.4	0.09	9.60
August	2004	3.045129	7.04	115	167	24.5	13.7	19.0	7.1	6.94	3.80	3.03	1.3	0.02	10.10
September	2004	3.091067	7.10	103	162	24.1	14.3	19.0	7.3	6.94	3.55	3.28	6.4	0.01	9.90
October	2004	3.122548	7.19	131	169	19.6	16.1	17.9	7.7	6.90	2.49	1.74	1.2	0.03	8.40
November	2004	3.109233	7.16	144	189	22.6	14.0	15.7	7.9	6.82	2.94	2.25	2.2	0.25	7.50
December	2004	4.691871	6.88	101	138	22.0	10.5	13.6	8.5	6.70	4.25	2.85	13.8	0.41	2.10
January	2005	5.539323	6.75	87	121	16.6	9.1	11.3	9.0	6.65	3.47	2.76	18.9	0.22	3.30
February	2005	4.864107	6.81	94	121	26.2	10.6	10.7	9.1	6.64	4.65	4.11	115.8	0.23	7.50
March	2005	5.224968	6.82	78	116	15.2	10.3	10.1	8.6	6.67	10.55	11.51	19.7	0.50	6.90
April	2005	5.4946	6.71	87	94	8.2	8.8	11.4	8.0	6.65	5.69	4.43	6.8	0.25	5.70
May	2005	4.359871	6.83	100	135	18.9	8.3	13.3	7.9	6.64	4.08	2.59	10.4	0.07	6.10
June	2005	3.229467	6.96	118	156	21.6	11.7	15.8	7.3	6.75	3.47	1.84	1.1	0.21	7.80
July	2005	2.724516	7.06	137	172	20.3	14.6	17.8	6.9	6.88	3.88	2.18	0.8	0.12	9.8
August	2005	2.590419	7.13	167	199	29.5	16.3	19.1	7.1	6.95	2.19	0.85	2.5	0.01	6.1
September	2005	2.889	7.09	152	206	24.6	16.3	19.8	7.4	6.85	1.97	1.23	1.4	0.03	6.9
October	2005	5.922	6.94	103	130	36.2	10.5	17.8	8.2	6.87	4.30	5.61	169.3	0.16	6.8
November	2005	5.138	6.81	112	135	10.1	9.8	15.7	8.5	6.87	2.04	0.87	1.5	0.05	7.8
December	2005	5.100	6.86	103	136	17.8	11.2	12.7	8.3	6.84	5.57	3.66	6.5	0.22	5.3
January	2006	6.071	6.69	82	108	13.8	8.9	11.8	7.5	6.72	4.66	2.66	76.2	0.31	6.90
February	2006	5.234	6.82	109	122	16.0	9.5	11.0	7.9	6.75	6.48	3.19	10.3	0.32	4.70
March	2006	3.163	7.05	172	199	25.9	16.6	11.0	7.9	6.75	12.10	5.98	23.5	2.17	9.20
April	2006	2.935	7.11	199	234	47.9	17.1	12.4	7.9	6.85	8.90	6.63	37.6	0.99	4.30
May	2006	4.938	6.92	119	142	31.6	11.1	13.5	8.1	6.84	3.53	2.70	0.9	0.25	12.40
June	2006	6.894	6.71	68	95	13.9	7.5	15.1	7.5	6.81	10.14	17.09	33.7	0.33	4.10
July	2006	3.932	6.98	116	170	20.8	12.8	17.7	7.5	6.82	2.36	0.56	0.2	0.22	5.1
August	2006	3.018	7.12	154	189	37.1	15.5	19.5	6.9	6.87	1.27	0.04	2.1	0.01	9.2
September	2006	3.126	7.14	169	206	29.6	16.0	19.0	7.6	6.79	1.42	0.91	6.0	0.14	10.0
October	2006	3.548	7.11	143	172	20.0	16.0	18.0	8.2	6.80	0.96	0.33	8.8	0.05	1.4
November	2006	6.070	6.82	99	119	26.0	10.1	15.7	7.8	6.81	1.18	0.43	0.5	0.13	8.9
December	2006	4.019	6.96	151	142	20.7	13.6	14.1	8.0	6.83	1.59	0.13	0.5	1.39	6.6
Min. Month		2.59	6.69	57	94	8.2	7.4	10.09	6.91	6.64	0.96	0.04	0.00	0.01	1.40
Seasonal Average		**3.70**	**7.02**	**124**	**166**	**23.9**	**13.3**	**17.25**	**7.53**	**6.84**	**3.70**	**3.54**	**13.88**	**0.13**	**7.72**
Average		**4.20**	**6.96**	**118**	**152**	**22.4**	**12.5**	**14.75**	**7.76**	**6.81**	**5.12**	**4.03**	**28.09**	**0.91**	**7.66**
Max. Month		6.89	7.19	199	234	47.9	17.1	19.76	9.09	7.02	15.59	19.49	410.00	8.40	18.50

Table 3. Attleboro WWTF 2004-2006 monthly average discharge data.

ATTLEBORO WWTF

Attleboro, Massachusetts

Monthly Averages 2004-2006

GENERAL		INFLUENT						EFFLUENT							
DATE		INF	pH	BOD	TSS	NH4	Temp	DO	pH	BOD	TSS	F.COLI	TKN	NH4	TN
Month	Year	MGD		mg/L	mg/L	mg/L	Deg C	mg/L		mg/L	mg/L	# / 100ml	mg/L	mg/L	mg/L
January	2004	5.270	7.6	158	157	17.7	9.4	10.4	7.2	3.1	1.4	0	1.9	0.3	24.0
February	2004	4.803	7.6	184	170	18.2	9.4	10.4	7.3	2.4	1.3	1	1.9	0.1	18.0
March	2004	4.839	7.7	181	190	20.6	11.1	10.2	7.2	2.0	1.2	0	0.0	0.2	22.0
April	2004	7.033	7.3	143	141	14.7	10.0	9.8	7.2	3.0	2.2	1	0.6	0.3	0.6
May	2004	5.403	7.4	209	197	18.4	13.8	9.5	7.1	1.7	1.3	2	2.2	0.2	23.2
June	2004	4.905	7.5	196	222	19.5	17.2	8.6	7.1	1.5	1.1	0	0.6	0.3	24.6
July	2004	4.528	7.4	181	220	20.2	19.4	8.1	7.2	1.5	1.2	2	0.0	0.2	29.0
August	2004	4.071	7.3	191	186	23.2	21.1	7.9	7.1	1.6	1.7	1	1.5	0.6	34.5
September	2004	2.877	7.4	220	196	24.2	21.1	8.4	7.1	1.7	2.5	1	1.8	0.2	34.2
October	2004	2.683	7.5	210	218	23.2	18.9	9.3	7.2	1.4	1.0	0	1.5	0.1	33.5
November	2004	2.453	7.5	196	235	26.3	16.1	9.5	7.2	1.9	1.4	0	2.1	0.3	32.1
December	2004	3.009	7.4	176	182	21.0	12.8	10.0	7.3	1.8	1.1	1	1.1	0.2	20.1
January	2005	3.512	7.3	160	145	15.2	10.6	11.0	7.4	2.3	1.4	1	0.5	0.0	17.5
February	2005	3.498	7.4	164	138	17.0	9.4	4.5	7.2	2.4	1.1	0	1.4	0.4	23.4
March	2005	3.847	7.5	139	153	18.1	9.4	9.9	7.3	3.2	2.3	3	4.0	1.0	24.3
April	2005	4.774	7.3	141	136	12.7	11.1	9.7	7.3	2.3	1.7	1	0.0	0.2	15.0
May	2005	3.548	7.0	242	231	15.4	13.9	9.5	7.3	2.1	1.3	0	1.1	0.1	24.1
June	2005	3.251	7.5	210	232	17.5	17.8	9.1	7.3	1.4	1.5	11	1.6	0.0	17.6
July	2005	2.703	7.0	216	272	20.8	20.6	8.5	7.1	1.5	1.3	1	2.1	0.1	30.1
August	2005	2.779	7.4	276	273	34.5	23.3	8.1	7.4	1.7	1.8	1	2.4	0.1	16.4
September	2005	2.658	7.4	211	238	24.7	22.8	8.2	7.2	1.3	1.3	6	1.6	0.1	31.6
October	2005	4.604	7.4	146	170	16.2	20.0	8.7	7.4	1.6	2.3	2	0.0	0.1	29.0
November	2005	3.870	7.3	139	138	16.8	16.7	9.3	7.4	2.0	1.1	19	1.1	0.1	20.1
December	2005	3.412	7.4	150	124	17.3	13.9	10.6	7.5	2.9	1.6	945	1.0	0.0	17.0
January	2006	4.158	7.4	123	112	14.7	13.3	9.7	7.4	2.1	1.3	29	1.5	0.1	14.5
February	2006	3.613	7.4	154	131	18.8	12.8	9.6	7.3	3.0	2.6	66	2.7	3.3	12.7
March	2006	2.389	7.6	260	166	23.2	13.3	9.7	7.4	3.2	1.7	94	0.9	1.5	16.9
April	2006	2.493	7.6	230	240	27.5	15.0	9.3	7.5	4.0	6.3	2278	26.0	12.5	26.0
May	2006	3.670	7.5	208	210	18.7	16.1	9.2	7.4	2.9	3.0	97	1.0	0.0	17.3
June	2006	5.647	7.2	256	291	12.9	16.7	8.3	7.4	4.8	4.5	46	1.0	0.0	6.6
July	2006	3.581	7.3	291	307	13.2	18.9	8.3	7.5	1.4	1.0	26	1.7	0.0	14.7
August	2006	3.041	7.3	308	401	20.0	21.7	7.9	7.2	2.1	1.4	10	0.5	0.0	24.0
September	2006	2.574	7.4	224	255	39.6	20.6	8.5	7.3	1.8	1.4	15	1.4	0.0	22.4
October	2006	2.629	7.5	251	244	27.8	18.9	8.6	7.3	1.8	1.3	8	1.6	3.1	20.6
November	2006	3.872	7.4	162	167	18.4	16.7	8.8	7.6	2.4	3.5	49	2.8	3.5	20.8
December	2006	3.068	7.6	193	173	17.0	14.4	9.5	7.6	1.5	2.0	22	15.0	3.2	21.6
Min. Month		2.389	7.0	123	112	12.7	9.4	4.5	7.1	1.3	1.0	0	0.0	0.0	0.6
Seasonal Average		3.620	7.3	225	242	22	19	8.6	7.3	1.9	1.7	13	1.3	0.3	24.1
Average		3.752	7.4	198	203	20.1	15.8	9.1	7.3	2.2	1.8	104	2.4	0.9	21.7
Max. Month		7.033	7.7	308	401	39.6	23.3	11.0	7.6	4.8	6.3	2278	26.0	12.5	34.5

STUDY APPROACH AND METHODS

Sample Collection and Analysis

The study design is described in detail in the Ten Mile River Water Quality Sampling Plan (http://www.dem.ri.gov/pubs/qapp/tenmile.pdf). Staff from RIDEM collected water chemistry, bacteriological, and other physical data in the Ten Mile River and impoundments during a series of nine surveys. These surveys were conducted on the dates shown in Table 4.

Table 4. Sampling dates for 2007 and 2008.

Date-Year		
22-May-07	31-Jul-07	12-Sep-07
19-Jun-07	21-Aug-07	6-Mar-08
2-Jul-07	4-Sep-07	1-Aug-08

Sampling events in both 2007 and 2008 covered five (5) stations in the mainstem Ten Mile River and single stations each in Turner Reservoir, Slater Park Pond, and Omega Pond. Table 5 lists the sampling station name, description, and general type of data collected at each site. Figure 4 shows the geographic location of sampling stations and compliments Table 5. Laboratory parameters for each site are described in the Ten Mile River Water Quality Sampling Plan (RIDEM 2007), and methods are shown in Tables 6 and 7.

On a given sampling date, all eight stations were sampled over the course of a single day-typically beginning at station TM1 at 0900 hrs and ending at TM8 at approximately1400 hrs. All water quality samples collected for laboratory analysis were grab samples taken just below the water surface from the main body of flow (unless there was not enough depth to submerse the sample container). Samples were collected either by using an extension rod extended from the streambank or by wading into the river. A handheld YSI 85 Multiprobe was used to measure conductivity, temperature, and dissolved oxygen (both in mg/l and % saturation) at each station.

In-situ multi-parameter data loggers (YSI 6600) were deployed at different locations in the Turner Reservoir and Central Pond to collect continuous diel data for dissolved oxygen, temperature, and chlorophyll a. These data were used to assess diel changes in the parameters measured and specifically to confirm or refute the existing dissolved oxygen impairments for the Turner Reservoir and Central Pond.

Table 5.Ten Mile River sample sites, descriptions, and field and lab measurements.

Station	*Station Description*	*Type of Field Measurement(s)*
TM1	Ten Mile River at Central Avenue Bridge, Pawtucket, RI.	(Analytical-TP, NH_3-N, TKN, NO3, NO2, Total and dissolved metals, hardness, Fecal Coliform) **Multiprobe** (DO; Temperature; Specific Conductance) **Flow Measurement- Read Staff Gauge**
TM2	Slater Park Pond outlet at Armstice Boulevard Bridge, Pawtucket, RI.	(Analytical-TP, NH_3-N, TKN, NO3, NO2, Total and dissolved metals, hardness, Fecal Coliform) **Multiprobe** (DO; Temperature; Specific Conductance)
TM3	Ten Mile River at Slater Park, Pawtucket, RI.	(Analytical-TP, NH_3-N, TKN, NO3, NO2, Total and dissolved metals, hardness, Fecal Coliform) **Multiprobe** (DO; Temperature; Specific Conductance)
TM4	Turner Reservoir at Route 152, East Providence, RI.	(Analytical-TP, NH_3-N, TKN, NO3, NO2, Total and dissolved metals, hardness, Fecal Coliform) **Multiprobe** (DO; Temperature; Specific Conductance)
TM5	Tuner Reservoir outflow at Route 114A, East Providence, RI.	(Analytical-TP, NH_3-N, TKN, NO3, NO2, Total and dissolved metals, hardness, Fecal Coliform) **Multiprobe** (DO; Temperature; Specific Conductance) **Read USGS Staff Gauge**
TM6	Ten Mile River at Route 114, East Providence, RI.	(Analytical-TP, NH_3-N, TKN, NO3, NO2, Total and dissolved metals, hardness, Fecal Coliform) **Multiprobe** (DO; Temperature; Specific Conductance)
TM7	Ten Mile River at Roger Williams Way, East Providence, RI.	(Analytical-TP, NH_3-N, TKN, NO3, NO2, Total and dissolved metals, hardness, Fecal Coliform) **Multiprobe** (DO; Temperature; Specific Conductance)
TM8	Omega Pond outlet to Seekonk River off Roger Williams Way at RR bridge, East Providence, RI.	(Analytical-TP, NH_3-N, TKN, NO3, NO2, Total and dissolved metals, hardness, Fecal Coliform) **Multiprobe** (DO; Temperature; Specific Conductance) **Read Staff Gauge**

Figure 4. Ten Mile River Sampling Stations for the 2007 and 2008 surveys.

Table 6. Summary of field measurements and methods.

Parameter	Method
Discharge (Flow)	Marsh-McBirney current meter
Specific Conductance	YSI Model 85 (handheld)
Temperature	YSI Model 85 (handheld)
Dissolved Oxygen	YSI Model 85 (handheld)

Table 7. Summary of laboratory measurements and methods.

Parameter	EPA Method
Fecal Coliform	SM MF 9222D[1]
Ammonia Nitrogen	350.1
Nitrate Nitrogen	353.2
Nitrite Nitrogen	353.2
Total Kjeldahl Nitrogen	351.2
Total Phosphorus	365.1
Total Metals	200.7/200.8/6010B
Dissolved Metals	200.7/200.8/6010B
Hardness	SM 2340B

[1]SM indicates Standard Methods rather than EPA method.

Quality Assurance

All water samples for laboratory analysis were collected in pre-cleaned containers supplied by ESS Laboratory in Cranston, RI and the EPA Lab in Chelmsford, MA. All samples for laboratory analysis were preserved as specified in the sampling plan (RIDEM 2007). Samples obtained for dissolved and total metals analysis were sent via overnight mail to the EPA laboratory in Chelmsford, while those obtained for nutrient and fecal coliform analysis were delivered to ESS Laboratory in Cranston within 6 hours of collection.

Field sampling and measurement protocols followed those specified in the sampling plan (RIDEM 2007) for *in-situ* temperature, dissolved oxygen, and specific conductance (YSI 85 Multiprobe meter). All meters were calibrated and post-calibrated per manufacturer's instructions.

Replicate samples were collected to assess total field and laboratory variation. Blanks were used (only with metals sample collection) to assess possible sample contamination. Replicate and blank samples were introduced in the field and submitted with the routine batches of samples to the laboratory. Generally speaking, all field duplicates were labeled as "TM99 or T99". This was done to insure that the laboratories did not know what station the duplicate sample was collected at. Only the field notes confirmed the location that the duplicate sample was collected.

OVERVIEW OF SURVEY CONDITIONS

Hydrologic and Meteorological Conditions

The US Geological Survey (USGS) operates a single gaging station (01109403) in the Ten Mile River (http://waterdata.usgs.gov/nwis/uv?01109403). The gage is located downstream of the Turner Reservoir and at the same location as station TM6 (Pawtucket Avenue- East Providence, RI). The calculated mean daily flow for the Ten Mile River at station 01109403 is 109 cfs and the 7Q10 flow is 19 cfs. Water quality sampling during 2007 and 2008 was conducted under a variety of flow regimes including periods of low and high flow, as well as periods of rising and falling flows (Figure 5).

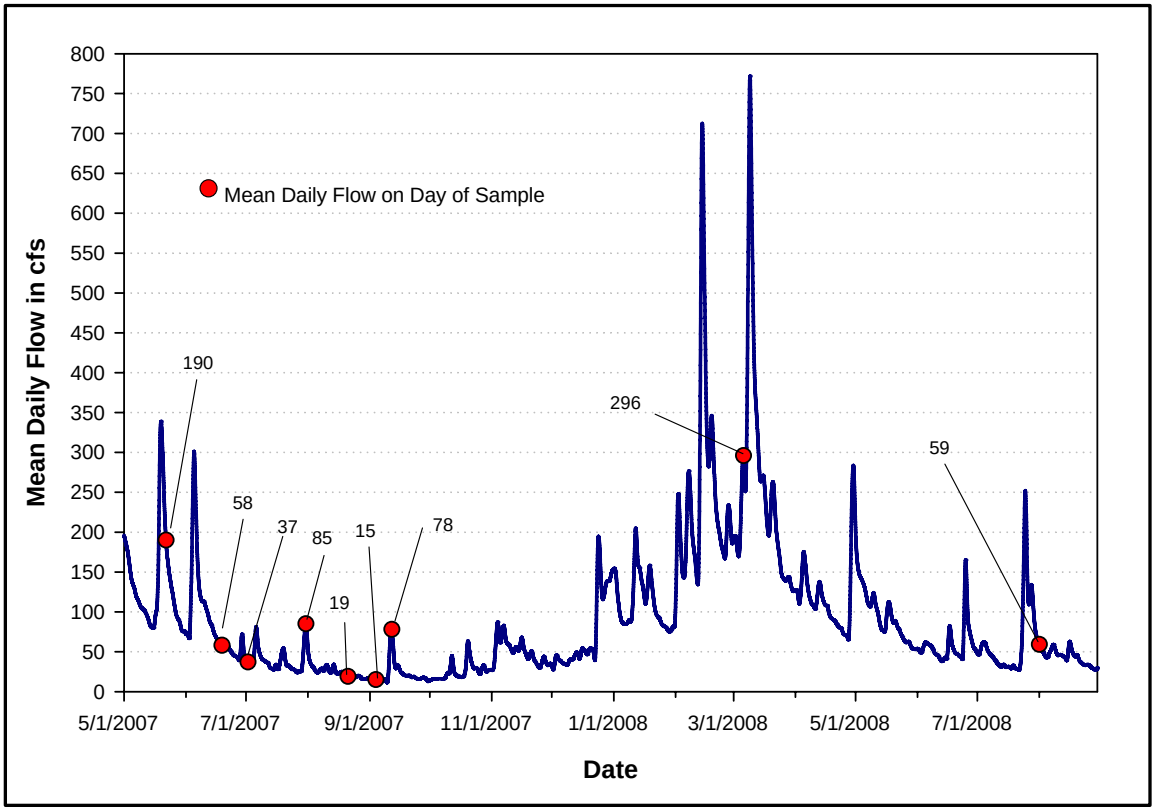

Figure 5. Sample dates relative to mean daily flow (USGS gaging station 01109403).

For purposes of data analysis, additional information such as previous weather (precipitation), and phase of hydrograph during each survey were acquired. This information, summarized below in Table 8, was used to classify the hydrologic and meteorlogical conditions at the time of each survey. As shown in Table 8, four of the nine surveys were conducted under what could be considered a dry weather condition and four of the surveys were conducted under the influence of wet weather.

Table 8. Hydrographic and meteorological conditions for 2007-2008 surveys.

Survey Date	*Hourly Flow at time of survey*[1]	*Phase of Hydrograph*	*Prior or Current Meteorological Condition)*		*Wet or Dry Weather Influenced*[2,3]
5/22/2007	192	Receeding limb of storm hydrograph	2.1 inches 6 days prior	High flows	**Wet**
6/19/2007	62	Slow recession not related to storm	0.11 inches 7 days prior	Mid-range	**Dry**
7/2/2007	39	Slow recession-baseflow	0.15 inches previous day	Mid-range	**Dry**
7/31/2007	88	Near peak, receeding limb of storm hydrograph	1.51 inches previous day	Wet Weather Influenced	**Wet**
8/21/2007	20	Low-steady state	Trace precipitation past 10 days	Low-flows	**Dry**
9/4/2007	16	Low-steady state	Trace precipitation past 24 days	Low-flows	**Dry**
9/12/2007	84	Near peak, receeding limb of storm hydrograph	2.11 inches 2 days prior	Wet Weather Influenced	**Wet**
3/6/2008	307	Rising	0.75 inches 2 days prior	High Flows	**Wet**
8/1/2008	60	Receeding limb of storm hydrograph	0.9 inches 5 days prior	Mid-range	**Wet**

[1] USGS gaging station 01109403
[2] As determined by DEM staff
[3] Flow affected by regulations and diversions from upstream reservoirs.

Data quality
QA/QC for Samples
Table 9 lists accuracy, precision, bias, and reporting limits for sample measurements.

Table 9. Accuracy, precision, bias, and reporting limits for sample measurements.

Analysis	*Field Accuracy*	*Laboratory Precision*	*Bias Contamination*	*Achievable Laboratory Limits*
Field				
Velocity	± 2% of reading; 0.1 f/s	N/A	N/A	0.05 f/s
Water Temperature	± 0.2°C			N/A
Dissolved Oxygen	N/A	N/A	5	1 mg/l
Specific Conductivity	N/A	N/A	5	1 umhos/cm
Laboratory				
Ammonia Nitrogen	< 30% RPD	< 20% RPD	< 0.10 mg/l	0.10 mg/l
NO3-NO2-Nitrogen	< 30% RPD	< 20% RPD	< 0.020 mg/l	0.02 mg/l
Total Kjeldahl Nitrogen	< 30% RPD	< 20% RPD	< 0.20 mg/l	0.20 mg/l
Total Phosphorus	< 30% RPD	< 20% RPD	< 0.020 mg/l	0.02 mg/l
Fecal Coliform Bacteria	< 20% RPD	< 20% RPD	> 2 CFU	< 1 CFU
Dissolved Metals[1]	< 30% RPD	< 20% RPD	< ½ reporting limit	[2]
Total Recoverable Metals[1]	< 30% RPD	< 20% RPD	< ½ reporting limit	[2]

[1]Suite of metals includes Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Sb, Se, Tl, V, and Zn.

[2]Reporting Limits (ug/l) are: Ag (0.20), Al (5.0), As (0.50), Ba (0.20), Be (0.20), Ca (100), Cd (0.20), Co (0.20), Cr (0.50), Cu (0.20), Fe (50) Mg (50), Mn (0.20), Mo (0.50), Ni (0.20), Pb (0.20), Sb (0.50), Se (1.0), Tl (0.50), V (0.20), Zn (5.0)

Field Sampling
Field sampling protocols followed those specified in the sampling plan (RIDEM 2007). Field QC requirements included the use of field replicates and field blanks (for dissolved and total metals samples) to assess total precision and field bias, respectively.

Laboratory Analysis
ESS Laboratory, located in Cranston, RI was used for all fecal coliform bacteria and nutrient analysis. The EPA Region 1 Laboratory in Chelmsford, MA was used for total

recoverable and dissolved metals analysis. Both labs prepared and submitted QA memos to RIDEM's Office of Water Resources for each sampling survey. Each memo summarized the QC procedures and results for sample transport and storage, sample holding times, and instrument calibration. The memo also included a QA summary of check standards, matrix spikes, method blanks (used to check for analytical bias), and lab-split samples (used to check for analytical precision).

Samples for dissolved and total recoverable metals analysis were shipped via overnight express to the EPA Laboratory. These samples did not need to be refrigerated. All samples were received at the EPA Lab in good condition and properly labeled.

The temperature of the coolers delivered to ESS Laboratory for all surveys ranged from 1.0 to 5.4 degrees Celsius. The sampling plan (RIDEM 2007) required a cooler temperature not to exceed 4 degrees Celsius, however since the maximum temperature of the coolers only exceeded this by a maximum of 1.4 degrees it was not considered problematic. As such all samples were accepted and were not qualified for being out of range. Holding times for all parameters were met during all surveys.
Instrument calibration and control checks were all within control limits for the project. An exception to this occurred during the March 6, 2008 survey. An unidentified and un-correctable (within the time of the field survey) problem occurred with the YSI 85 Multiprobe that caused invalid dissolved oxygen readings.

Evaluation of Data Quality

Data collected during this study were evaluated to determine whether data quality assurance/quality control (QA/QC) objectives for the project were met. Data were evaluated according to the measurement performance criteria described in Section A11 of the approved QA plan.

For the most part, data quality for this project met all field and lab QA/QC criteria. Individual exceptions that caused the results to be qualified as an estimate were marked with a "J" qualifier in the data tables. All qualifications will be taken into consideration for the purpose of data analysis. The data quality indicators evaluated in the following sections include analytical laboratory precision, field accuracy, bias/contamination, and data completeness.

Analytical Laboratory Precision

Analytical laboratory precision was determined by calculating the relative percent difference (RPD) between the initial laboratory result and the laboratory duplicate. The criterion used to assess measurement performance for precision for each parameter is given in Table 9.

The QAPP specified that laboratory split samples were to be analyzed for 10% of samples (at least once per batch), however in some cases samples from RIDEM were mixed with other samples from other entities and considered a single batch. As a result, some laboratory duplicates were performed on non-DEM samples. These results could

not be readily obtained. In addition, due to a miscommunication, no laboratory duplicates for fecal coliform bacteria were run.

Laboratory precision results are provided in Tables 10-20. No laboratory duplicates were run for the metals analysis for dry weather survey #1.

Table 10. Laboratory precision results for Nitrate-Nitrogen.

Station	*Date*	*Original Result (mg/l)*	*Laboratory Duplicate (mg/l)*	*Mean*	*Difference*	*Relative Percent Difference*	*Acceptable Y or N*
TM8d	5/22/2007	0.74	0.75	0.745	0.01	1	Y
TM5d	6/19/2007	1.35	1.35	1.35	0	0	Y
	7/2/2007						Y
TM2	7/31/2007	2.63	2.74	2.685	0.11	4	Y
TM1	8/21/2007	5.74	5.7	5.72	0.04	1	Y
	9/4/2007						Y
	9/12/2007						Y
	3/6/2008						Y
TM8	8/1/2008	0.26	0.26	0.26	0	0	Y

If cells are blank then no duplicate was analyzed for that parameter for that date.

Table 11. Laboratory precision results for Nitrite-Nitrogen.

Station	*Date*	*Original Result (mg/l)*	*Laboratory Duplicate (mg/l)*	*Mean*	*Difference*	*Relative Percent Difference*	*Acceptable Y or N*
TM8	5/22/2007	0.01	0.011	0.0105	0.001	10	Y
	6/19/2007				0		Y
	7/2/2007				0		Y
TM2	7/31/2007	0.086	0.082	0.084	0.004	5	Y
TM1	8/21/2007	0.012	0.012	0.012	0	0	Y
	9/4/2007				0		Y
	9/12/2007				0		Y
	3/6/2008				0		Y
TM8	8/1/2008	0.022	0.024	0.023	0.002	9	Y

If cells are blank then no duplicate was analyzed for that parameter for that date.

Table 12. Laboratory precision results for Ammonia-Nitrogen.

Station	*Date*	*Original Result (mg/l)*	*Laboratory Duplicate (mg/l)*	*Mean*	*Difference*	*Relative Percent Difference*	*Acceptable Y or N*
	5/22/2007						
	6/19/2007						
	7/2/2007						
	7/31/2007						
TM6	8/21/2007	0.013	0.016	0.0145	0.003	21	Y
	9/4/2007						
	9/12/2007						
	3/6/2008						
	8/1/2008						

If cells are blank then no duplicate was analyzed for that parameter for that date.

Table 13. Laboratory precision results for Total Kjehldahl Nitrogen.

Station	*Date*	*Original Result (mg/l)*	*Laboratory Duplicate (mg/l)*	*Mean*	*Difference*	*Relative Percent Difference*	*Acceptable Y or N*
TM8	5/22/2007						
	6/19/2007						
	7/2/2007						
	7/31/2007						
TM8	8/21/2007	1.09	0.9	0.995	0.19	19	Y
TM8	9/4/2007	1.49	1.17	1.33	0.32	24	**J**
	9/12/2007						
TM1	3/6/2008	0.52	0.52	0.52	0	0	Y
TM1	8/1/2008	1	0.95	0.975	0.05	5	Y

If cells are blank then no duplicate was analyzed for that parameter for that date.

J= RPD slightly exceeded Data Quality Objective (DQO) of 20%, however data was considered to be usable.

Table 14. Laboratory precision results for Total Phosphorus.

Station	*Date*	*Original Result (mg/l)*	*Laboratory Duplicate (mg/l)*	*Mean*	*Difference*	*Relative Percent Difference*	*Acceptable Y or N*
TM8	5/22/2007	0.05	0.044	0.047	0.006	13	Y
	6/19/2007						
	7/2/2007	0.04	0.04	0.04	0	0	Y
TM8	7/31/2007	0.092	0.103	0.0975	0.011	11	Y
TM8	8/21/2007	0.131	0.13	0.1305	0.001	1	Y
TM8	9/4/2007	0.061	0.058	0.0595	0.003	5	Y
TM8	9/12/2007	0.159	0.154	0.1565	0.005	3	Y
TM1	3/6/2008	0.037	0.046	0.0415	0.009	22	**J**
TM8	8/1/2008	0.063	0.051	0.057	0.012	21	**J**

If cells are blank then no duplicate was analyzed for that parameter for that date.

J= RPD slightly exceeded Data Quality Objective (DQO) of 20%, however data was considered to be usable.

Table 15. Laboratory precision results for dissolved metals-Survey #2 (June 19, 2007). Laboratory duplicate was collected at station TM2.

Constituent	*TM2*	*Lab Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	14	14	14	0	0	Y
Antimony (Sb)	ND	ND	NC	NC	NC	
Arsenic (As)	ND	ND	NC	NC	NC	
Barium (Ba)	23	23	23	0	0	Y
Beryllium (Be)	ND	ND	NC	NC	NC	
Cadmium (Cd)	0.17	0.16	0.165	0.01	6	Y
Calcium (Ca mg/L)	26	27	26.5	1	4	Y
Chromium (Cr)	1.7	1.8	1.75	0.1	6	Y
Cobalt (Co)	0.38	0.38	0.38	0	0	Y
Copper (Cu)	6.3	6.4	6.35	0.1	2	Y
Iron (Fe)	430	440	435	10	2	Y
Lead (Pb)	2.1	2.1	2.1	0	0	Y
Magnesium (Mg mg/L)	3.3	3.3	3.3	0	0	Y
Manganese (Mn)	140	140	140	0	0	Y
Molybdenum (Mo)	1.3	1.3	1.3	0	0	Y
Nickel (Ni)	19	19	19	0	0	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.58	0.55	0.565	0.03	5	Y
Zinc (Zn)	10	11	10.5	1	10	Y

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. QAPP specifies less than 20% RPD as acceptable for laboratory duplicate. **ND**= non-detect, **NC**= not calculated.

Table 16. Laboratory precision results for dissolved metals-Survey #3 (July 2, 2007). Laboratory duplicate was collected at station TM1.

Constituent	*TM1*	*Lab Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	9.9	10	9.95	0.1	1	Y
Antimony (Sb)	ND	ND	NC	NC	NC	
Arsenic (As)	0.76	0.81	0.785	0.05	6	Y
Barium (Ba)	24	24	24	0	0	Y
Beryllium (Be)	ND	ND	NC	NC	NC	
Cadmium (Cd)	0.17	0.18	0.175	0.01	6	Y
Calcium (Ca mg/L)	24	24	24	0	0	Y
Chromium (Cr)	1	0.99	0.995	0.01	1	Y
Cobalt (Co)	0.37	0.37	0.37	0	0	Y
Copper (Cu)	6.5	6.5	6.5	0	0	Y
Iron (Fe)	280	280	280	0	0	Y
Lead (Pb)	1.3	1.3	1.3	0	0	Y
Magnesium (Mg mg/L)	3.5	3.5	3.5	0	0	Y
Manganese (Mn)	180	180	180	0	0	Y
Molybdenum (Mo)	1.4	1.4	1.4	0	0	Y
Nickel (Ni)	22	22	22	0	0	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.46	0.44	0.45	0.02	4	Y
Zinc (Zn)	10	9.8	9.9	0.2	2	Y

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. QAPP specifies less than 20% RPD as acceptable for laboratory duplicate. **ND**= non-detect, **NC**= not calculated.

Table 17. Laboratory precision results for dissolved metals-Survey #4 (July 31, 2007). Laboratory duplicate was collected at station TM1.

Constituent	*TM1*	*Lab Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	8.1	6.9	7.5	1.2	16	Y
Antimony (Sb)	0.51	ND	0.51	NC	NC	
Arsenic (As)	0.83	0.84	0.835	0.01	1	Y
Barium (Ba)	24	24	24	0	0	Y
Beryllium (Be)	ND	ND	NC	NC	NC	
Cadmium (Cd)	0.2	0.18	0.19	0.02	11	Y
Calcium (Ca mg/L)	19	19	19	0	0	Y
Chromium (Cr)	0.97	1	0.985	0.03	3	Y
Cobalt (Co)	0.38	0.39	0.385	0.01	3	Y
Copper (Cu)	7.6	7.7	7.65	0.1	1	Y
Iron (Fe)	180	190	185	10	5	Y
Lead (Pb)	1.5	1.5	1.5	0	0	Y
Magnesium (Mg mg/L)	2.9	3	2.95	0.1	3	Y
Manganese (Mn)	190	190	190	0	0	Y
Molybdenum (Mo)	1.9	1.9	1.9	0	0	Y
Nickel (Ni)	24	25	24.5	1	4	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.83	0.84	0.835	0.01	1	Y
Zinc (Zn)	8.2	7.9	8.05	0.3	4	Y

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. QAPP specifies less than 20% RPD as acceptable for laboratory duplicate. **ND**= non-detect, **NC**= not calculated.

Table 18. Laboratory precision results for dissolved metals-Survey #7 (September 12, 2007). Laboratory duplicate was collected at station TM2.

Constituent	*TM2*	*Lab Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	9.3	8.7	9	0.6	7	Y
Antimony (Sb)	0.55	0.55	0.55	0	0	Y
Arsenic (As)	0.73	0.7	0.715	0.03	4	Y
Barium (Ba)	30	30	30	0	0	Y
Beryllium (Be)	ND	ND	NC	NC	NC	
Cadmium (Cd)	0.27	0.28	0.275	0.01	4	Y
Calcium (Ca mg/L)	24	23	23.5	1	4	Y
Chromium (Cr)	0.62	0.65	0.635	0.03	5	Y
Cobalt (Co)	0.66	0.67	0.665	0.01	2	Y
Copper (Cu)	7.9	8.2	8.05	0.3	4	Y
Iron (Fe)	130	130	130	0	0	Y
Lead (Pb)	0.93	0.95	0.94	0.02	2	Y
Magnesium (Mg mg/L)	3.1	3.2	3.15	0.1	3	Y
Manganese (Mn)	310	310	310	0	0	Y
Molybdenum (Mo)	2.1	2.1	2.1	0	0	Y
Nickel (Ni)	29	29	29	0	0	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.58	0.56	0.57	0.02	4	Y
Zinc (Zn)	16	16	16	0	0	Y

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. QAPP specifies less than 20% RPD as acceptable for laboratory duplicate. **ND**= non-detect, **NC**= not calculated.

Table 19. Laboratory precision results for dissolved metals-Survey #8 (March 6, 2008). Laboratory duplicate was collected at station TM1.

Constituent	*TM1*	*Lab Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	34	34	34	0	0	Y
Antimony (Sb)	ND	ND	NC	NC	NC	
Arsenic (As)	ND	ND	NC	NC	NC	
Barium (Ba)	25	24	24.5	1	4	Y
Beryllium (Be)	ND	ND	NC	NC	NC	
Cadmium (Cd)	0.2	ND	0.2	NC	NC	
Calcium (Ca mg/L)	15	16	15.5	1	6	Y
Chromium (Cr)	ND	ND	NC	NC	NC	
Cobalt (Co)	0.41	0.4	0.405	0.01	2	Y
Copper (Cu)	5.5	5.8	5.65	0.3	5	Y
Iron (Fe)	150	150	150	0	0	Y
Lead (Pb)	0.75	0.77	0.76	0.02	3	Y
Magnesium (Mg mg/L)	2.8	2.8	2.8	0	0	Y
Manganese (Mn)	90	91	90.5	1	1	Y
Molybdenum (Mo)	0.61	ND	0.61	NC	NC	
Nickel (Ni)	11	11	11	0	0	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.2	0.2	0.2	0	0	Y
Zinc (Zn)	20	20	20	0	0	Y

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. QAPP specifies less than 20% RPD as acceptable for laboratory duplicate. **ND**= non-detect, **NC**= not calculated.

Table 20. Laboratory precision results for dissolved metals-Survey #9 (August 1, 2008). Laboratory duplicate was collected at station TM1.

Constituent	*TM1*	*Lab Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	22	22	22	0	0	Y
Antimony (Sb)	ND	ND	NC	NC	NC	
Arsenic (As)	1.20	1.20	1.2	0	0	Y
Barium (Ba)	25	25	25	0	0	Y
Beryllium (Be)	ND	ND	NC	NC	NC	
Cadmium (Cd)	0.22	0.21	0.215	0.01	5	Y
Calcium (Ca mg/L)	21	21	21	0	0	Y
Chromium (Cr)	2.10	2.10	2.1	0	0	Y
Cobalt (Co)	0.45	0.42	0.435	0.03	7	Y
Copper (Cu)	9.90	10	9.95	0.1	1	Y
Iron (Fe)	680	670	675	10	1	Y
Lead (Pb)	3.10	3.20	3.15	0.1	3	Y
Magnesium (Mg mg/L)	3.30	3.20	3.25	0.1	3	Y
Manganese (Mn)	230.	220	225	10	4	Y
Molybdenum (Mo)	2.30	2.30	2.3	0	0	Y
Nickel (Ni)	27	27	27	0	0	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.93	0.88	0.905	0.05	6	Y
Zinc (Zn)	11.00	12.00	11.5	1	9	Y

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. QAPP specifies less than 20% RPD as acceptable for laboratory duplicate. **ND**= non-detect, **NC**= not calculated.

As shown in Tables 13 (TKN) and 14 (TP), three (3) data points were qualified and should be taken into consideration when using the data for mass loadings calculations and for interpreting results. With these exceptions, the RPD for all parameters met the target laboratory precision objectives.

Field Accuracy

Field accuracy was determined by calculating the relative percent difference (RPD) between the original field sample and the field duplicate. The criterion used to assess measurement performance for field accuracy for each parameter is given in Table 9. The QAPP specified that field duplicates were to be analyzed for 10% of samples (or at least once per batch). Field accuracy results for fecal coliform bacteria are provided below in Tables 21 and 22, with a description of the modified performance criteria. Tables 23-27 provide field accuracy results for nutrients. Field accuracy results for metals are presented in Tables 28-36.

Table 21. Field accuracy results for fecal coliform bacteria.

Station	*Date*	*Original Result CFU/100ml*	*Field Duplicate CFU/100ml*	*Mean*	*Difference*	*Relative Percent Difference*	*Acceptable Y or N*
TM8	5/22/2007	150	150	150	0	0	Y
TM5	6/19/2007	17	19	18	2	11	Y
TM4	7/2/2007	160	160	160	0	0	Y
TM6	7/31/2007	66	140	103	74	72	**N**
TM3	8/21/2007	30	57	43.5	27	62	**N**
TM7	9/4/2007	37	15	26	22	85	**N**
TM2	9/12/2007	1200	460	830	740	89	**N**
TM1	3/6/2008	52	62	57	10	18	Y
TM4	8/1/2008	69	45	57	24	42	**N**

Initially, consistent with the approved QA Plan (2007), field replicates and laboratory duplicates were compared to the precision criteria using a formula that had been used for previous TMDL studies. As seen in Table 7, more than half of the field and laboratory replicates failed this test. Further investigation revealed that a more proper (and acceptable) method to assess data quality for fecal coliform is to use the method described by Rippey et al, 1987. DEM opted to apply this method to assess data quality for the fecal coliform bacteria dataset.

The precision of the mTEC membrane filtration technique for fecal coliform is ±35% at the 95% confidence interval (Rippey et al., 1987). Field replicates and laboratory duplicates were then compared to the confidence interval criteria mentioned above and the mean of the two values to assess data reliability. These results are presented below in Table 8. All field replicates fell within their respective confidence intervals confirming adequate data quality. As a result, all values were considered acceptable.

Table 22. Field accuracy results for fecal coliform bacteria (modified).

Station	*Date*	*Original Result CFU/100ml*	*Field Duplicate CFU/100ml*	*Mean*	*Confidence Interval (-95%)*	*Confidence Interval (+95%)*	*Acceptable Y or N*
TM8	5/22/2007	150	150	150	98	203	Y
TM5	6/19/2007	17	19	18	12	24	Y
TM4	7/2/2007	160	160	160	104	216	Y
TM6	7/31/2007	66	140	103	67	139	Y
TM3	8/21/2007	30	57	43.5	28	59	Y
TM7	9/4/2007	37	15	26	17	35	Y
TM2	9/12/2007	1200	460	830	540	1121	Y
TM1	3/6/2008	52	62	57	37	77	Y
TM4	8/1/2008	69	45	57	37	77	Y

Table 23. Field accuracy results for Nitrate-Nitrogen.

Station	*Date*	*Original Result (mg/l)*	*Field Duplicate (mg/l)*	*Mean*	*Difference*	*Relative Percent Difference*	*Acceptable Y or N*
TM8	5/22/2007	0.71	0.74	0.725	0.03	4	Y
TM5	6/19/2007	1.27	1.28	1.275	0.01	1	Y
TM4	7/2/2007	2.04	2.02	2.03	0.02	1	Y
TM6	7/31/2007	0.421	0.42	0.4205	0.001	0	Y
TM3	8/21/2007	4.98	5	4.99	0.02	0	Y
TM7	9/4/2007	0.728	0.73	0.729	0.002	0	Y
TM2	9/12/2007	2.53	2.5	2.515	0.03	1	Y
TM1	3/6/2008	1.19	1.16	1.175	0.03	3	Y
TM4	8/1/2008	0.815	0.78	0.7975	0.035	4	Y

Table 24. Field accuracy results for Nitrite-Nitrogen.

Station	*Date*	*Original Result (mg/l)*	*Field Duplicate (mg/l)*	*Mean*	*Difference*	*Relative Percent Difference*	*Acceptable Y or N*
TM8	5/22/2007	0.01	0.01	0.01	0	0	Y
TM5	6/19/2007	0.07	0.07	0.07	0	0	Y
TM4	7/2/2007	0.089	0.089	0.089	0	0	Y
TM6	7/31/2007	0.039	0.039	0.039	0	0	Y
TM3	8/21/2007	0.027	0.027	0.027	0	0	Y
TM7	9/4/2007	0.032	0.034	0.033	0.002	6	Y
TM2	9/12/2007	0.027	0.026	0.0265	0.001	4	Y
TM1	3/6/2008	0.018	0.016	0.017	0.002	12	Y
TM4	8/1/2008	0.056	0.055	0.0555	0.001	2	Y

Table 25. Field accuracy results for Ammonia-Nitrogen.

Station	*Date*	*Original Result (mg/l)*	*Field Duplicate (mg/l)*	*Mean*	*Difference*	*Relative Percent Difference*	*Acceptable Y or N*
TM8	5/22/2007	0.7	0.6	0.65	0.1	15	Y
TM5	6/19/2007	0.3	0.1	0.2	0.2	**100**	**N**
TM4	7/2/2007	0.22	0.19	0.205	0.03	15	Y
TM6	7/31/2007	0.12	0.12	0.12	0	0	Y
TM3	8/21/2007	0.13	0.14	0.135	0.01	7	Y
TM7	9/4/2007	0.27	0.2	0.235	0.07	30	Y
TM2	9/12/2007	0.29	0.28	0.285	0.01	4	Y
TM1	3/6/2008	0.2	0.21	0.205	0.01	5	Y
TM4	8/1/2008	0.15	0.18	0.165	0.03	18	Y

N= not acceptable. Result not used.

Table 26. Field accuracy results for Total Kjehldahl Nitrogen.

Station	*Date*	*Original Result (mg/l)*	*Field Duplicate (mg/l)*	*Mean*	*Difference*	*Relative Percent Difference*	*Acceptable Y or N*
TM8	5/22/2007	1.3	1.2	1.2	0.1	8	Y
TM5	6/19/2007	1	0.9	0.9	0.1	11	Y
TM4	7/2/2007	0.76	0.77	0.77	0.01	1	Y
TM6	7/31/2007	0.98	0.99	0.99	0.01	1	Y
TM3	8/21/2007	0.46	0.57	0.57	0.11	19	Y
TM7	9/4/2007	1	1.58	1.58	0.58	**37**	**J**
TM2	9/12/2007	1.2	1.12	1.12	0.08	7	Y
TM1	3/6/2008	0.93	0.52	0.52	0.41	**79**	**N**
TM4	8/1/2008	1.24	1.5	1.5	0.26	17	Y

J= RPD exceeded Data Quality Objective (DQO) of 20%, however data was considered to be usable.
N= not acceptable. Result not used.

Table 27. Field accuracy results for Total Phosphorus.

Station	*Date*	*Original Result (mg/l)*	*Field Duplicate (mg/l)*	*Mean*	*Difference*	*Relative Percent Difference*	*Acceptable Y or N*
TM8	5/22/2007	0.048	0.05	0.049	0.002	4	Y
TM5	6/19/2007	0.05	0.049	0.0495	0.001	2	Y
TM4	7/2/2007	0.041	0.034	0.0375	0.007	19	Y
TM6	7/31/2007	0.061	0.075	0.068	0.014	21	Y
TM3	8/21/2007	0.07	0.074	0.072	0.004	6	Y
TM7	9/4/2007	0.098	0.083	0.0905	0.015	17	Y
TM2	9/12/2007	0.067	0.081	0.074	0.014	19	Y
TM1	3/6/2008	0.037	0.065	0.051	0.028	55	**N**
TM4	8/1/2008	0.077	0.073	0.075	0.004	5	Y

N= not acceptable. Result not used.

The data quality objectives for field accuracy met the measurement performance criteria for a majority of nutrient parameters during all surveys. Exceptions include the following:

1. A RPD of 100% was calculated for the ammonia nitrogen sample collected on 6/19/2007 at station TM5. This data was not utilized for analysis.

2. A RPD of 37% was calculated for the TKN sample collected on 9/4/2007 at station TM7. This data was qualified as (J) since the RPD exceeded the DQO of 20%, however the data was considered to be usable although the RPD should be taken into consideration when using the data for mass loadings calculations and for interpreting results.

3. A RPD of 79% was calculated for the TKN sample collected on 3/6/2008 at station TM1. This data was not used for analysis.

4. A RPD of 55% was calculated for the TP sample collected on 3/6/2008 at station TM1. This data was not used for analysis.

Table 28. Field accuracy results for dissolved metals-Survey #1 (May 22, 2007).

Constituent	*TM8*	*Field Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	21	18	19.5	3	15	Y
Antimony (Sb)	0.71	ND	0.71	NC	NC	
Arsenic (As)	0.57	0.62	0.595	0.05	8	Y
Barium (Ba)	18	17	17.5	1	6	Y
Beryllium (Be)	ND	ND	N	NC	NC	
Cadmium (Cd)	0.17	0.17	0.17	0	0	Y
Calcium (Ca mg/L)	17	17	17	0	0	Y
Chromium (Cr)	1.2	1	1.1	0.2	18	Y
Cobalt (Co)	0.35	0.33	0.34	0.02	6	Y
Copper (Cu)	6.2	5.9	6.05	0.3	5	y
Iron (Fe)	270	190	230	80	**35**	**J**
Lead (Pb)	0.87	0.71	0.79	0.16	20	Y
Magnesium (Mg mg/L)	2.6	2.7	2.65	0.1	4	Y
Manganese (Mn)	140	130	135	10	7	Y
Molybdenum (Mo)	0.92	0.93	0.925	0.01	1	Y
Nickel (Ni)	15	15	15	0	0	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.42	0.42	0.42	0	0	
Zinc (Zn)	15	11	13	4	**31**	**J**

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. **Laboratory Duplicates were not run during this analysis.** QAPP specifies less than 30% RPD as acceptable for field duplicate.
ND= non-detect, **NC**= not calculated. **J**= RPD slightly exceeded DQO however data was considered to be usable.

Table 29. Field accuracy results for dissolved metals-Survey #2 (June 19, 2007).

Constituent	*TM5*	*Field Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	6.5	7.6	7.05	1.1	16	Y
Antimony (Sb)	ND	0.58	0.58	NC	NC	
Arsenic (As)	ND	ND	NC	NC	NC	
Barium (Ba)	14	15	14.5	1	7	Y
Beryllium (Be)	ND	ND	NC	NC	NC	
Cadmium (Cd)	ND	ND	NC	NC	NC	
Calcium (Ca mg/L)	18	18	18	0	0	Y
Chromium (Cr)	1	1.1	1.05	0.1	10	Y
Cobalt (Co)	0.28	0.29	0.285	0.01	4	Y
Copper (Cu)	6	6.3	6.15	0.3	5	Y
Iron (Fe)	320	340	330	20	6	Y
Lead (Pb)	0.96	1	0.98	0.04	4	Y
Magnesium (Mg mg/L)	2.8	2.9	2.85	0.1	4	Y
Manganese (Mn)	49	51	50	2	4	Y
Molybdenum (Mo)	1	1	1	0	0	Y
Nickel (Ni)	13	14	13.5	1	7	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.50	0.52	0.51	0.02	4	Y
Zinc (Zn)	ND	ND	NC	NC	NC	

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. QAPP specifies less than 30% RPD as acceptable for field duplicate. **ND**= non-detect, **NC**= not calculated. **J**= RPD slightly exceeded DQO however data was considered to be usable.

Table 30. Field accuracy results for dissolved metals-Survey #3 (July 2, 2007).

Constituent	*TM4*	*Field Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	7.4	9	8.2	1.6	20	Y
Antimony (Sb)	ND	ND	NC	NC	NC	
Arsenic (As)	0.76	0.74	0.75	0.02	3	Y
Barium (Ba)	19	19	19	0	0	Y
Beryllium (Be)	ND	ND	NC	NC	NC	
Cadmium (Cd)	ND	ND	NC	NC	NC	
Calcium (Ca mg/L)	23	23	23	0	0	Y
Chromium (Cr)	0.72	0.71	0.715	0.01	1	Y
Cobalt (Co)	0.29	0.29	0.29	0	0	Y
Copper (Cu)	6.1	6.2	6.15	0.1	2	Y
Iron (Fe)	160	140	150	20	13	Y
Lead (Pb)	0.49	0.42	0.455	0.07	15	Y
Magnesium (Mg mg/L)	3.1	3.1	3.1	0	0	Y
Manganese (Mn)	42	34	38	8	21	Y
Molybdenum (Mo)	1.6	1.7	1.65	0.1	6	Y
Nickel (Ni)	14	14	14	0	0	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.46	0.42	0.44	0.04	9	Y
Zinc (Zn)	ND	ND	NC	NC	NC	

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. QAPP specifies less than 30% RPD as acceptable for field duplicate. **ND**= non-detect, **NC**= not calculated.

Table 31. Field accuracy results for dissolved metals-Survey #4 (July 31, 2007).

Constituent	*TM6*	*Field Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	ND	ND	NC	NC	NC	
Antimony (Sb)	ND	ND	NC	NC	NC	
Arsenic (As)	1	1	1	0	0	Y
Barium (Ba)	16	16	16	0	0	Y
Beryllium (Be)	ND	ND	NC	NC	NC	
Cadmium (Cd)	ND	ND	NC	NC	NC	
Calcium (Ca mg/L)	22	22	22	0	0	Y
Chromium (Cr)	ND	ND	NC	NC	NC	
Cobalt (Co)	0.32	0.31	0.315	0.01	3	Y
Copper (Cu)	5.3	4.9	5.1	0.4	8	Y
Iron (Fe)	ND	ND	NC	NC	NC	
Lead (Pb)	ND	ND	NC	NC	NC	
Magnesium (Mg mg/L)	3	3	3	0	0	Y
Manganese (Mn)	19	18	18.5	1	5	Y
Molybdenum (Mo)	2	2.1	2.05	0.1	5	Y
Nickel (Ni)	10	11	10.5	1	10	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.54	0.56	0.55	0.02	4	Y
Zinc (Zn)	ND	ND	NC	NC	NC	

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. QAPP specifies less than 30% RPD as acceptable for field duplicate. **ND**= non-detect, **NC**= not calculated.

Table 32. Field accuracy results for dissolved metals-Survey #5 (August 21, 2007).

Constituent	*TM3*	*Field Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	14	ND	NC	NC	NC	
Antimony (Sb)	ND	0.52	0.52	NC	NC	
Arsenic (As)	0.64	0.7	0.67	0.06	9	Y
Barium (Ba)	31	30	30.5	1	3	Y
Beryllium (Be)	ND	ND	NC	NC	NC	
Cadmium (Cd)	ND	ND	NC	NC	NC	
Calcium (Ca mg/L)	31	31	31	0	0	Y
Chromium (Cr)	0.61	ND	0.61	NC	NC	
Cobalt (Co)	0.29	0.28	0.285	0.01	4	Y
Copper (Cu)	5.2	4.9	5.05	0.3	6	Y
Iron (Fe)	120	51	85.5	69	**81**	**N**
Lead (Pb)	0.58	0.24	0.41	0.34	**83**	**N**
Magnesium (Mg mg/L)	3.3	3.4	3.35	0.1	3	Y
Manganese (Mn)	170	170	170	0	0	Y
Molybdenum (Mo)	1.7	1.7	1.7	0	0	Y
Nickel (Ni)	16	16	16	0	0	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.28	0.24	0.26	0.04	15	Y
Zinc (Zn)	5.7	5.3	5.5	0.4	7	Y

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. **Laboratory Duplicates were not run during this analysis.** QAPP specifies less than 30% RPD as acceptable for field duplicate.
ND= non-detect, **NC**= not calculated.

Table 33. Field accuracy results for dissolved metals-Survey #6 (September 4, 2007).

Constituent	*TM7*	*Field Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	ND	ND	NC	NC	NC	
Antimony (Sb)	ND	ND	NC	NC	NC	
Arsenic (As)	1.3	1.3	1.3	0	0	Y
Barium (Ba)	31	31	31	0	0	Y
Beryllium (Be)	ND	ND	NC	NC	NC	
Cadmium (Cd)	ND	ND	NC	NC	NC	
Calcium (Ca mg/L)	32	32	32	0	0	Y
Chromium (Cr)	ND	ND	NC	NC	NC	
Cobalt (Co)	0.45	0.45	0.45	0	0	Y
Copper (Cu)	3.3	3.3	3.3	0	0	Y
Iron (Fe)	60	59	59.5	1	2	Y
Lead (Pb)	ND	ND	NC	NC	NC	
Magnesium (Mg mg/L)	3.6	3.7	3.65	0.1	3	Y
Manganese (Mn)	300	300	300	0	0	Y
Molybdenum (Mo)	2.2	2.2	2.2	0	0	Y
Nickel (Ni)	14	14	14	0	0	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.46	0.47	0.465	0.01	2	Y
Zinc (Zn)	ND	ND	NC	NC	NC	

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. **Laboratory Duplicates were not run during this analysis.** QAPP specifies less than 30% RPD as acceptable for field duplicate.
ND= non-detect, **NC**= not calculated.

Table 34. Field accuracy results for dissolved metals-Survey #7 (September 12, 2007).

Constituent	*TM2*	*Field Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	ND	ND	NC	NC	NC	
Antimony (Sb)	ND	ND	NC	NC	NC	
Arsenic (As)	1	1	1	0	0	Y
Barium (Ba)	16	16	16	0	0	Y
Beryllium (Be)	ND	ND	NC	NC	NC	
Cadmium (Cd)	ND	ND	NC	NC	NC	
Calcium (Ca mg/L)	22	22	22	0	0	Y
Chromium (Cr)	ND	ND	NC	NC	NC	
Cobalt (Co)	0.32	0.31	0.315	0.01	3	Y
Copper (Cu)	5.3	4.9	5.1	0.4	8	Y
Iron (Fe)	ND	ND	NC	NC	NC	
Lead (Pb)	ND	ND	NC	NC	NC	
Magnesium (Mg mg/L)	3	3	3	0	0	Y
Manganese (Mn)	19	18	18.5	1	5	Y
Molybdenum (Mo)	2	2.1	2.05	0.1	5	Y
Nickel (Ni)	10	11	10.5	1	10	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.54	0.56	0.55	0.02	4	Y
Zinc (Zn)	ND	ND	NC	NC	NC	

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. QAPP specifies less than 30% RPD as acceptable for field duplicate. **ND**= non-detect, **NC**= not calculated.

Table 35. Field accuracy results for dissolved metals-Survey #8 (March 6, 2008).

Constituent	*TM1*	*Field Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	34	34	34	0	0	Y
Antimony (Sb)	ND	ND	NC	NC	NC	
Arsenic (As)	ND	ND	NC	NC	NC	
Barium (Ba)	25	24	24.5	1	4	Y
Beryllium (Be)	ND	ND	NC	NC	NC	
Cadmium (Cd)	0.2	ND	0.2	NC	NC	
Calcium (Ca mg/L)	15	16	15.5	1	6	Y
Chromium (Cr)	ND	ND	NC	NC	NC	
Cobalt (Co)	0.41	0.4	0.405	0.01	2	Y
Copper (Cu)	5.5	5.6	5.55	0.1	2	Y
Iron (Fe)	150	140	145	10	7	Y
Lead (Pb)	0.75	0.72	0.735	0.03	4	Y
Magnesium (Mg mg/L)	2.8	2.8	2.8	0	0	Y
Manganese (Mn)	90	90	90	0	0	Y
Molybdenum (Mo)	0.61	ND	0.61	NC	NC	
Nickel (Ni)	11	11	11	0	0	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.2	0.2	0.2	0	0	Y
Zinc (Zn)	20	20	20	0	0	Y

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. QAPP specifies less than 30% RPD as acceptable for field duplicate. **ND**= non-detect, **NC**= not calculated.

Table 36. Field accuracy results for dissolved metals-Survey #9 (August 1, 2008).

Constituent	*TM4*	*Field Dup*	*Mean*	*Difference*	*RPD*	*Acceptable Y or N*
Aluminum (Al)	11	10	10.5	1	10	Y
Antimony (Sb)	ND	ND	NC	NC	NC	
Arsenic (As)	1.20	1.10	1.15	0.1	9	Y
Barium (Ba)	19	19	19	0	0	Y
Beryllium (Be)	ND	ND	NC	NC	NC	
Cadmium (Cd)	ND	ND	NC	NC	NC	
Calcium (Ca mg/L)	17	17	17	0	0	Y
Chromium (Cr)	1.20	1.20	1.2	0	0	Y
Cobalt (Co)	ND	ND	NC	NC	NC	
Copper (Cu)	7.40	7.20	7.3	0.2	3	Y
Iron (Fe)	370	370	370	0	0	Y
Lead (Pb)	1.20	1.20	1.2	0	0	Y
Magnesium (Mg mg/L)	2.70	2.80	2.75	0.1	4	Y
Manganese (Mn)	52	48	50	4	8	Y
Molybdenum (Mo)	1.60	1.70	1.65	0.1	6	Y
Nickel (Ni)	16	16	16	0	0	Y
Selenium (Se)	ND	ND	NC	NC	NC	
Silver (Ag)	ND	ND	NC	NC	NC	
Thallium (Tl)	ND	ND	NC	NC	NC	
Vanadium (V)	0.79	0.75	0.77	0.04	5	Y
Zinc (Zn)	ND	ND	NC	NC	NC	

All samples analyzed at EPA Region I Laboratory in Chelmsford, MA. QAPP specifies less than 30% RPD as acceptable for field duplicate. **ND**= non-detect, **NC**= not calculated.

The data quality objectives for field accuracy met the measurement performance criteria for a majority of dissolved metals during all surveys. Exceptions include the following:

1. Relative percent differences of 35% and 31% were calculated for the iron (Fe) sample and zinc (Zn) sample, both collected on 6/19/2007 at station TM8. These data were qualified as (J) since the relative percent differences exceeded the DQO of 30%, however the data was considered to be usable although the RPD should be taken into consideration when using the data for mass loadings calculations and for interpreting results.

2. Relative percent differences of 81% and 83% were calculated for the iron (Fe) sample and lead (Pb) sample, both collected on 8/21/2007 at station TM3. These data were not used for analysis.

Analytical Bias

Analytical bias was evaluated using method blanks, laboratory check standards (LCS) (or quality check standards (QCS) for metals analysis, as defined by the EPA Lab), and matrix spikes (Table 37). Each of these control samples were run once per batch.

Table 37. Measurements of Analytical Bias and Data Quality Objectives.

Parameter	*LCS DQO*	*Method Blank DQO*	*Matrix Spike DQO*
Ammonia Nitrogen	± 10%	< QL	± 10%
Nitrate-Nitrite Nitrogen	± 10%	< ½ QL	± 10%
Total Kjehldahl Nitrogen	± 20%	< QL	± 25%
Total Phosphorus	± 10%	< ½ QL	± 10%
Dissolved Metals	± 10%	< ½ RL	± 30%
Fecal Coliform Bacteria	NA	< 1 cfu/ml	NA

QL= Quantitation Limit, RL= Reporting Limit, NA= not applicable

Method blanks for all nutrient analysis were below quantitation limits (or ½ QL). Method blanks were not run for fecal coliform bacteria. Method blanks for all metals were below reporting limits (RL) with the following exception.

1. For samples collected on March 6, 2008, the laboratory reagent blanks for lead and manganese were above the reporting limits. For lead, laboratory reagent blank concentration was 0.53 ug/l (the reporting limit is 0.50 ug/l). For manganese the laboratory reagent concentration was 1.1 ug/l (the reporting limit is 0.50).

Laboratory check standard deviations for all parameters met data quality objectives (Table 38).

Table 38. Matrix Spike Data Quality Objective Results.

Date	*Parameter*	*% Recovery*	*Acceptable Limits*	*Qualifier*
5/21/07	Total Phosphorus	86	90-110	J- acceptable
6/19/07	Nitrate-Nitrite	115	90-110	J- acceptable
7/31/07	Nitrate-Nitrite	83	90-110	J- acceptable
7/31/07	Total Phosphorus	74	90-110	J- acceptable
8/21/07	Nitrate	112	90-110	J- acceptable
9/04/07	Total Phosphorus	150	90-110	J- acceptable
9/12/07	Total Phosphorus	77	90-110	J- acceptable
8/01/08	Nitrate-Nitrite	81	90-110	J- acceptable
8/01/08	Total Phosphorus	88	90-110	J- acceptable

After review of LCS and QCS, method blank, and matrix spike results, analytical bias was considered acceptable for all parameters for the entire project.

Field Bias

Field-blank samples were submitted to determine bias from contamination in the field. Field-blanks were only submitted with metals analyses. Field-blank contamination was suspected when measured values exceeded the corresponding reporting limits. Without exception, all submitted field-blank measurement values were below reporting limits.

Additional Data Evaluation (2013)

During development of the total phosphorus TMDLs for Central Pond, Turner Reservoir, and Omega Pond, it was determined that the total phosphorus value obtained from station TM8 on Sept. 12, 2007 was likely contaminated. The value of 0.159 mg/l was three times higher than the total phosphorus values obtained from the other 7 stations during that same time period. There was no evidence of sediment release of phosphorus. Approximately two inches of rain fell in the 2 days prior to sampling, however none of the other stations had concentration data that was elevated, relative to dry weather concentrations.

Data Completeness

The measurement performance criteria for data completeness for all parameters are given in Section 11 of the approved QAPP. To summarize, data are considered to be complete if the data collected are considered to be usable. For all parameters, the QAPP sets a goal of 100%. For the most part, this was accomplished and nearly all of the data collected were considered usable for TMDL assessment analysis. **The following results were not acceptable and were not included in any analysis:**

1. Ammonia Nitrogen sample collected on 6/19/2007 at Station TM5.
2. Total Kjeldahl Nitrogen sample collected on 3/6/2008 at station TM1, and
3. Total Phosphorus sample collected on 3/6/2008 at station TM1.
4. Iron (Fe) and lead (Pb) samples collected on 8/21/2007 at TM3.
5. Total Phosphorus sample collected on 9/12/2007 at station TM8.

These results significantly failed to meet field accuracy data quality objectives and could not be qualified.

Results

In-Situ Parameters

Temperature

Surface water temperature data are summarized below. Figure 6 graphically displays median temperatures calculated for each station following segregation by flow and weather condition. All temperature data are presented in Appendix A. Table 1. Black symbols display low flow and dry weather median temperatures and white symbols display high flow-wet weather median temperatures.

As one would expect in an impounded river system, surface water temperatures generally increase between impoundment inflow and outflow. This increase is most notable in Central Pond and least notable in Slater Park Pond. Slight increases are also observed in Omega Pond during low flow conditions. Decreases in shading and the resulting increases in solar radiation, combined with increases in residence time are responsible for these observed increases in temperature. Slight but consistent decreases in temperature were observed downstream of Turner Reservoir. This section of river between station TM5 and TM7 exhibits a higher degree of channel complexity than the remainder of the river and temperatures may be moderated in this segment via subsurface-surface water exchange.

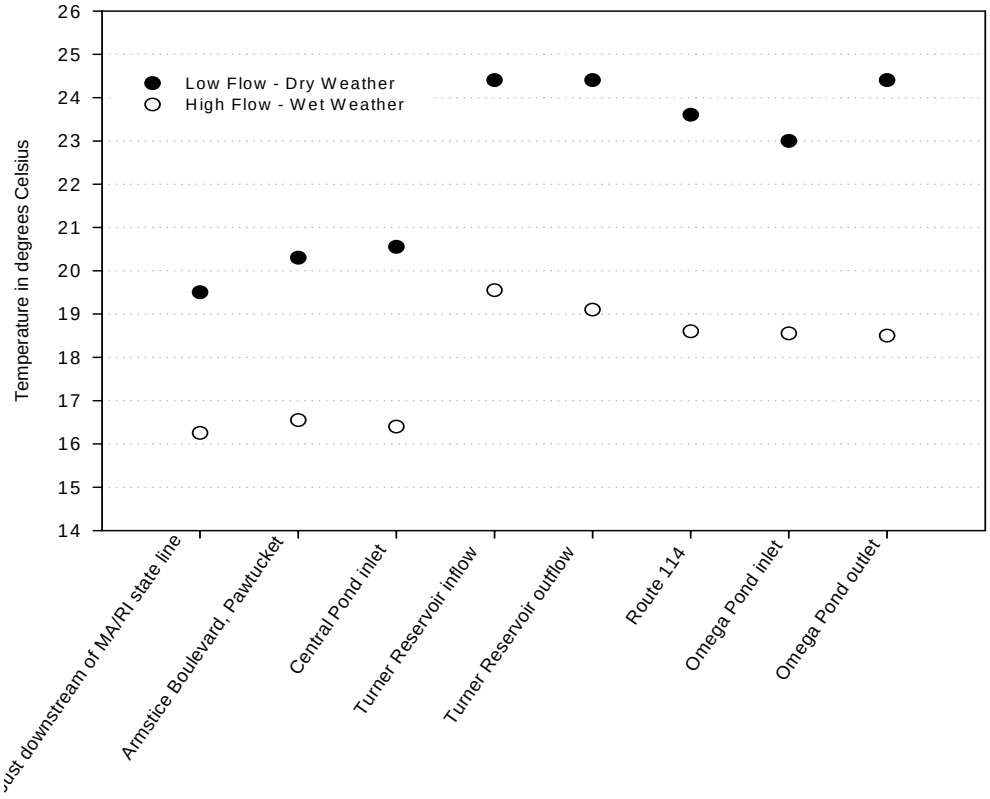

Figure 6. Water temperatures in the Ten Mile River and impoundments.

Specific Conductance

Specific Conductance (SC) is a measure of how well water conducts an electrical current. Conductivity increases with increasing amount and mobility of ions. These ions, which come from the breakdown of compounds, conduct electricity because they are negatively or positively charged when dissolved in water. Therefore, SC is an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron. As such, it can be a useful indicator of water pollution.

Specific conductance can be controlled by:

1. wastewater from sewage treatment plants and other point sources.

2. wastewater from septic systems and drainfield on-site wastewater treatment and disposal systems

3. urban runoff from roads (especially road salt). This source has a particularly episodic nature with pulsed inputs when it rains or during more prolonged snowmelt periods. It may "shock" organisms with intermittent extreme concentrations of pollutants which seem low when averaged over a week or month.

4. agricultural runoff of water draining agricultural fields typically has extremely high levels of dissolved salts. Although a minor fraction of the total dissolved solids, nutrients (ammonium-nitrogen, nitrate-nitrogen and phosphate from fertilizers) and pesticides (insecticides and herbicides mostly) typically have significant negative impacts on streams and lakes receiving agricultural drainage water.

5. atmospheric inputs of ions are typically relatively minor except in ocean coastal zones where ocean water increases the salt load ("salinity") of dry aerosols and wet (precipitation) deposition. This oceanic effect can extend inland about 50-100 kilometers and be predicted with reasonable accuracy.

Specific Conductance data are summarized below in Figure 7 and are provided in full in Appendix A, Table 2.

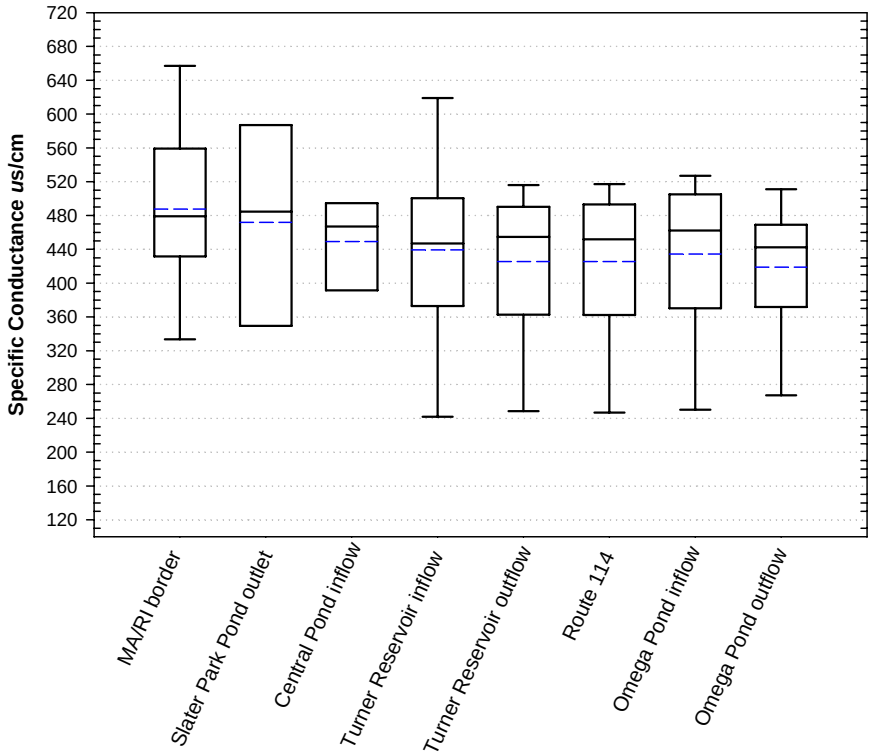

Figure 7. Specific conductance in the Ten Mile River and impoundments.
Box plots include the mean (dashed line in box), median (solid line in box), the 25th-75th percentile range (solid boxes), and maximum and minimum values in dataset (error bars). Sample size (n) is 9 for each station.

Several general conclusions from the available specific conductance data:

1) Median specific conductance values decrease slightly in a downstream direction.

2) Some of the highest values were recorded just downstream of the RI/MA state line and at the outlet of Slater Park Pond.

3) The Attleboro WWTF discharge is approximately 1.0 km upstream of this station and likely has an effect, particularly during low flows.

4) There exists a trend of increasing specific conductance with decreasing flow.

5) Overall, specific conductance values (range of 240-670 us/cm) in the Ten Mile River appear to be similar to those reported in other "urban" rivers in Rhode Island.

In-Situ Dissolved Oxygen

In-situ dissolved oxygen data, as percent saturation, are summarized below in Figure 8 and are provided in full in Appendix A, Table 3. Dissolved oxygen, in mg/l are presented in Appendix A, Table 4. These data are limited in usefulness with respect to providing insight into dissolved oxygen dynamics and trends in the Ten Mile River system. The purpose of the in-situ recordings was to confirm that oxygen concentrations were above the state's mg/l and percent saturation criterion. Continuous dissolved oxygen data are discussed later in this report.

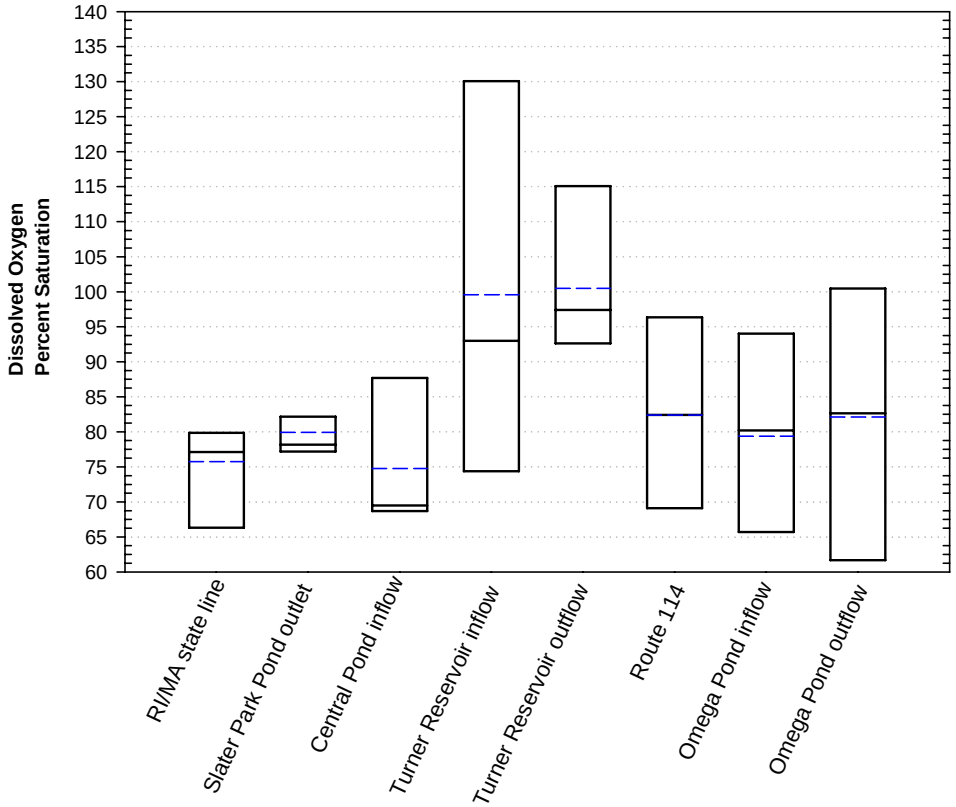

Figure 8. Dissolved oxygen as percent saturation in the Ten Mile River and impoundments.
Box plots include the mean (dashed line in box), median (solid line in box), the 25th-75th percentile range (solid boxes), and maximum and minimum values in dataset (error bars). Sample size (n) is 9 for each station.

Conventional Parameters

Fecal Coliform Bacteria

A summary of fecal coliform concentrations is plotted in Figure 8 and all data are presented in AppendixB, Table A. Laboratory results indicate that for most surveys, the highest fecal coliform concentrations occurred at stations TM1, TM2, and TM3. The overall downward trend in concentration from the MA/RI border to the Turner Reservoir is evident in Figure 8. A slight upward concentration trend can be seen from the outlet of the reservoir to the outlet of Omega Pond, however this increase is inconsistent between surveys and is not isolated to either dry (low flow) or wet weather (high flow) influenced conditions. Variability remains fairly consistent in the downstream direction.

Table 39 presents geometric mean and percentile statistics calculated using dry and wet weather influenced data (as defined in Table 8). With the exception of Turner Reservoir, all waterbody segments in the Ten Mile River exhibit elevated wet weather (high flow) influenced fecal coliform bacteria levels relative to those during dry weather and low flow. Based on plotted data, there was no significant relationship between concentration and river flow at any of the eight stations within the survey area.

Applicable criteria for fecal coliform bacteria in surface waters are taken from Table 1.8.D. (2) of DEM's Water Quality Regulations (DEM 2009). The fecal coliform criteria for Class B waters apply to all segments in the Ten Mile River and impoundments. For Class B waters, fecal coliform bacteria concentrations are not to exceed a geometric mean value of 200 MPN and not more than 10% of the samples shall exceed a value of 400 MPN. This is the primary contact recreational/swimming criteria for freshwater.

For assessment purposes[1], geometric mean and 90th percentile statistics for each waterbody segment were calculated and compared to the criteria described above. This analysis is shown in Table 40. Sampling stations were sorted such that they represented specific waterbody segments in the mainstem and impoundments and data were pooled accordingly. The entire Turner Reservoir and the lower portion of the Ten Mile River to Omega Pond appear to meet all applicable criteria for fecal coliform, while the upper Segment (01A) of the Ten Mile River, Slater Park Pond, and Omega Pond fail to meet one or both portions of the criteria. In summary:

- The 2007 data confirm the existing fecal coliform listing for Slater Park Pond.
- New 303d listings for fecal coliform bacteria may be necessary for the upper segment of the Ten Mile River and Omega Pond, which are not currently listed.
- Both portions of the Turner Reservoir meet applicable criteria for fecal coliform bacteria and it may be worth considering removing this parameter from the current 303d List.

[1] Swimming (recreational use) is currently assessed using enterococci data. If none exists, fecal coliform data is used.

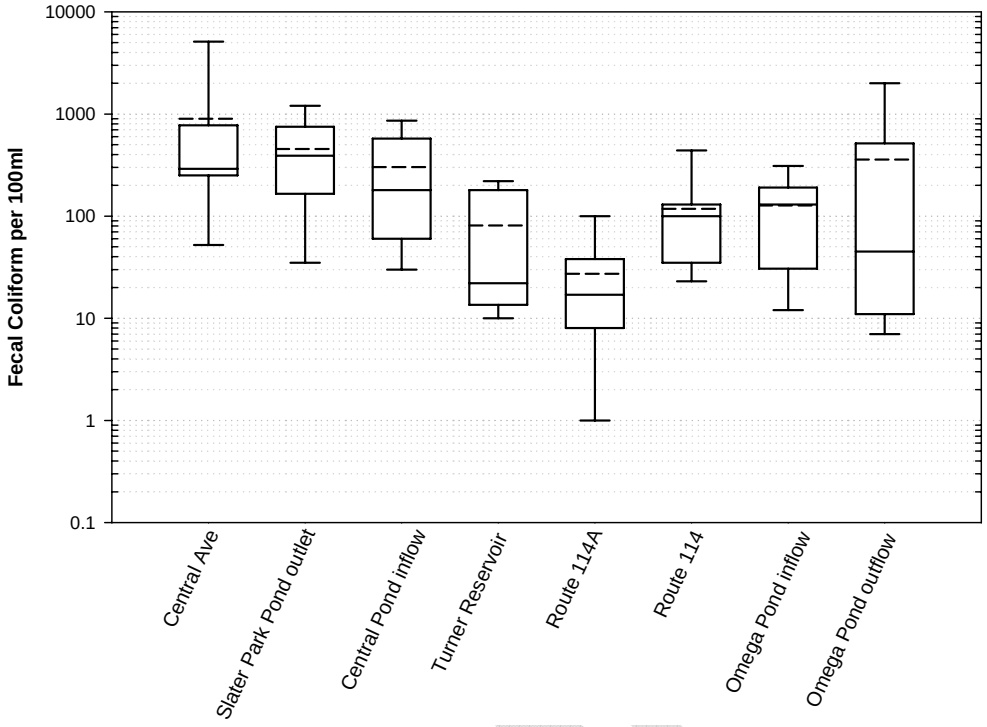

Figure 9. Fecal coliform concentrations in the Ten Mile River and impoundments.
Box plots include the mean (dashed line in box), median (solid line in box), the 25th-75th percentile range (solid boxes), and maximum and minimum values in dataset (error bars). Sample size (n) is 9 for each station.

Table 39. Statistical analysis of dry and wet weather-influenced fecal coliform data.

Waterbody Name	Waterbody Segment ID	Representative Station(s)	DW Geometric Mean Value	DW 90th Percentile Value	WW Geometric Mean Value	WW 90th Percentile Value
Ten Mile River	RI0004009R-01A	TM1	187	352	392	2370
		TM3				
Slater Park Pond	RI0004009L-02	TM2	333	596	269	1074
Turner Reservoir	RI0004009L-01A	TM4	29	124	66	214
Turner Reservoir	RI0004009L-01B	TM4	19	78	29	206
		TM5				
Ten Mile River	RI0004009R-01B	TM5	47	146	41	291
		TM6				
		TM7				
Omega Pond	RI0004009L-03	TM8	24	67	78	1664

Table 40. Fecal Coliform Summary[1] for Ten Mile River and Impoundments.

Waterbody Name	Waterbody Segment ID	Class	Representative Station(s)	Total Number of Samples	Geometric Mean Value	90th[2] Percentile Value
Ten Mile River	RI0004009R-01A	B	TM1	18	**260**	**962**
		B	TM3			
Slater Park Pond	RI0004009L-02	B	TM2	9	**303**	**864**
Turner Reservoir	RI0004009L-01A	B	TM4	9	42	204
Turner Reservoir	RI0004009L-01B	B	TM4	18	23	172
		B	TM5			
Ten Mile River	RI0004009R-01B	B	TM5	27	44	182
		B	TM6			
		B	TM7			
Omega Pond	RI0004009L-03	B	TM8	9	66	**1104**

[1] Includes all fecal coliform data collected by RIDEM in 2007 and 2008.

Total Phosphorus

A statistical summary of total phosphorus data collected during the nine surveys is presented in Figure 10 and all data are provided in tabular form in Appendix B, Table 2. No samples collected from any of the eight stations during any of the nine surveys exhibited a total phosphorus concentration below the State of Rhode Island's 0.025 mg/l TP criteria (shown in Figure 10). Survey median total phosphorus concentrations ranged from a maximum of 0.065 mg/l at the outflow of Slater Park Pond to a minimum of 0.052 mg/l at the inflow to Central Pond. The most elevated watershed wide phosphorus concentrations occurred during the July 31 and Aug 21, 2007 surveys with all station median values notably higher than during other surveys. There is no relationship between total phosphorus concentration and river flow at any of the eight stations within the Ten Mile.

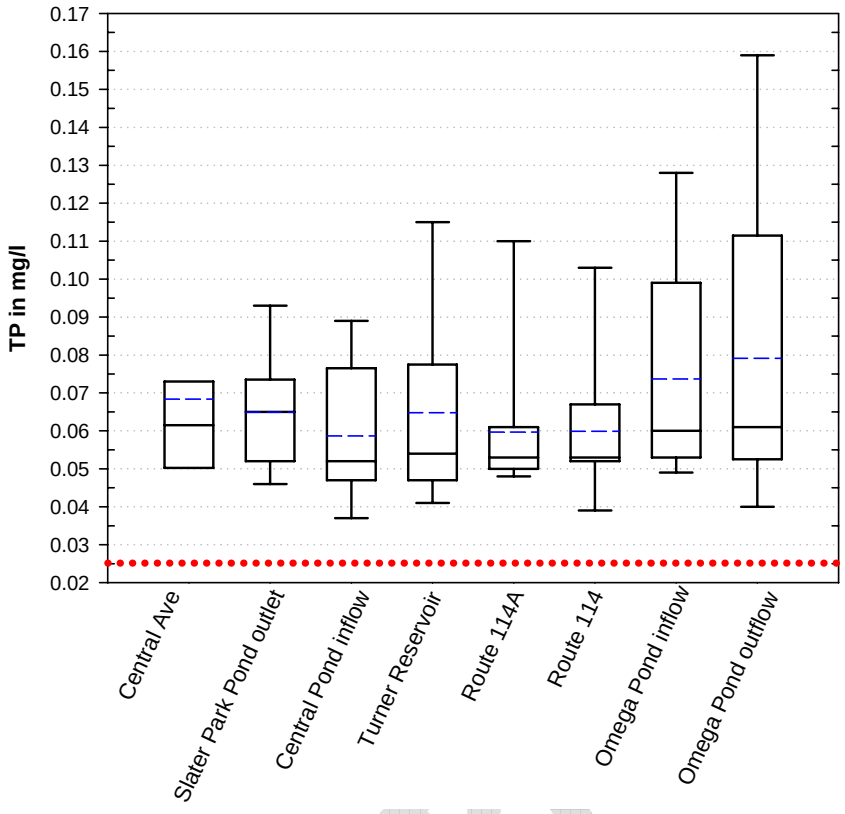

Figure 10. Total Phosphorus concentrations in the Ten Mile River and impoundments.
Box plots include the mean (dashed line in box), median (solid line in box), the 25th-75th percentile range (solid boxes), and maximum and minimum values in dataset (error bars). Sample size (n) is 9 for each station. Red dotted line represents 0.025 mg/l criteria.

The criteria for total phosphorus are located in Table 1 of DEM's Water Quality Regulations (DEM 2009), which states that *"average total phosphorus shall not exceed 0.025 mg/l in any lake, pond, kettlehole, or reservoir, and average total phosphorus in tributaries at the point where they enter such bodies of water shall not cause exceedance of this phosphorus criteria."* This criterion applies only to Slater Park Pond, Turner Reservoir, and Omega Pond. It does not apply to free-flowing river sections of the Ten Mile River. Survey mean total phosphorus concentrations in Slater Park Pond, Turner Reservoir, and Omega Pond were fairly consistent (0.065 mg/l, 0.065 mg/l, and 0.079 mg/l, respectively). These data confirm the total phosphorus impairments for these waterbodies as described on the 2008 303d List.

Nitrogen

Water samples were analyzed for several forms of nitrogen including nitrate (NO3-N), nitrite (NO2-N), ammonia (NH3), and total Kjeldahl nitrogen (TKN). From these data, total nitrogen (TN), organic nitrogen (ON), and dissolved inorganic nitrogen (DIN) were calculated. Plots of nitrate and ammonia as well as calculated total nitrogen are provided in Figures 11-14. All nitrogen data are provided in tabular form in Appendix B, Tables C-F.

The principal form of nitrogen in the Ten Mile River system under all survey conditions was nitrate. Given the existence of two wastewater treatment facilities in the watershed, this is not unexpected. As shown in Figure 11, nitrate concentrations are fairly consistent in the section of the Ten Mile River between Central Avenue (at the MA/RI state line) and the inflow of Central Pond, indicating that little or no uptake is occurring in the river. Mean nitrate concentrations then drop significantly from 2.59 mg/l at the inlet of Central Pond to 0.82 mg/l at the outlet of the Pond.

Central Pond is a shallow impoundment characterized by significant wetland areas near the inflow of the pond. Average depth of the pond is approximately 1.3 meters (4.2 feet). The sediments in the northern third of the pond are composed mainly of organic material and fine sediment. The significant drop in median nitrate concentration downstream of Central Pond is likely due to a combination of denitrification in the sediments and uptake by phytoplankton. Median nitrate concentrations continue to decline in a downstream direction with notable drops in concentration occurring just downstream of the Turner Reservoir (from 0.82 mg/l upstream to 0.54 mg/l downstream) and Omega Pond (0.62 mg/l upstream to 0.38 mg/l downstream).

Ammonia nitrogen concentrations are fairly low at all stations, ranging from a survey median of 0.30 mg/l at Central Avenue, located just downstream of the Attleboro WWTF discharge to.0.18 mg/l at Omega Pond (Figure 12). The highest ammonia concentrations within the Ten Mile River and impoundments occurred during the May 22, 2007 survey with a maximum ammonia concentration of 1.30 mg/l observed at Central Ave. Ammonia toxicity increases with increasing pH and increasing temperature. Neither chronic nor acute violations of the state's ammonia criteria were observed at any of the stations during the nine surveys.

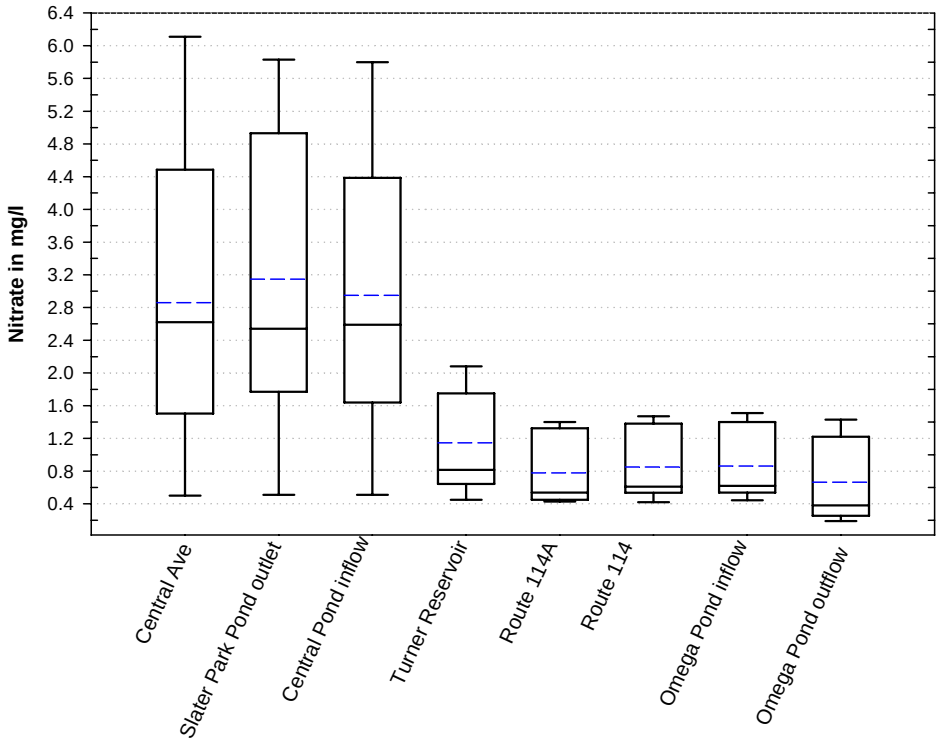

Figure 11. Nitrate-nitrogen concentrations in the Ten Mile River and impoundments.
Box plots include the mean (blue dashed line in box), median (solid line in box), the 25th-75th percentile range (solid boxes), and maximum and minimum values in dataset (error bars). Sample size (n) is 9 for each station.

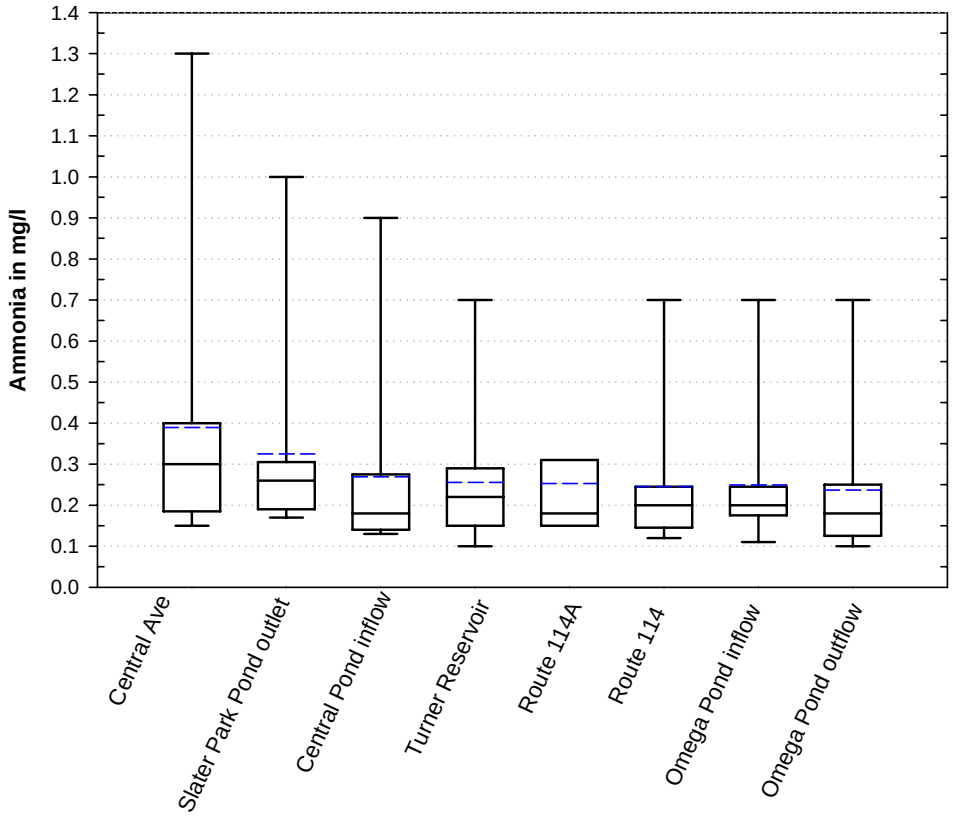

Figure 12. Ammonia-nitrogen concentrations in the Ten Mile River and impoundments.
Box plots include the mean (blue dashed line in box), median (solid line in box), the 25th-75th percentile range (solid boxes), and maximum and minimum values in dataset (error bars). Sample size (n) is 9 for each station.

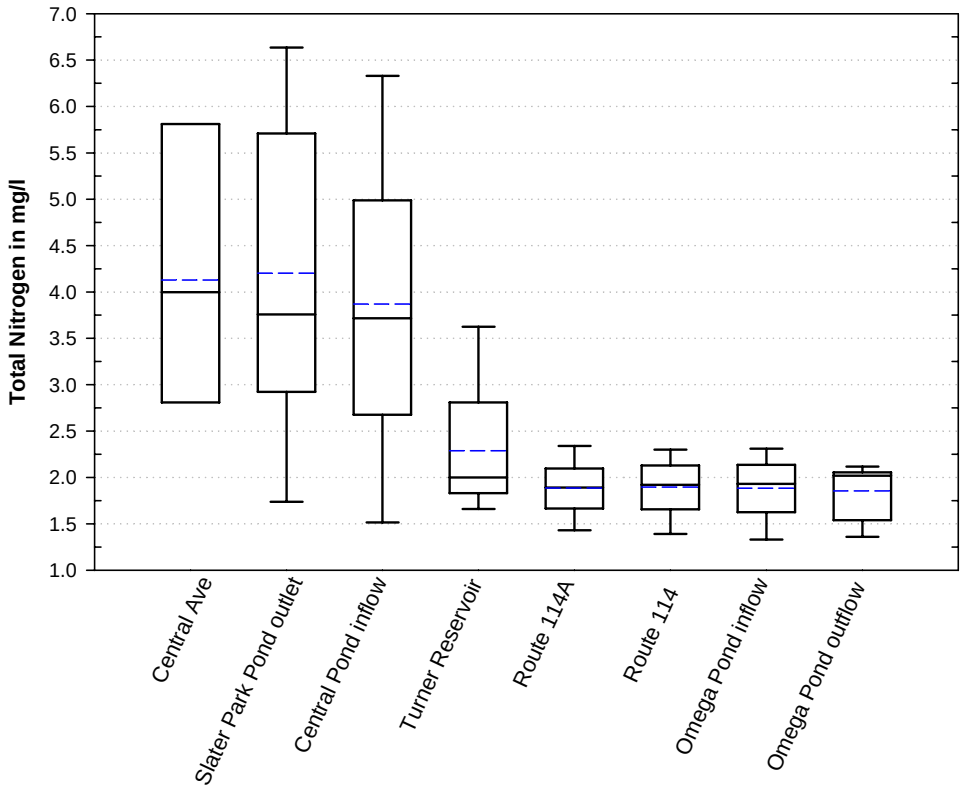

Figure 13. Total Nitrogen (TN) concentrations in the Ten Mile River and impoundments.
Box plots include the mean (blue dashed line in box), median (solid line in box), the 25th-75th percentile range (solid boxes), and maximum and minimum values in dataset (error bars). Sample size (n) is 9 for each station.

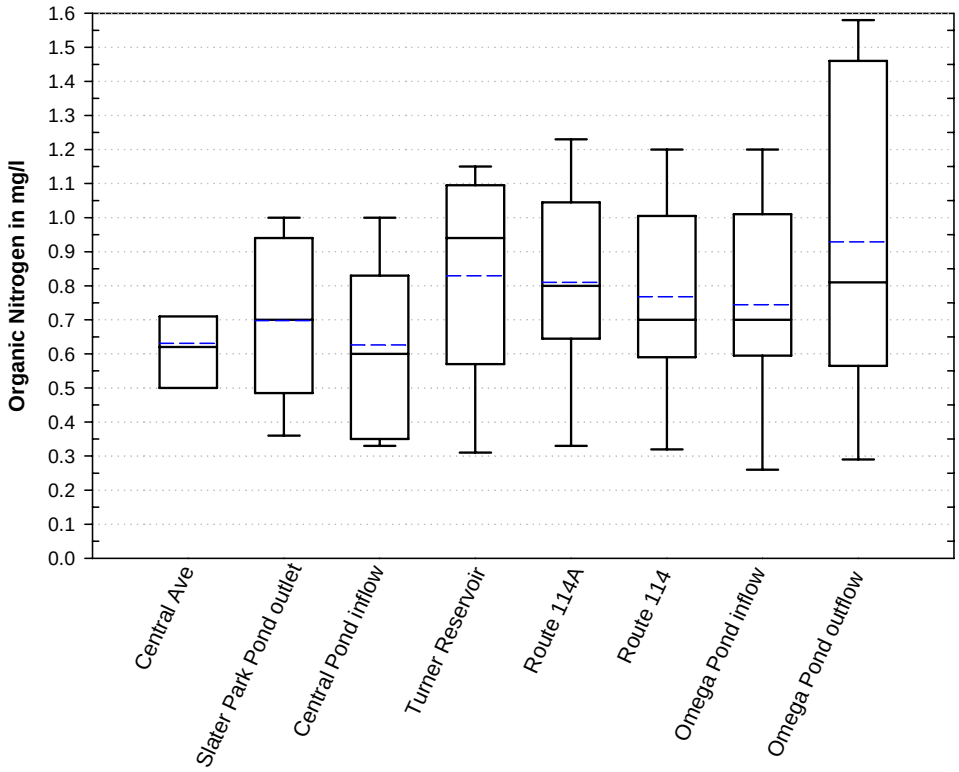

Figure 14. Organic Nitrogen concentrations in the Ten Mile River and impoundments.
Box plots include the mean (blue dashed line in box), median (solid line in box), the 25th-75th percentile range (solid boxes), and maximum and minimum values in dataset (error bars). Sample size (n) is 9 for each station.

Dissolved Metals

Metals are introduced in aquatic systems naturally as a result of the weathering of soils and rocks and from a variety of human activities involving the mining, processing, or use of metals and/or substances that contain metal pollutants. The most common heavy metal pollutants are arsenic, cadmium, chromium, copper, nickel, lead, and mercury. Trace metals are generally found in higher concentrations in urbanized and urbanizing areas than in natural systems, due to increased numbers of people, roads, vehicles, and building materials introduced into the landscape. Heavy metals, especially copper, lead, cadmium, and zinc, are by far the most common priority pollutants found in urban runoff with copper being suggested as presenting the most significant threat to aquatic biota (USEPA, 1983).

The Ten Mile River, Central Pond, Turner Reservoir, and Omega Pond all have aquatic life impairments for several metals including copper, cadmium, and lead. These listings

were based on historic data collected by the Narragansett Bay Commission in 2000 and 2001. Given the historic industrial activity along the river, the existence of two wastewater treatment facilities, and the highly urbanized nature of the watershed, it was felt that metals analysis should be included in the 2007 and 2008 monitoring program.

All surface water samples sent to the EPA Laboratory in Chelmsford, MA were analyzed for both the dissolved and total fractions of a suite of metals (listed in Table 13). The metals of concern (on the states 303(d) list) are dissolved Cd, Cu, and Pb. Both dissolved and total fractions of other metals were evaluated relative to current water quality criteria. This evaluation revealed exceedances of the chronic criteria for total aluminum and total iron in the Ten Mile River, Slater Park Pond, Central Pond, and Omega Pond. These data will be discussed later in this report. All dissolved metals data are presented in tabular form in Appendix C, Tables A-I.

Dissolved Cadmium

Dissolved cadmium data, segregated by weather and flow condition are presented graphically in Figure 15. The highest dry and wet weather median and maximum values for dissolved cadmium were found at station TM1, located approximately 1km downstream of the Attleboro WWTF discharge and just downstream of the RI/MA state line. The statistics in Figure X show that, overall, the most elevated levels of cadmium in the Ten Mile River and impoundments occur during high flow/wet weather conditions. This suggests either:

1. Introduction of cadmium into the river or its impoundments via point sources such as stormwater or,

2. Resuspension of sediment-bound cadmium into the water column due to elevated flows, streambank and streambed scour.

Cadmium is a relatively rare element that is a minor nutrient for plants at low concentrations (Lane and Morel 2000; Lee et al. 1995; Price and Morel 1990), but is toxic to aquatic life at concentrations only slightly higher. It occurs mainly as a component of minerals in the earth's crust at an average concentration of 0.18 ppm (Babich and Stotzky 1978). Cadmium levels in soils usually range from approximately 0.01 to 1.8 ppm (Lagerwerff and Specht 1970). In natural freshwaters, cadmium sometimes occurs at concentrations of less than 0.1 μg/L, but in environments impacted by man, concentrations can be several micrograms per liter or greater (Abbasi and Soni 1986; Allen 1994; Annune et al. 1994; Flick et al. 1971; Friberg et al. 1971; Henriksen and Wright 1978; Nilsson 1970; Spry and Wiener 1991). Cadmium can enter the environment from various anthropogenic sources, such as by-products from zinc refining, coal combustion, mine wastes, electroplating processes, iron and steel production, pigments, fertilizers and pesticides (Hutton 1983; Pickering and Gast 1972).

Cadmium compounds are used in a wide-range of products, including electroplating, fabrics, plastics, ceramics and glass, paints, tires, and other electronics. This makes the presence of cadmium in surface waters nearly ubiquitous in areas with high levels of

urbanization, including commercial and industrial land uses. Stormwater runoff typically contains traces of cadmium derived from tires, vehicle lubricants, exhaust fumes, and cigarette butts.

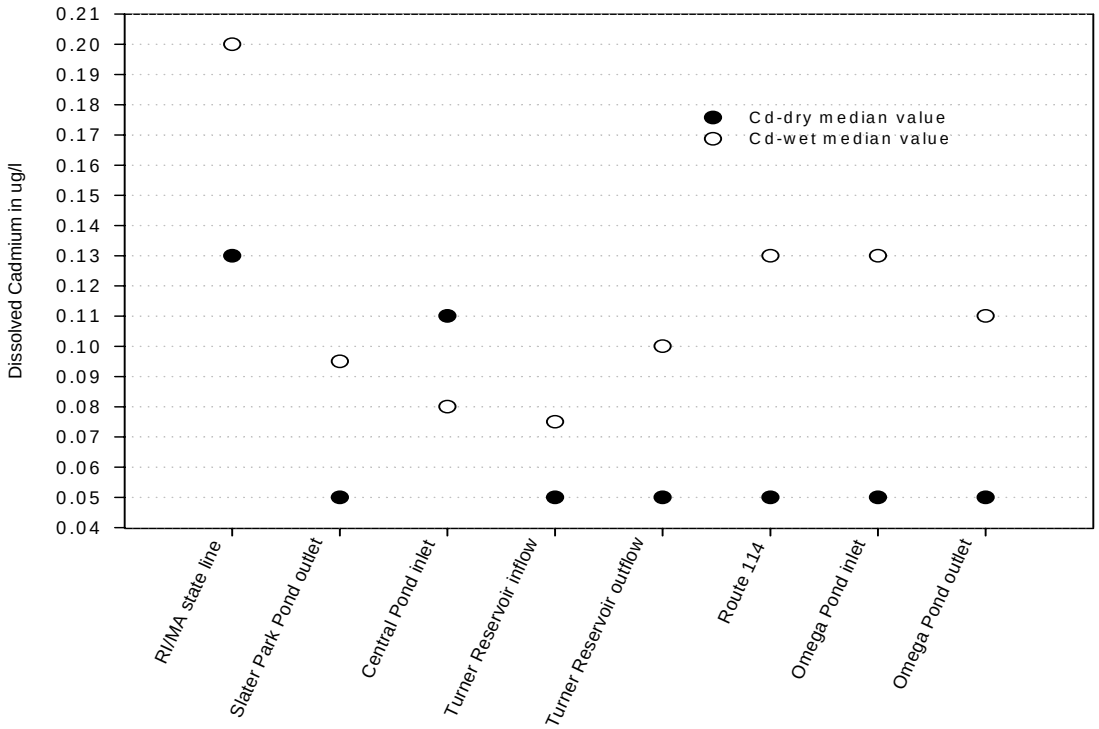

Figure 15. Dissolved Cadmium concentrations in the Ten Mile River and impoundments.
Data are segregated by weather/flow. Each symbol represents a calculated median value for that station from a sample size of n=9. Black symbols represent those samples collected during dry weather/low flow conditions. White symbols represent those samples collected during wet weather/high flow conditions.

Dissolved Lead

Dissolved lead data, segregated by weather/flow condition are presented graphically in Figure 16. The highest median and maximum values for dissolved lead were found at station TM1, located approximately 1km downstream of the Attleboro WWTF discharge and just downstream of the RI/MA state line. Both dry and wet weather median lead values then exhibit a decreasing trend in the downstream direction. Overall, median wet weather-high flow lead values are slightly elevated with respect to dry weather.

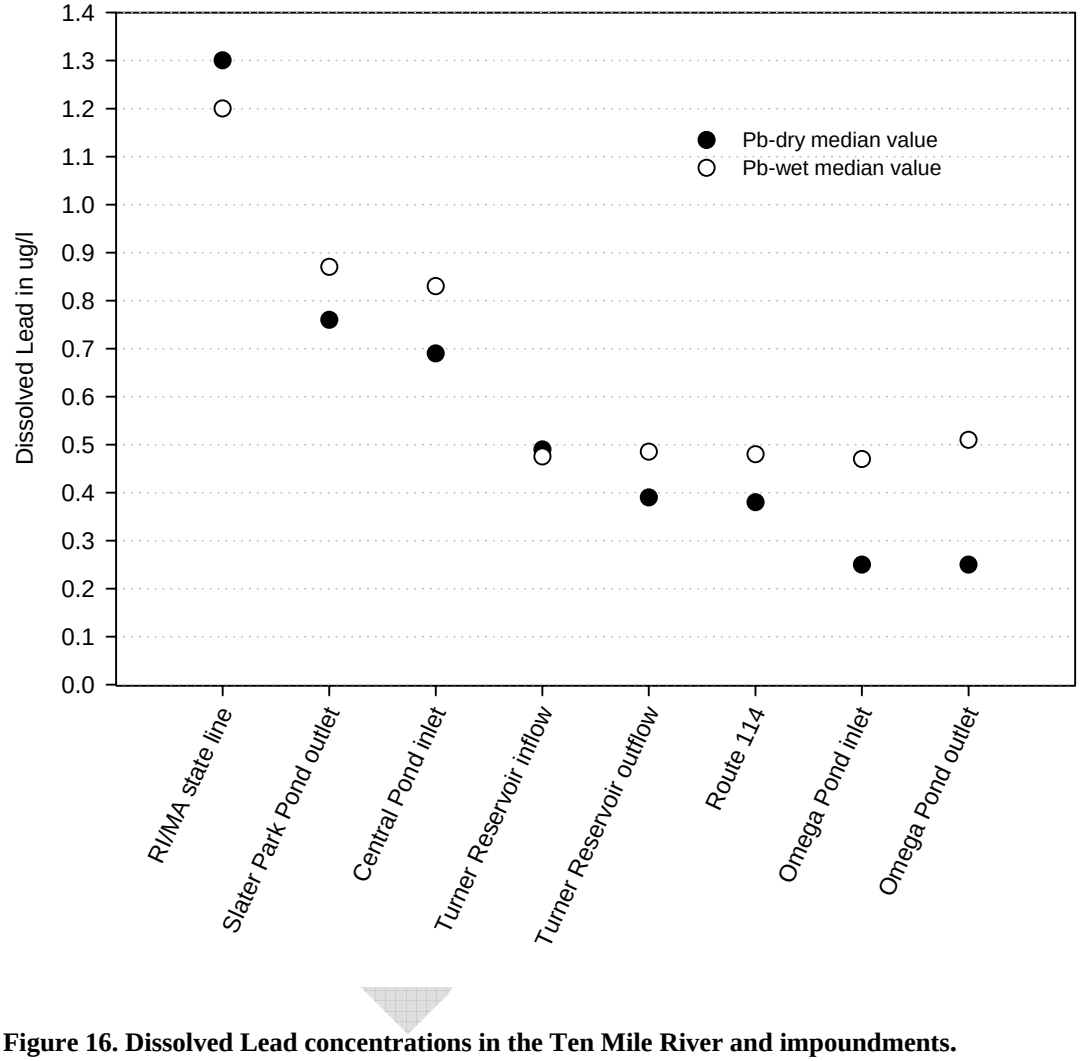

Figure 16. Dissolved Lead concentrations in the Ten Mile River and impoundments.
Data are segregated by weather/flow. Each symbol represents a calculated median value for that station from a sample size of n=9. Black symbols represent those samples collected during dry weather/low flow conditions. White symbols represent those samples collected during wet weather/high flow conditions.

No lead is added at sewage treatment works as part of the treatment process.
Any lead in sewage effluent is there because it has somehow entered the sewerage system via drains in homes, or business premises, or from drains in the streets and roads. The main routes by which lead containing materials can end up in sewage and subsequently in surface waters (http://www.water.org.uk/static/files_archive/1Lead_-_Water_UK.pdf :

Industrial activities

- any businesses using lead solders, working lead sheet, or handling lead-acid batteries may allow particles containing lead or battery acid containing lead to get into the drains.

Service activities

- oil based fuels and lubricants and brake fluids contain trace amounts of lead and any spills in garages and workshops may therefore result in trace amounts of lead being washed down the drain.

Run-off

- particles of dust from vehicle exhaust fumes contain some lead, even though leaded fuels are still not used; these particles will be washed off streets and pavements down road drains when it rains.

Domestic activities

- lead occurs naturally in most foods and so is present in all human wastes which are flushed down the toilet.

- trace amounts of lead are known to be present in detergents, bleach and toiletries such as shampoo; water from washing and bathing may therefore contain minute amounts of lead when it is flushed away.

- lead pipes in older houses may leach small amounts of lead into the water supply and be flushed down drains.

- Domestic water supply

Dissolved Copper

Dissolved copper data, segregated by weather/flow condition are presented graphically in Figure 17. As with cadmium and lead, median high and low flow copper concentrations are highest in the upper segments of the Ten Mile River, near the state line. From the state line to in the inlet of Central Pond, median wet weather copper concentrations are higher than those during dry weather. The opposite is true for the remainder of the river system with dry weather median copper concentrations notably higher than during wet weather.

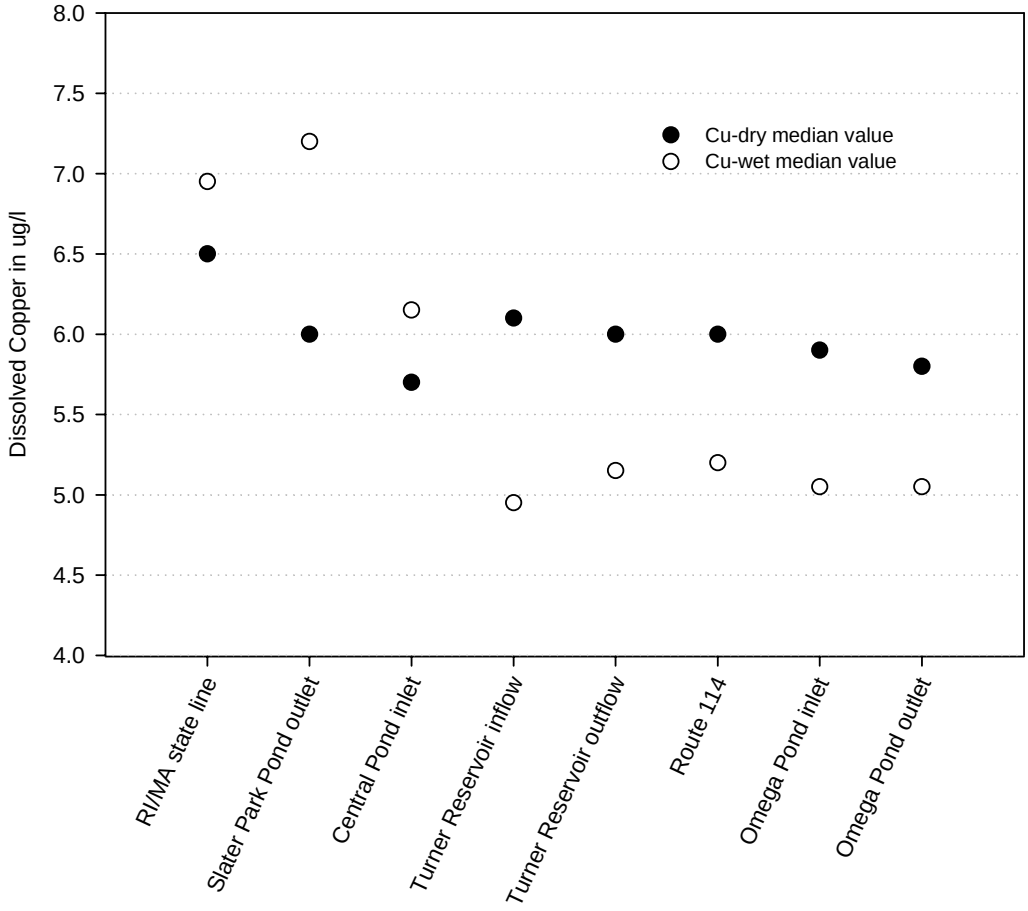

Figure 17. Dissolved Copper concentrations in the Ten Mile River and impoundments.
Data are segregated by weather/flow. Each symbol represents a calculated median value for that station from a sample size of n=9. Black symbols represent those samples collected during dry weather/low flow conditions. White symbols represent those samples collected during wet weather/high flow conditions.

Copper is an abundant trace element found in the earth's crust and is a naturally occurring element that is generally present in surface waters (Nriagu, 1979). Copper is a micronutrient for both plants and animals at low concentrations and is recognized as essential to virtually all plants and animals (Kapustka et al., 2004). However, it may become toxic to some forms of aquatic life at elevated concentrations. Thus, copper concentrations in natural environments, and its biological availability, are important. Naturally occurring concentrations of copper have been reported from 0.03 to 0.23 ug/L in surface seawaters and from 0.20 to 30 ug/L in freshwater systems (Bowen, 1985).

Copper concentrations in locations receiving anthropogenic inputs can vary anywhere from levels that approach natural background to 100 ug/L or more (e.g., Lopez and Lee, 1977; Nriagu, 1979; Hem, 1989) and have in some cases been reported in the 200,000 ug/L range in mining areas (Davis and Ashenberg, 1989; Robins et al., 1997). Mining,

leather and leather products, fabricated metal products, and electric equipment are a few of the industries with copper-bearing discharges that contribute to anthropogenic inputs of copper to surface waters (Patterson et al., 1998).

Total Metals

All total metals data are presented in tabular form in Appendix D, Tables J-R.

Total Iron

A statistical summary of total iron data collected during the nine surveys is presented in Figures 18.

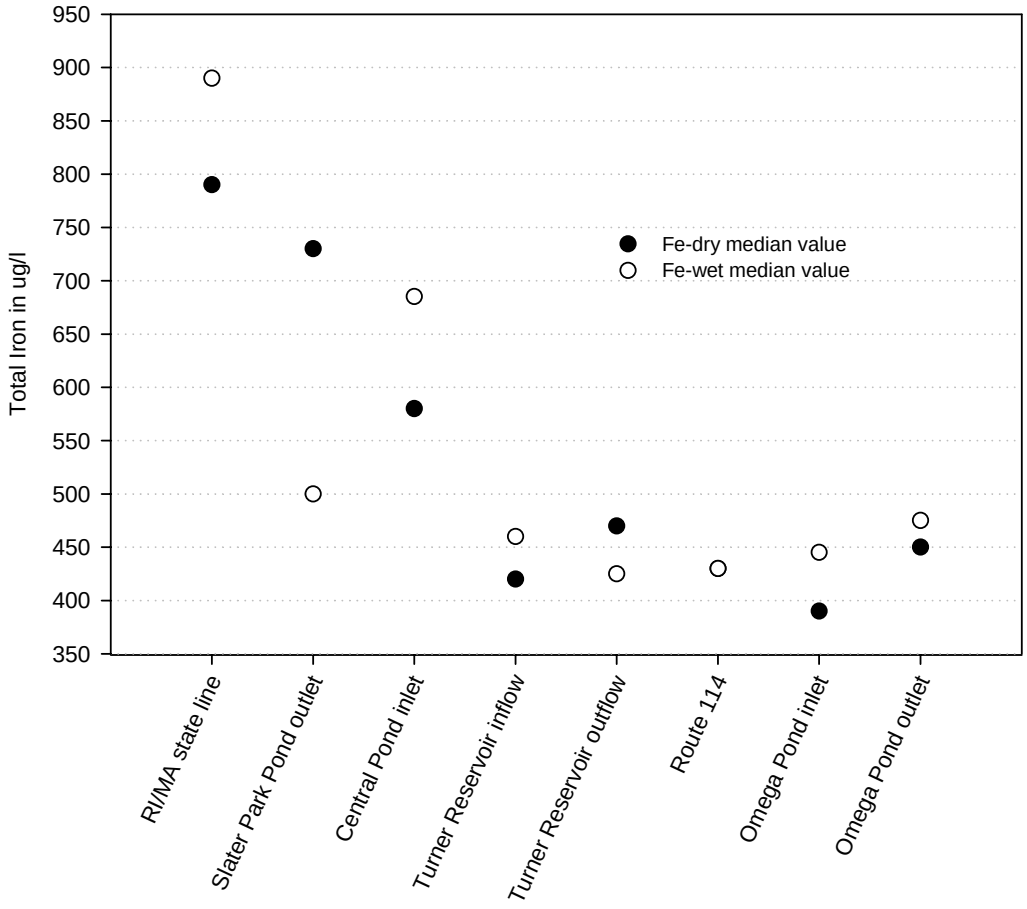

Figure 18. Total Iron concentrations in the Ten Mile River and impoundments.
Data are segregated by weather/flow. Each symbol represents a calculated median value for that station from a sample size of n=9. Black symbols represent those samples collected during dry weather/low flow conditions. White symbols represent those samples collected during wet weather/high flow conditions.

Total Aluminum

A statistical summary of total aluminum data collected during the nine surveys is presented in Figure 19 and all data are provided in tabular form in Tables 2 and 3 Appendix A. Median aluminum concentrations are highest at the RI/MA state line and proceed to decrease in a downstream direction. Slight increases in wet weather-high flow median aluminum values are seen from the Turner Reservoir outflow to Omega Pond.

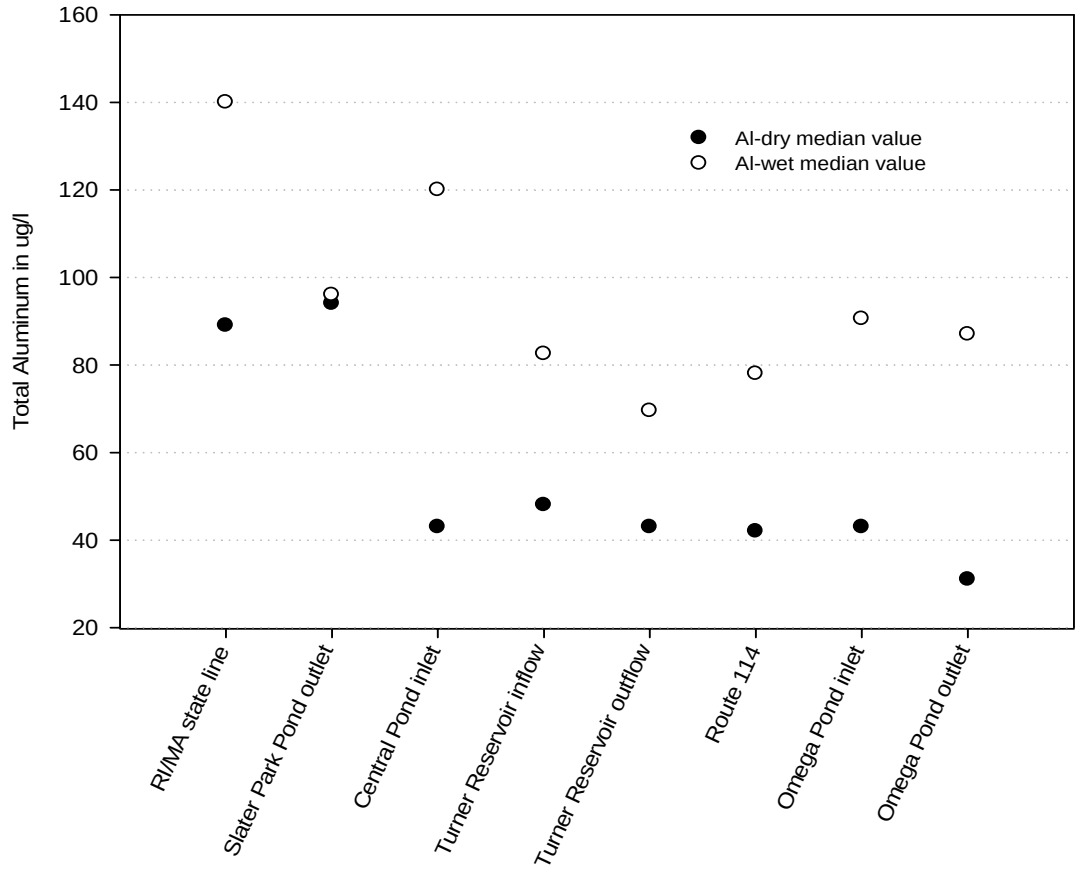

Figure 19. Total Aluminum concentrations in the Ten Mile River and impoundments.
Data are segregated by weather/flow. Each symbol represents a calculated median value for that station from a sample size of n=9. Black symbols represent those samples collected during dry weather/low flow conditions. White symbols represent those samples collected during wet weather/high flow conditions.

The following information relating to aluminum was taken from United Nations Environment Programme -Environmental Health Criteria 194

http://www.inchem.org/documents/ehc/ehc/ehc194.htm

Aluminum is released to the environment both by natural processes and from anthropogenic sources. It is highly concentrated in soil-derived dusts from such activities as mining and agriculture, and in particulate matter from coal combustion. Aluminum silicate (clays), a major component of soils, contribute to the aluminum levels of dust. Natural processes far outweigh direct anthropogenic contributions to the environment. Mobilization of aluminum through human actions is mostly indirect and occurs as a result of emission of acidifying substances. In general, decreasing pH results in an increase in mobility and bioavailability for monomeric forms of aluminum.

Aluminum occurs ubiquitously in the environment in the form of silicates, oxides and hydroxides, combined with other elements such as sodium and fluorine and as complexes with organic matter. It is not found as a free metal because of its reactivity. It has only one oxidation state (+3) in nature; therefore, its transport and distribution in the environment depend only upon its coordination chemistry and the chemical-physical characteristics of the local environmental system. At pH values greater than 5.5, naturally occurring aluminum compounds exist predominantly in an undissolved form such as gibbsite ($Al(OH)_3$) or as alumino-silicates, except in the presence of high amounts of dissolved organic material, which binds with aluminum and can lead to increased concentrations of dissolved aluminum in streams and lakes.

Several factors influence aluminum mobility and subsequent transport within the environment. These include chemical speciation, hydrological flow paths, soil-water interactions, and the composition of the underlying geological materials. The solubility of aluminum in equilibrium with solid phase $Al(OH)_3$ is highly dependent on pH and on complexing agents such as fluoride, silicate, phosphate and organic matter. The chemistry of inorganic aluminum in acid soil and stream water can be considered in terms of mineral solubility, ion exchange and water mixing processes.

Metals Violations in the Ten Mile River and Impoundments

The water quality standards for toxics, including dissolved metals, set forth in Appendix B of the state of Rhode Island Department of Environmental Management Water Quality Regulations (DEM 2006) state that "to protect aquatic life, the one-hour average concentration of a pollutant should not exceed the acute criteria more than once every three years on the average. The four-day average concentration of a pollutant should not exceed the chronic criteria more than once every three years on the average. These aquatic life criteria shall be achieved in all waters, except mixing zones, regardless of the waters' classification. In addition, the acute and chronic aquatic life criteria for freshwaters shall not be exceeded at or above the lowest average 7 consecutive day low flow with an average recurrence frequency of once in 10 years (7Q10)".

For the metals of concern (Copper-Cu, Lead-Pb, and Cadmium-Cd) in the Ten Mile River, the dissolved metal as opposed to the total metal more closely approximates the bioavailable fraction of the metal in the water column. Toxicity of these dissolved metals is dependant on hardness.

Freshwater aquatic life criteria for certain metals are expressed as a function of hardness because hardness and/or water quality characteristics that are usually correlated with hardness can affect the toxicities of some metals. Increasing hardness has the effect of decreasing the toxicity of certain metals to aquatic life. Both chronic and acute aquatic life criteria for Cu, Pb, and Cd are a function of hardness. Hardness, expressed as mg/l $CaCO_3$ was calculated from calcium (Ca) and magnesium (Mg) data using the following formula:

$$[CaCO_3] = 2.5(Ca^{2+}) + 4.1(Mg^{2+})$$

Tables 1 and 2 in DEM's Water Quality Regulations (DEM 2009) present the acute and chronic freshwater criteria for dissolved metals. The chronic and acute criteria of these metals apply to the dissolved form and are calculated using water hardness (in mg/l as $CaCO_3$) based on equations in Table 2-Appendix B of Rhode Island's Water Quality Regulations and shown below in Table 41.

Table 41. Applicable Freshwater Criteria Equations and Base e Exponential Values.

Parameter	ACUTE (ug/l) $CF \times e^{(m_a [\ln Hardness] + b_a)}$			CHRONIC (ug/l) $CF \times e^{(m_c [\ln Hardness] + b_c)}$		
	CF =	m_a =	b_a =	CF =	m_c =	b_c =
Cadmium	@	1.0166	-3.924	@	0.7409	-4.719
Copper	0.96	0.9422	-1.700	0.96	0.8545	-1.702
Lead	#	1.273	-1.46	#	1.273	-4.705

@ = Cadmium Conversion Factors: acute CF= 1.136672 – [(ln H) x 0.041838] chronic CF= 1.101672 – [(ln H) x 0.041838]
# = Lead Conversion Factors: acute and chronic CF= 1.46203 – [(ln H) x 0.145712]

These criteria apply to the mainstem and all impoundments in the Ten Mile River. Since hardness data are available for each station and each sample run, it was possible to calculate acute and chronic criteria for the metals of concern at the time of sample.

Hardness data in the Ten Mile River were analyzed for any notable and/or significant trends with respect to flow condition and longitudinal changes. This analysis resulted in several observations:

- A weak correlation exists between hardness values and flow, which generally show an inverse correlation. Calculated mean hardness values at station TM6 (Route 114 at USGS gaging station) were plotted against mean daily flow. Although a slight trend was observed, linear regression of the data resulted in an r^2 value of 0.35.

- There was an observable decrease in mean hardness in the downstream direction under the low flow dry weather condition and a slight increase in the downstream direction under the high flow wet weather condition (Figure 20).

- Notable differences exist between mean dry and wet weather hardness values at all stations in the Ten Mile River and impoundments (Figure 20).

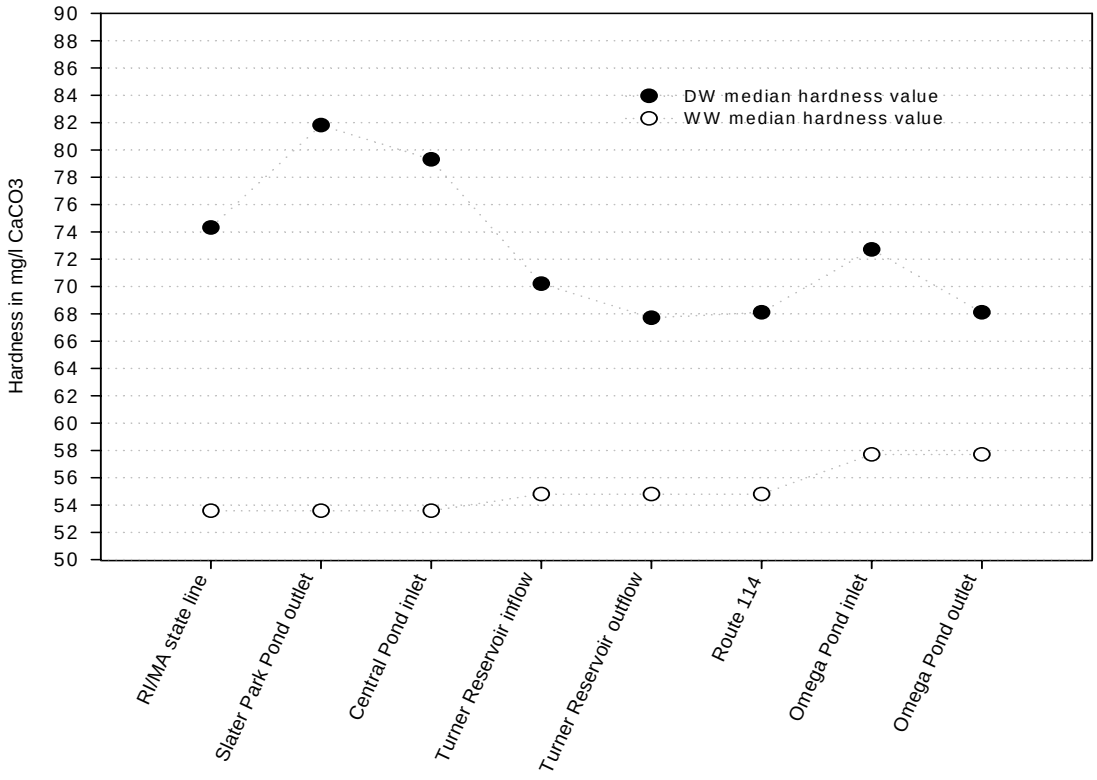

Figure 20. Hardness summary in the Ten Mile River and Impoundments.

Hardness data was not necessary to calculate acute and chronic copper criteria. RIDEM has adopted site-specific copper (Cu) criteria for several urban rivers including the entire Ten Mile River and impoundments. The proposed site specific dissolved copper criteria for all waterbody segments in Ten Mile is 20.41ug/l acute and 14.45 ug/l chronic.

Ambient water quality criteria for aluminum and iron are for the total, *not dissolved* fraction. The aquatic life criteria for total aluminum in freshwater is acute- 750 ug/l and chronic- 87 ug/l (freshwater criteria for aluminum are for waters in which the pH is between 6.5 and 9). The aquatic life criteria for total lead in freshwater is acute- none and chronic- 1000 ug/l.

With respect to dissolved metals criteria, Rhode Island's Water Quality Regulations specify that more than one "exceedance" of either the acute or chronic criteria every three years constitutes a "violation" of the water quality criteria. A summary of total and

dissolved metals data with respect to acute and chronic violations and confirming or refuting existing impairments is provided below in Table 42.

Table 42. Dissolved and total metals violations in the Ten Mile River 2007-2008.

Ten Mile River RI0004009-10A	***Sample Size n***	***# Chronic Violations***	***# Acute Violations***	***Notes***
Cadmium (Cd)	18	5	0	Keep on 2010 303(d) List
Lead (Pb)	18	4	0	Keep on 2010 303(d) List
Iron (Fe)	18	3	0	Add to 2010 303(d) List
Aluminum (Al)	18	12	0	Add to 2010 303(d) List
Central Pond RI0004009L-01A	***Sample Size n***	***# Chronic Violations***	***# Acute Violations***	***Notes***
Cadmium (Cd)	9	1	0	WW impairment-add to 2010 303(d) List
Lead (Pb)	9	0	0	Remove from 2010 303(d) List
Iron (Fe)	9	0	0	No impairment
Aluminum (Al)	9	2	0	Add to 2010 303(d) List
	9			
Turner Reservoir RI0004009L-01B	***Sample Size n***	***# Chronic Violations***	***# Acute Violations***	***Notes***
Cadmium (Cd)	18	1	0	WW impairment-add to 2010 303(d) List
Lead (Pb)	18	0	0	Remove from 2010 303(d) List
Iron (Fe)	18	0	0	No impairment
Aluminum (Al)	18	1	0	Add to 2010 303(d) List
Ten Mile River RI0004009-10B	***Sample Size n***	***# Chronic Violations***	***# Acute Violations***	***Notes***
Cadmium (Cd)	27	5	0	Add to 2010 303(d) List
Lead (Pb)	27	0	0	Remove from 2010 303(d) List
Iron (Fe)	27	0	0	No impairment
Aluminum (Al)	27	4	0	Add to 2010 303(d) List
Omega Pond RI0004009L-03	***Sample Size n***	***# Chronic Violations***	***# Acute Violations***	***Notes***
Cadmium (Cd)	9	2	0	Add to 2010 303(d) List
Lead (Pb)	9	0	0	Remove from 2010 303(d) List
Iron (Fe)	9	0	0	No impairment
Aluminum (Al)	9	2	0	Add to 2010 303(d) List

ANCILLARY DATA COLLECTION ACTIVITIES

Dissolved oxygen monitoring in Central Pond and Turner Reservoir

Continuous monitoring of dissolved oxygen, temperature, specific conductance, and chlorophyll a was conducted in Central Pond and the Turner Reservoir in the summer and fall of 2007. YSI 6600 meters were deployed at a single site in Central Pond and surface and depth stations at a single location in the Turner Reservoir (Figure 21). Sonde preparation, calibration (pre- and post-), deployment, and data QA/QC were conducted according to an EPA approved quality assurance plan
http://www.dem.ri.gov/pubs/qapp/nbfsmn.pdf

The sonde in Central Pond was deployed in the lower portion of the reservoir in approximately 1.8 meters of water and 0.9 meters below the surface. The sonde in the Turner Reservoir was deployed in the lower and deepest portion of the reservoir in approximately 3.7 meters of water. The surface sonde was placed approximately 1.8 meters from the surface and the bottom sonde was placed approximately 1.8 meters off the bottom).

Dissolved oxygen (in percent saturation) and chlorophyll a data for all sondes are summarized in Figures 22-24. The station results are as follows using the freshwater warm water fish habitat criteria for dissolved oxygen:

Central Pond- **no** violations

Lower Turner Reservoir (surface water station)-
4 violations to the daily average (<60% saturation)
95 violations of the instantaneous values (<5 mg/L) using hourly data

Lower Turner Reservoir (bottom water column station)-
2 violations of the 7 day mean (<6 mg/L for a 7 day period)
8 violations of the daily average (<60% saturation)
217 violations of the instantaneous values (<5 mg/L) using hourly data

Both Central Pond and Turner Reservoir exhibited wide swings in dissolved oxygen as evidenced in Figures 22-24. Variation in dissolved oxygen concentration in lakes is complex, depending primarily on productivity, stability of the water column, pollutant inputs, and morphology. The dissolved oxygen concentration is typically not uniform in the vertical and horizontal directions and may have significant seasonal variations. In shallow lakes, photosynthesis during high light levels and low wind levels may result in dissolved oxygen concentrations in the range of 17-30 mg/L (170-300%). Warming of lakes during the spring and summer can produce gas supersaturation near the thermocline, and photosynthesis also increases the oxygen concentration above the thermocline.

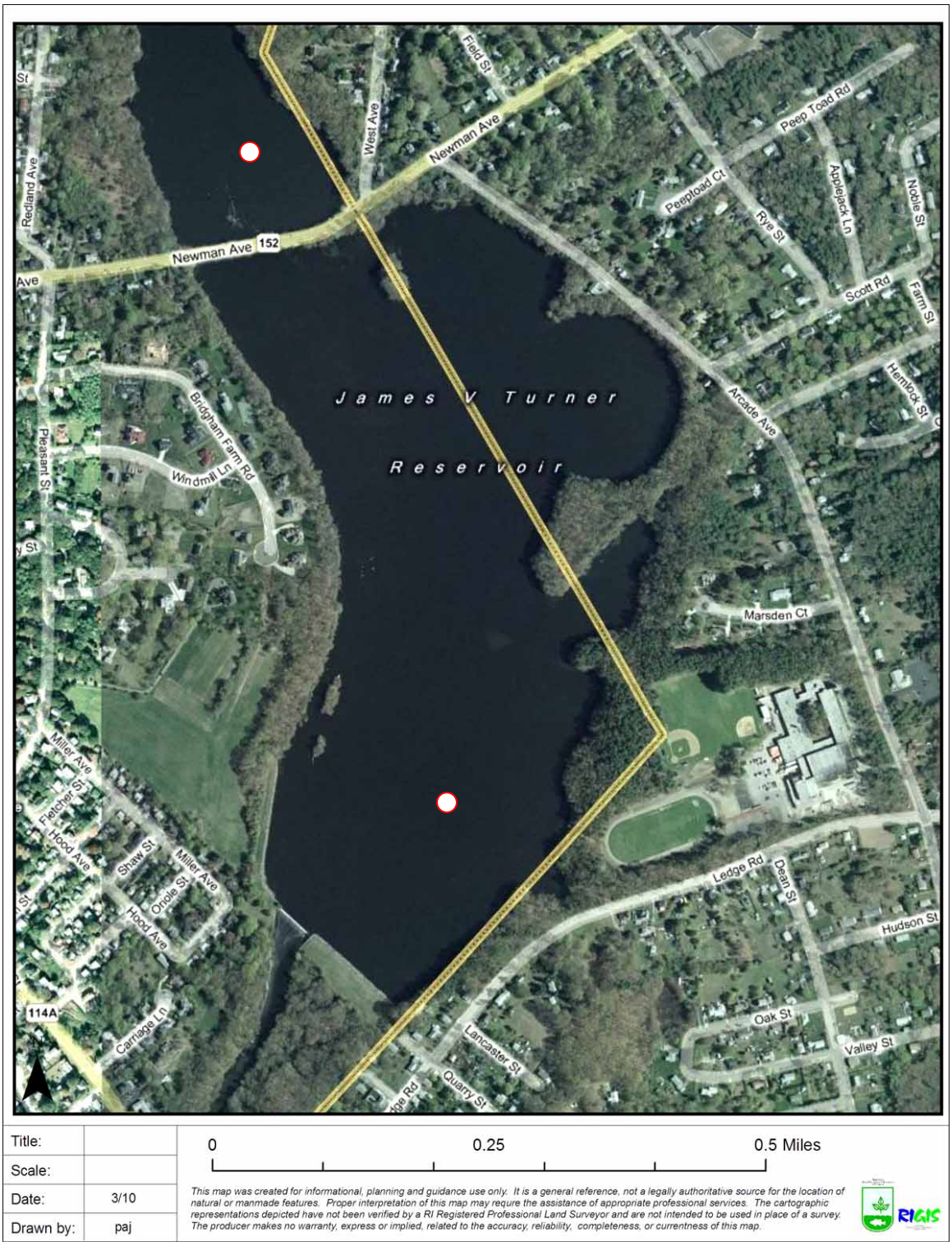

Figure 21. YSI 6600 Sonde Deployment Locations (2007)

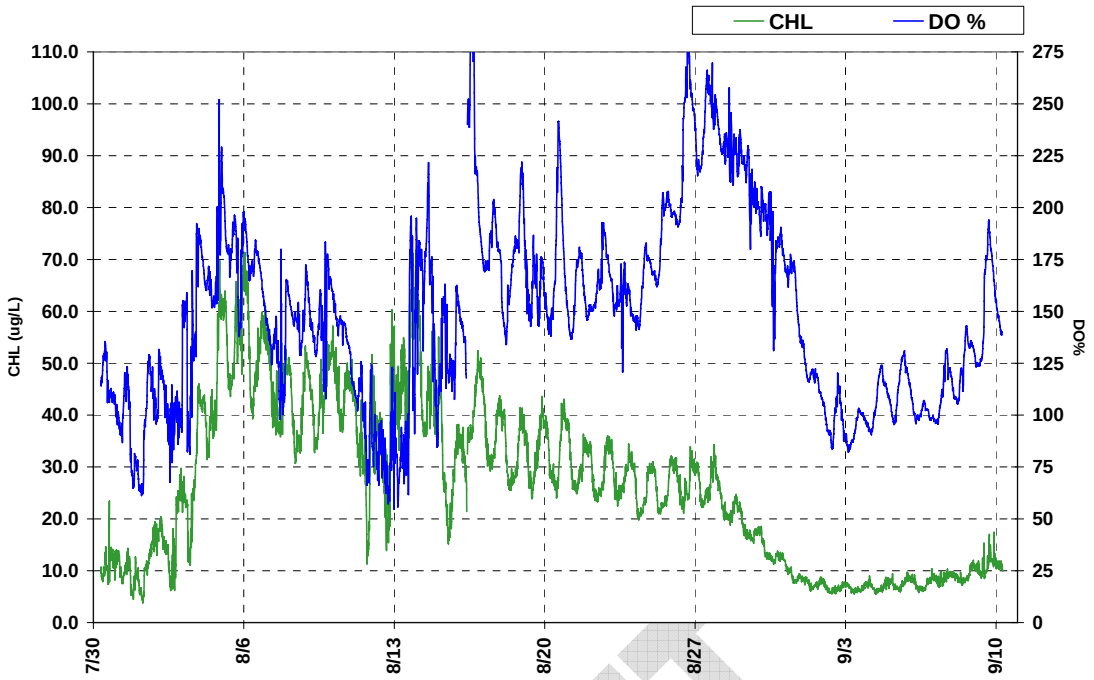

Figure 22. Chlorophyll a and Dissolved Oxygen (percent saturation) in Central Pond.

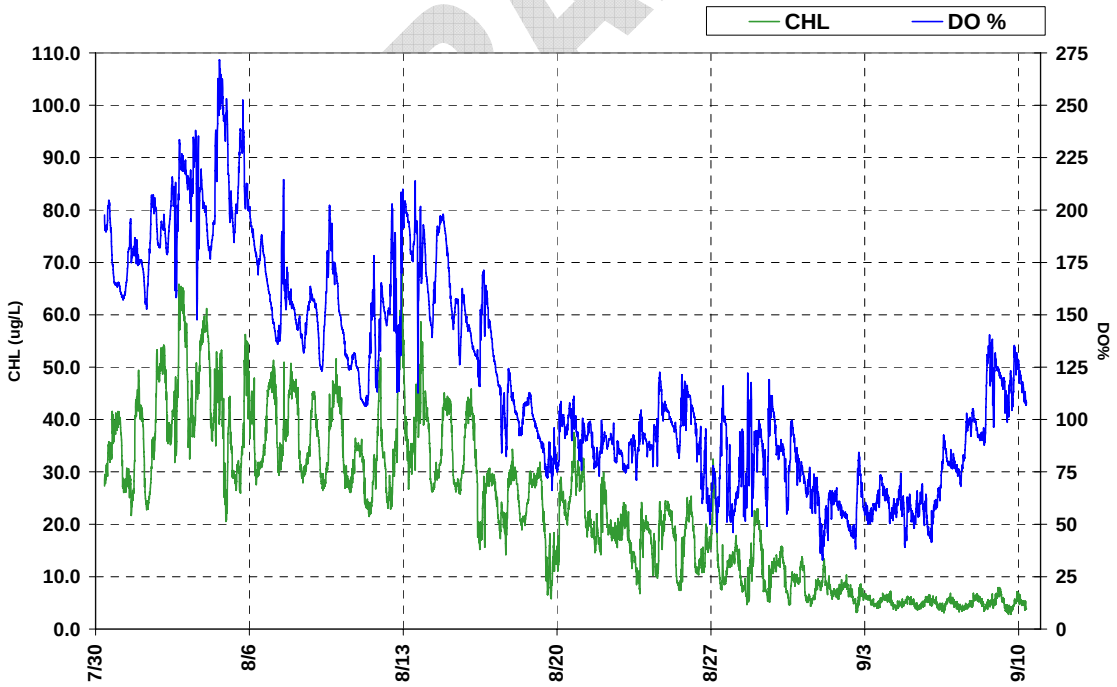

Figure 23. Chlorophyll a and Dissolved Oxygen (percent saturation) in Turner Reservoir (surface station).

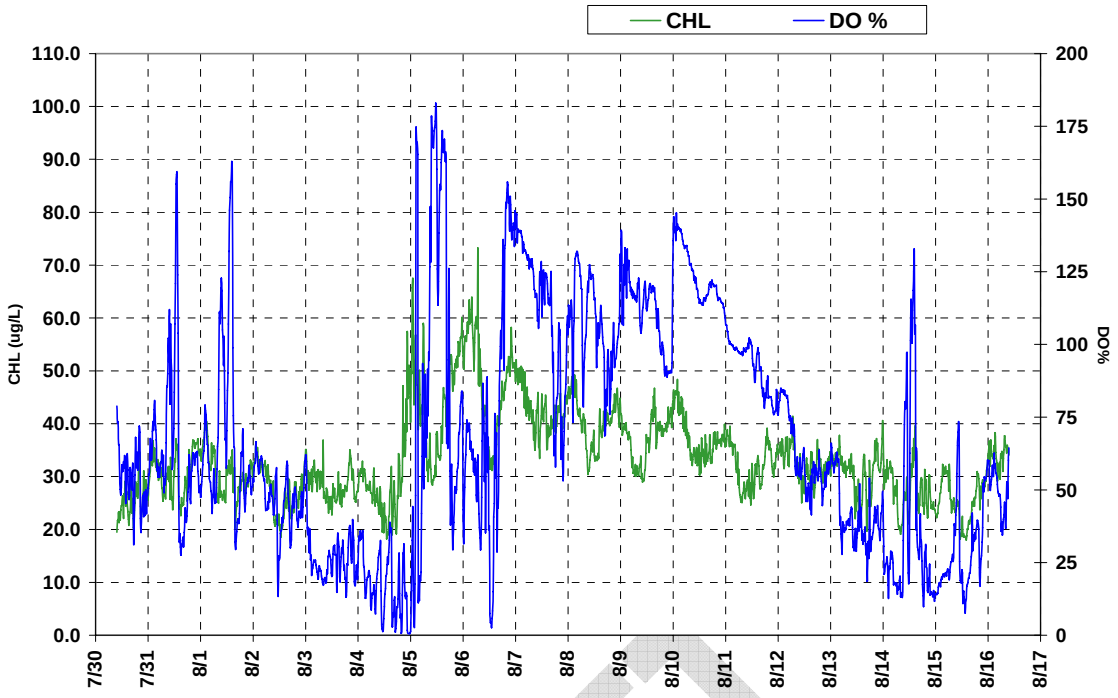

Figure 24. Chlorophyll a and Dissolved Oxygen (percent saturation) in Turner Reservoir (bottom station).

BIO-MONITORING AND HABITAT ASSESSMENTS

ESS Group, Inc. (ESS) was contracted by RIDEM in 2007 to execute a three –year biological sampling and taxonomic identification program that provides benthic macroinvertebrate data from selected wadeable streams in the state. Primary tasks included (1) collection of benthic macroinvertebrates, water quality data and habitat information; (2) sorting of benthic macroinverebrate samples; (3) taxonomic identification of benthic macroinvertebrates; and (4) analysis of results. All work was performed in accordance with an EPA-Approved and project specific QAPP (http://www.dem.ri.gov/pubs/qapp/taxbenth.pdf).

The Rapid Bioassessment Protocol (RBP) is an integrated approach for assessing aquatic ecosystems and entails assessing local habitat features (e.g., physical structure, flow regime, riparian structure), water quality parameters and biologic indicators and comparing these data to an empirically defined reference condition. ESS sampled, sub-sampled, and sorted organisms in accordance with EPA's Rapid Bioassessment Protocols For Use In Wadeable Streams and Rivers, July 1999, EPA 841-B-99-002 (Barbour et al., 1999).

Bio-monitoring and habitat assessments were conducted at two locations in the Ten Mile River in 2007 and 2008. Station TEN01 is located in Attleboro, Massachusetts at Tiffany Street and station TEN02 is located at the MA/RI state line at Central Avenue in Pawtucket, RI. Discussion of results in this data report is limited to the Rhode Island station TEN02 (herein referred to as the 'Ten Mile River' at the MA/RI state line) in 2007.

2007 Assessment

Based on data from U.S. Geological Survey gages in the state, stream flows during the 2007 sampling period fell as low as the 99.5% exceedance flow for September. Stream flow conditions were also the lowest to coincide with sampling since the first year of ESS's original contract with RIDEM in 2002. Habitat assessment results showed the Ten Mile River as being moderately impaired with only 50% comparability to the reference station.

As described in the ESS report, the Ten Mile River was found to be mainly impaired due to the relatively low values of EPT index, abundance ratio of scrapers to filterers, and abundance of shredders to total site abundance. Compared to the reference site, the Ten Mile River had seven fewer taxa overall, six of which were EPT taxa. Additionally, the ratio of Hydropsychidae to total Trichoptera was relatively high at just over 68%

Of particular note was the relatively high specific conductance levels (620 umhos) measured instream during the habitat survey.

CYANOBACTERIA BLOOM

In mid-August, DEM staff observed a dense algal bloom in Central Pond and the Turner Reservoir (Figure 25). In September 2007 the Department of Environmental Management and the Department of Health (HEALTH) issued a joint advisory recommending that people temporarily avoid recreational activities that include contact with water from the Ten Mile River including its impoundments, Central Pond, Turner Reservoir and Omega Pond. The river originates in Massachusetts and forms the boundary between Massachusetts and Rhode Island along the northern half of East Providence and Seekonk. DEM observed a dense algae bloom turning the waters of Turner Reservoir a bright green color. Laboratory results from tests found high levels of the naturally occurring algal toxin, Microcystin. These levels, exceeded 25,000 micrograms per liter, which is significantly above the guideline of 40 micrograms per liter from the World Health Organization.

Figure 25. Photograph of Central Pond taken by DEM staff in August 2007.

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APPENDIX A- IN-SITU DATA

Table A. 1. Temperature

Temperature (in-situ)

Station No.	Ten Mile River	Impoundment	WWTF/outfall/other	Location	Temperature in Degrees Celsius									Statistics				Comments
					22-May-07	19-Jun-07	2-Jul-07	31-Jul-07	21-Aug-07	4-Sep-07	12-Sep-07	6-Mar-08	1-Aug-08	Mean	Standard Deviation	Minimum	Maximum	Count	
				Survey Number	1	2	3	4	5	6	7	8	9						
TM1	●			Just downstream of MA/RI state line	13.8	20.9	18.4	24.2	17.5	19.5	18.7	5.0	23.7	**18.0**	5.80	5	24	9	
TM2		●		Armstice Boulevard, Pawtucket	14.7	21.6	18.3	24.5	18.0	20.3	18.4	5.5	23.9	**18.4**	5.72	6	25	9	
TM3	●			Central Pond inlet	14.6	20.8	18.5	24.5	NA	20.3	18.2	5.4	23.5	**18.2**	6.05	5	25	8	
TM4		●		Turner Reservoir inflow	17.5	25.1	24.0	28.0	22.8	24.4	21.6	7.2	27.9	**22.1**	6.42	7	28	9	
TM5	●			Turner Reservoir outflow	16.0	24.4	24.6	27.5	22.5	23.5	22.2	6.7	27.4	**21.6**	6.55	7	28	9	
TM6	●			Route 114	15.6	23.8	23.6	26.9	21.5	22.5	21.6	6.8	26.3	**21.0**	6.24	7	27	9	
TM7	●			Omega Pond inlet	15.5	23.8	23.0	26.9	21.3	22.6	21.6	6.4	26.2	**20.8**	6.32	6	27	9	
TM8		●		Omega Pond outlet	15.8	25.0	24.4	26.3	22.1	24.1	21.2	7.0	25.9	**21.3**	6.25	7	26	9	

Table A. 2. Specific Conductance

Specific Conductance (in-situ)

Station No.	Ten Mile River	Impoundment	WWTF/outfall/other	Location	Specific Conductance in uS									Statistics				Comments
					22-May-07	19-Jun-07	2-Jul-07	31-Jul-07	21-Aug-07	4-Sep-07	12-Sep-07	6-Mar-08	1-Aug-08	Mean	Standard Deviation	Minimum	Maximum	Count	
				Survey Number	1	2	3	4	5	6	7	8	9						
TM1	●			Just downstream of MA/RI state line	334	442	489	479	586	657	532	450	421	**488**	95	334	657	9	
TM2		●		Armstice Boulevard, Pawtucket	320		518	477	610	671	492	438	250	**472**	139	250	671	8	
TM3	●			Central Pond inlet	298	457	501	474		580	475	460	370	**449**	81	298	560	8	
TM4		●		Turner Reservoir inflow	242	399	479	447	480	521	619	420	347	**439**	107	242	619	9	
TM5	●			Turner Reservoir outflow	249	367	455	449	469	512	516	455	358	**425**	86	249	516	9	
TM6	●			Route 114	247	369	452	444	472	514	517	460	355	**426**	87	247	517	9	
TM7	●			Omega Pond inlet	250	378	462	452	488	527	522	468	363	**434**	89	250	527	9	
TM8		●		Omega Pond outlet	267	370	442	415	476	511	462	452	374	**419**	73	267	511	9	

Table A. 3. Dissolved Oxygen as Percent Saturation

Dissolved Oxygen (in-situ)

Station No.	Ten Mile River	Impoundment	WWTF/outfall/other	Location	Percent Saturation									Statistics				Comments
					22-May-07	19-Jun-07	2-Jul-07	31-Jul-07	21-Aug-07	4-Sep-07	12-Sep-07	6-Mar-08	1-Aug-08	Mean	Standard Deviation	Minimum	Maximum	Count	
				Survey Number	1	2	3	4	5	6	7	8	9						
TM1	●			Just downstream of MA/RI state line	95.7	77.8	77.9	80.5	65.9	64.2	76.4	NA	67.6	**75.75**	10.19	64.20	95.70	8	
TM2		●		Armistice Boulevard, Pawtucket	95.9	80.5	69.5	82.7	77.4	78.3	77.1	NA	78.0	**79.93**	7.49	69.50	95.90	8	
TM3	●			Central Pond inlet	94.1	59.4	75.0	87.7		68.7	69.5	NA	69.1	**74.79**	12.07	59.40	94.10	7	
TM4		●		Turner Reservoir inflow	95.2	131.9	132.8	124.6	82.5	71.7	67.1	NA	90.8	**99.58**	26.71	67.10	132.80	8	
TM5	●			Turner Reservoir outflow	97.4	92.1	106.6	123.3	94.2	75.1	97.4	NA	117.9	**100.50**	15.28	75.10	123.30	8	
TM6	●			Route 114	100.8	72.7	79.5	99.5	67.9	66.6	86.9	NA	85.3	**82.40**	13.21	66.60	100.80	8	
TM7	●			Omega Pond inlet	96.8	75.0	75.4	102.8	62.6	51.6	85.7	NA	85.0	**79.36**	16.95	51.60	102.80	8	
TM8		●		Omega Pond outlet	98.3	111.2	59.5	82.9	53.3	101.2	82.4	NA	68.2	**82.13**	20.73	53.30	111.20	8	

Table A. 4. Dissolved Oxygen in mg/l.

Dissolved Oxygen (in-situ)

Station No.	Ten Mile River	Impoundment	WWTF/outfall/other	Location	Concentration (mg/l DO)									Statistics				Comments
					22-May-07	19-Jun-07	2-Jul-07	31-Jul-07	21-Aug-07	4-Sep-07	12-Sep-07	6-Mar-08	1-Aug-08	Mean	Standard Deviation	Minimum	Maximum	Count	
				Survey Number	1	2	3	4	5	6	7	8	9						
TM1	●			Just downstream of MA/RI state line	9.9	6.9	7.2	6.7	6.3	5.8	7.1	NA	5.7	**6.97**	1.31	5.71	9.90	8	
TM2		●		Armstice Boulevard, Pawtucket	9.8	7.1	6.5	7.1	7.2	7.1	7.2	NA	6.6	**7.32**	1.02	6.53	9.76	8	
TM3	●			Central Pond inlet	9.6	6.9	7.0	7.3	NA	6.2	6.5	NA	5.9	**7.06**	1.21	5.87	9.56	7	
TM4		●		Turner Reservoir inflow	9.0	10.4	11.2	9.7	8.6	5.9	5.9	NA	7.1	**8.48**	1.99	5.91	11.17	8	
TM5	●			Turner Reservoir outflow	9.0	7.5	8.9	9.7	8.2	6.4	8.5	NA	9.3	**8.43**	1.08	6.37	9.72	8	
TM6	●			Route 114	10.0	6.1	6.8	7.9	6.0	5.8	7.6	NA	6.9	**7.14**	1.39	5.76	10.01	8	
TM7	●			Omega Pond inlet	9.7	6.5	6.5	8.2	5.5	4.5	7.5	NA	6.9	**6.90**	1.60	4.45	9.66	8	
TM8		●		Omega Pond outlet	9.6	9.2	5.0	6.7	4.7	8.5	7.3	NA	5.5	**7.05**	1.92	4.65	9.58	8	

APPENDIX B- CONVENTIONAL PARAMETER DATA

Table B. 1. Fecal Coliform Bacteria.

Fecal Coliform Bacteria

Station No.	Ten Mile River	Impoundment	WWTF/outfall/other	Location	Concentration CFU/100ml									Statistics						Comments
					22-May-07	19-Jun-07	2-Jul-07	31-Jul-07	21-Aug-07	4-Sep-07	12-Sep-07	6-Mar-08	1-Aug-08	Geometric Mean Value	90th Percentile Value	Standard Deviation	Minimum	Maximum	Count	
				Survey Number	1	2	3	4	5	6	7	8	9							
				Dry or Wet weather influenced (D or W)	**W**	**D**	**D**	**W**	**D**	**D**	**W**	**W**	**D**							
TM1	●			Central Ave	250	290	290	1200	310	250	5100	**52**	350	**384**	**1980**	1608	52	5100	9	
TM2		●		Slater Park Pond outlet	160	170	410	780	720	210	**1200**	35	390	**303**	**864**	378	35	1200	9	
TM3	●			Central Pond inflow	150	180	230	780	**30**	50	860	70	370	176	**796**	312	30	860	9	
TM4		●		Turner Reservoir	200	11	**160**	20	10	16	220	22	**69**	42	**204**	87	10	220	9	
TM5	●			Route 114A	100	**17**	57	1	16	19	19	15	1	13	**66**	32	1	100	9	
TM6	●			Route 114	120	100	140	**66**	100	45	440	23	25	79	**200**	128	23	440	9	
TM7	●			Omega Pond inlet	110	130	140	310	150	**37**	24	12	230	85	**246**	98	12	310	9	
TM8		●		Omega Pond outlet	**150**	81	45	880	7	10	2000	12	30	66	**1104**	676	7	2000	9	
TM8		●		Field Duplicate	**150**															
TM5	●			Field Duplicate		**19**														
TM4		●		Field Duplicate			**160**													
TM6	●			Field Duplicate				**140**												
TM3		●		Field Duplicate					**57**											
TM7	●			Field Duplicate						**15**										
TM2	●			Field Duplicate							**460**									
TM1	●			Field Duplicate								**62**								
TM4		●		Field Duplicate									**45**							

Table B. 2. Total Phosphorus

Total Phosphorus

Station No.	Ten Mile River	Impoundment	WWTF/outfall/other	Location	Concentration (mg/l P)									Statistics						Comments
					22-May-07	19-Jun-07	2-Jul-07	31-Jul-07	21-Aug-07	4-Sep-07	12-Sep-07	6-Mar-08	1-Aug-08	Mean	Median	Standard Deviation	Minimum	Maximum	Count	
				Survey Number	1	2	3	4	5	6	7	8	9							
				Dry or Wet weather influenced (D or W)	W	D	D	W	D	D	W	W	D							
TM1	●			Central Ave	0.050	0.073	0.060	0.129	0.073	0.051	0.063	**0.037**	0.048	0.065	0.060	0.027	0.04	0.13	9	
TM2		●		Slater Park Pond outlet	0.052	0.062	0.070	0.093	0.077	0.065	**0.067**	0.046	0.052	**0.065**	0.065	0.014	0.05	0.09	9	
TM3	●			Central Pond inflow	0.047	0.056	0.052	0.089	**0.070**	0.037	0.083	0.047	0.047	**0.059**	0.052	0.018	0.04	0.09	9	
TM4		●		Turner Reservoir	0.046	0.071	**0.041**	0.078	0.115	0.048	0.054	0.053	**0.077**	**0.065**	0.054	0.023	0.04	0.12	9	
TM5	●			Route 114A	0.048	**0.050**	0.050	0.064	0.110	0.050	0.053	0.054	0.058	**0.060**	0.053	0.020	0.05	0.11	9	
TM6	●			Route 114	0.052	0.073	0.039	**0.061**	0.103	0.053	0.053	0.052	0.053	0.060	0.053	0.018	0.04	0.10	9	
TM7	●			Omega Pond inlet	0.049	0.058	0.052	0.100	0.128	**0.098**	0.064	0.054	0.060	0.074	0.060	0.028	0.05	0.13	9	
TM8		●		Omega Pond outlet	**0.048**	0.057	0.040	0.092	0.131	0.061	0.159	0.061	0.063	**0.079**	0.061	0.041	0.04	0.16	9	
TM8		●		Field Duplicate	**0.050**															
TM5	●			Field Duplicate		**0.049**														
TM4		●		Field Duplicate			**0.034**													
TM6	●			Field Duplicate				**0.075**												
TM3		●		Field Duplicate					**0.074**											
TM7	●			Field Duplicate						**0.083**										
TM2	●			Field Duplicate							**0.081**									
TM1	●			Field Duplicate								**0.065**								
TM4		●		Field Duplicate									**0.073**							

Nitrite Nitrogen

Station No.	Ten Mile River	Impoundment	WWTF/outfall/other	Location	Concentration (mg/l NO2)									Statistics					Comments
					22-May-07	19-Jun-07	2-Jul-07	31-Jul-07	21-Aug-07	4-Sep-07	12-Sep-07	6-Mar-08	1-Aug-08	Mean	Standard Deviation	Minimum	Maximum	Count	
				Survey Number	1	2	3	4	5	6	7	8	9						
				Dry or Wet weather influenced (D or W)	W	D	D	W	D	D	W	W	D						
TM1	●			Central Ave	0.010	0.030	0.020	**0.005**	0.012	0.029	0.024	**0.018**	0.016	**0.02**	0.01	0.01	0.03	9	
TM2		●		Slater Park Pond outlet	0.010	0.030	0.044	0.086	0.033	0.035	**0.027**	0.018	0.021	**0.03**	0.02	0.01	0.09	9	
TM3	●			Central Pond inflow	0.010	**0.005**	0.031	0.071	**0.027**	**0.005**	0.027	0.016	0.029	**0.02**	0.02	0.01	0.07	9	
TM4		●		Turner Reservoir	0.010	0.070	**0.089**	0.096	0.050	0.034	0.095	0.021	**0.056**	**0.06**	0.03	0.01	0.10	9	
TM5	●			Route 114A	0.010	**0.070**	0.040	0.052	0.037	0.051	0.033	0.026	0.046	**0.04**	0.02	0.01	0.07	9	
TM6	●			Route 114	0.010	0.050	0.031	**0.039**	0.023	0.039	0.027	0.025	0.029	**0.03**	0.01	0.01	0.05	9	
TM7	●			Omega Pond inlet	0.010	0.040	0.028	0.037	0.020	**0.032**	0.025	0.026	0.026	**0.03**	0.01	0.01	0.04	9	
TM8		●		Omega Pond outlet	**0.010**	0.040	0.027	0.029	0.020	0.021	0.016	0.028	0.022	**0.02**	0.01	0.01	0.04	9	
TM8		●		Field Duplicate	**0.010**														
TM5	●			Field Duplicate		**0.070**													
TM4		●		Field Duplicate			**0.089**												
TM6	●			Field Duplicate				**0.039**											
TM3		●		Field Duplicate					**0.027**										
TM7	●			Field Duplicate						**0.034**									
TM2	●			Field Duplicate							**0.026**								
TM1	●			Field Duplicate								**0.016**							
TM4		●		Field Duplicate									**0.055**						

Table B. 3. Nitrite Nitrogen

Nitrate Nitrogen

Station No.	Ten Mile River	Impoundment	WWTF/outfall/other	Location	Concentration (mg/l NO3)									Statistics					Comments
					22-May-07	19-Jun-07	2-Jul-07	31-Jul-07	21-Aug-07	4-Sep-07	12-Sep-07	6-Mar-08	1-Aug-08	Mean	Standard Deviation	Minimum	Maximum	Count	
				Survey Number	1	2	3	4	5	6	7	8	9						
				Dry or Wet weather influenced (D or W)	W	D	D	W	D	D	W	W	D						
TM1	●			Central Ave	0.500	2.620	3.240	1.830	5.730	6.110	2.700	**1.190**	1.820	**2.86**	1.92	0.50	6.11	9	
TM2		●		Slater Park Pond outlet	0.510	3.520	4.120	2.540	5.830	5.740	**2.530**	1.160	2.380	**3.15**	1.85	0.51	5.83	9	
TM3	●			Central Pond inflow	0.510	3.250	3.790	2.270	**4.980**	5.800	2.590	1.010	2.360	**2.95**	1.72	0.51	5.80	9	
TM4		●		Turner Reservoir	0.450	1.460	**2.040**	0.814	0.680	0.606	2.080	1.370	**0.815**	**1.15**	0.62	0.45	2.08	9	
TM5	●			Route 114A	0.580	**1.270**	1.400	0.428	0.433	0.539	0.497	1.380	0.467	**0.78**	0.43	0.43	1.40	9	
TM6	●			Route 114	0.610	1.350	1.470	**0.421**	0.547	0.761	0.523	1.410	0.569	**0.85**	0.43	0.42	1.47	9	
TM7	●			Omega Pond inlet	0.620	1.370	1.510	0.443	0.540	**0.728**	0.535	1.430	0.596	**0.86**	0.44	0.44	1.51	9	
TM8		●		Omega Pond outlet	**0.710**	1.120	1.320	0.381	0.270	0.189	0.324	1.430	0.238	**0.66**	0.50	0.19	1.43	9	
TM8		●		Field Duplicate	**0.74**														
TM5	●			Field Duplicate		**1.28**													
TM4		●		Field Duplicate			**2.02**												
TM6	●			Field Duplicate				**0.42**											
TM3		●		Field Duplicate					**5.00**										
TM7	●			Field Duplicate						**0.73**									
TM2	●			Field Duplicate							**2.50**								
TM1	●			Field Duplicate								**1.16**							
TM4		●		Field Duplicate									**0.78**						

Table B. 4. Nitrate Nitrogen

Ammonia Nitrogen

Station No.	Ten Mile River	Impoundment	WWTF/outfall/other	Location	Concentration (mg/l NH3)									Statistics						Comments
					22-May-07	19-Jun-07	2-Jul-07	31-Jul-07	21-Aug-07	4-Sep-07	12-Sep-07	6-Mar-08	1-Aug-08	Mean	median	Standard Deviation	Minimum	Maximum	Count	
				Survey Number	1	2	3	4	5	6	7	8	9							
				Dry or Wet weather influenced (D or W)	W	D	D	W	D	D	W	W	D							
TM1	●			Central Ave	1.30	0.30	0.31	0.33	0.15	0.17	0.47	**0.20**	0.27	**0.39**	**0.30**	0.36	0.15	1.30	9	
TM2		●		Slater Park Pond outlet	1.00	0.20	0.27	0.26	0.18	0.23	**0.29**	0.17	0.32	**0.32**	**0.26**	0.26	0.17	1.00	9	
TM3	●			Central Pond inflow	0.90	0.20	0.14	0.18	**0.13**	0.18	0.25	0.14	0.30	**0.27**	**0.18**	0.24	0.13	0.90	9	
TM4		●		Turner Reservoir	0.70	0.10	**0.22**	0.15	0.18	0.28	0.30	0.22	**0.15**	**0.26**	**0.22**	0.18	0.10	0.70	9	
TM5	●			Route 114A	0.70	**0.30**	0.14	0.10	0.18	0.35	0.19	0.18	0.18	**0.26**	**0.18**	0.18	0.10	0.70	9	
TM6	●			Route 114	0.70	0.20	0.20	**0.12**	0.13	0.26	0.16	0.21	0.23	**0.25**	**0.20**	0.18	0.12	0.70	9	
TM7	●			Omega Pond inlet	0.70	0.20	0.17	0.11	0.18	**0.27**	0.19	0.20	0.22	**0.25**	**0.20**	0.17	0.11	0.70	9	
TM8		●		Omega Pond outlet	**0.70**	0.10	0.24	0.14	0.26	0.11	0.17	0.23	0.18	**0.24**	**0.18**	0.18	0.10	0.70	9	
TM8		●		Field Duplicate	**0.60**															
TM5	●			Field Duplicate		**0.10**														
TM4		●		Field Duplicate			**0.19**													
TM6	●			Field Duplicate				**0.12**												
TM3		●		Field Duplicate					**0.14**											
TM7	●			Field Duplicate						**0.20**										
TM2	●			Field Duplicate							**0.28**									
TM1	●			Field Duplicate								**0.21**								
TM4		●		Field Duplicate									**0.18**							

Table B. 5. Ammonia Nitrogen.

Total Kjeldahl Nitrogen

Station No.	Ten Mile River	Impoundment	WWTF/outfall/other	Location	Concentration (mg/l TKN)									Statistics					Comments
					22-May-07	19-Jun-07	2-Jul-07	31-Jul-07	21-Aug-07	4-Sep-07	12-Sep-07	6-Mar-08	1-Aug-08	Mean	Standard Deviation	Minimum	Maximum	Count	
				Survey Number	1	2	3	4	5	6	7	8	9						
				Dry or Wet weather influenced (D or W)	W	D	D	W	D	D	W	W	D						
TM1	●			Central Ave	1.90	1.50	0.90	0.97	0.62	0.34	1.12		1.00	**1.04**	0.49	0.34	1.90	8	
TM2		●		Slater Park Pond outlet	1.70	1.20	0.63	1.00	0.76	0.86	**1.20**	0.56	1.29	**1.02**	0.36	0.56	1.70	9	
TM3	●			Central Pond inflow	1.50	1.00	0.69	0.99	**0.46**	0.53	1.10	0.49	1.30	**0.90**	0.37	0.46	1.50	9	
TM4		●		Turner Reservoir	1.30	1.20	**0.76**	1.09	1.17	1.02	1.45	0.53	**1.24**	**1.08**	0.28	0.53	1.45	9	
TM5	●			Route 114A	1.30	**1.00**	0.83	0.95	1.12	1.15	1.34	0.51	1.41	**1.07**	0.28	0.51	1.41	9	
TM6	●			Route 114	1.30	0.90	0.78	**0.98**	0.82	1.07	1.36	0.53	1.38	**1.01**	0.29	0.53	1.38	9	
TM7	●			Omega Pond inlet	1.30	0.90	0.77	1.01	0.77	**1.00**	1.39	0.46	1.34	**0.99**	0.31	0.46	1.39	9	
TM8		●		Omega Pond outlet	**1.30**	0.90	0.77	0.95	1.09	1.49	1.71	0.52	1.76	**1.17**	0.43	0.52	1.76	9	
TM8		●		Field Duplicate	**1.20**														
TM5	●			Field Duplicate		**0.90**													
TM4		●		Field Duplicate			**0.77**												
TM6	●			Field Duplicate				**0.99**											
TM3		●		Field Duplicate					**0.57**										
TM7	●			Field Duplicate						**1.58**									
TM2	●			Field Duplicate							**1.12**								
TM1	●			Field Duplicate								**0.52**							
TM4		●		Field Duplicate									**1.50**						

Table B. 6. Total Kjeldahl Nitrogen

APPENDIX C- DISSOLVED METALS DATA

Table C. 1. May 22, 2007 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

										For QA QC check	
Date of Collection:		5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007
	Station	**TM1 Blank**	**TM1**	**TM2**	**TM3**	**TM4**	**TM5**	**TM6**	**TM7**	**TM8**	**TM8 Field Dup**
Constituent	**RL**										
Aluminum (Al)	5.0	ND	30	86	27	35	28	29	30	21	18
Antimony (Sb)	0.5	ND	ND	ND	ND	ND	0.62	ND	ND	0.71	ND
Arsenic (As)	0.5	ND	0.57	0.67	0.63	0.6	0.56	0.59	0.57	0.57	0.62
Barium (Ba)	0.2	ND	19	21	19	16	17	17	18	18	17
Beryllium (Be)	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium (Cd)	0.1	ND	ND	**0.24**	ND	0.1	0.15	**0.21**	**0.21**	**0.17**	**0.17**
Calcium (Ca mg/L)	0.1	ND	17	17	17	15	16	16	17	17	17
Chromium (Cr)	0.5	ND	1.6	3	1.4	1.3	1.3	1.3	1.3	1.2	1
Cobalt (Co)	0.2	ND	0.42	0.52	0.39	0.37	0.4	0.37	0.35	0.35	0.33
Copper (Cu)	0.2	ND	**6.3**	**11**	**5.5**	**6**	**6.3**	**6.3**	**6.4**	**6.2**	5.9
Iron (Fe)	50	ND	360	660	310	320	300	320	330	270	190
Lead (Pb)	0.2	ND	1	**2.7**	0.86	1	0.89	1	1.1	0.87	0.71
Magnesium (Mg mg/L)	0.1	ND	2.7	2.7	2.7	2.5	2.6	2.6	2.6	2.6	2.7
Manganese (Mn)	0.2	ND	120	130	120	110	130	130	130	140	130
Molybdenum (Mo)	0.5	ND	0.74	0.67	0.63	0.61	0.78	0.8	0.72	0.92	0.93
Nickel (Ni)	0.2	ND	14	16	13	13	15	15	14	15	15
Selenium (Se)	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver (Ag)	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium (Tl)	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium (V)	0.2	ND	0.39	0.63	0.45	0.5	0.45	0.41	0.5	0.42	0.42
Zinc (Zn)	5.0	ND	11	13	10	9.2	14	10	9.9	15	11
Hardness as $CaCO_3$			53.6	53.6	53.6	47.8	50.7	50.7	53.2	53.2	53.6
Cd Acute Criteria			1.10	1.10	1.10	0.98	1.04	1.04	1.09	1.09	1.10
Cd Chronic Criteria			0.16	0.16	0.16	0.15	0.15	0.15	0.16	0.16	0.16
Cu Acute Criteria			7.5	7.5	7.5	6.7	7.1	7.1	7.4	7.4	7.5
Cu Chronic Criteria			5.3	5.3	5.3	4.8	5.0	5.0	5.2	5.2	5.3
Pb Acute Criteria			32.5	32.5	32.5	28.6	30.6	30.6	32.3	32.3	32.5
Pb Chronic Criteria			1.27	1.27	1.27	1.12	1.19	1.19	1.26	1.26	1.27

= Acute Violation
= Chronic Violation

Table C. 2. June 19, 2007 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

				for QA QC check				for QA QC check				
Date of Collection:		6/19/2007	6/19/2007	6/19/2007	6/19/2007	6/19/2007	6/19/2007	6/19/2007	6/19/2007	6/19/2007	6/19/2007	6/19/2007
	Station	**TM1 Blank**	**TM1**	**TM2**	**TM2 Lab Dup**	**TM3**	**TM4**	**TM5**	**TM5 Field Dup**	**TM6**	**TM7**	**TM8**
Constituent	**RL**											
Aluminum (Al)	5.0	ND	16	14	14	11	9.6	6.5	7.6	10	9.9	7.6
Antimony (Sb)	0.5	ND	ND	ND	ND	ND	ND	ND	0.58	ND	ND	0.69
Arsenic (As)	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium (Ba)	0.2	ND	24	23	23	23	14	14	15	15	16	15
Beryllium (Be)	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium (Cd)	0.1	ND	0.11	0.17	0.16	0.18	ND	ND	ND	ND	ND	ND
Calcium (Ca mg/L)	0.1	ND	24	26	27	25	19	18	18	19	20	19
Chromium (Cr)	1.0	ND	2.1	1.7	1.8	1.3	1.1	1	1.1	1.1	1.1	1.1
Cobalt (Co)	0.2	ND	0.35	0.38	0.38	0.32	0.28	0.28	0.29	0.28	0.26	ND
Copper (Cu)	0.2	ND	6.9	6.3	6.4	5.6	**6.1**	**6**	6.3	**6**	5.9	**6.1**
Iron (Fe)	50	ND	510	430	440	350	390	320	340	340	330	310
Lead (Pb)	0.2	ND	**2.5**	**2.1**	2.1	1.6	1.3	0.96	1	1	0.97	0.9
Magnesium (Mg mg/L)	0.1	ND	3.4	3.3	3.3	3.2	3	2.8	2.9	3	2.9	2.9
Manganese (Mn)	0.2	ND	130	140	140	130	60	49	51	63	70	19
Molybdenum (Mo)	0.5	ND	1.2	1.3	1.3	1.2	1	1	1	1	1	1
Nickel (Ni)	0.2	ND	19	19	19	17	14	13	14	14	14	13
Selenium (Se)	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver (Ag)	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium (Tl)	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium (V)	0.2	ND	0.67	0.58	0.55	0.53	0.53	0.50	0.52	0.52	0.50	0.59
Zinc (Zn)	5.0	ND	13	10	11	9.9	ND	ND	ND	ND	ND	ND
Hardness as $CaCO_3$			73.9	78.5	81.0	75.6	59.8	48.9	56.9	59.8	61.9	59.4
Cd Acute Criteria			1.50	1.59	1.64	1.53	1.22	1.00	1.16	1.22	1.26	1.21
Cd Chronic Criteria			0.20	0.21	0.21	0.20	0.17	0.15	0.17	0.17	0.18	0.17
Cu Acute Criteria			10.1	10.7	11.0	10.3	8.3	6.8	7.9	8.3	8.6	8.2
Cu Chronic Criteria			6.9	7.3	7.5	7.1	5.8	4.9	5.5	5.8	5.9	5.7
Pb Acute Criteria			46.4	49.6	51.3	47.6	36.7	29.4	34.8	36.7	38.2	36.5
Pb Chronic Criteria			1.81	1.93	2.00	1.85	1.43	1.15	1.35	1.43	1.49	1.42

= Acute Violation
= Chronic Violation

Table C. 3. July 2, 2007 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

			For QA QC check				For QA QC check					
Date of Collection:		7/2/2007	7/2/2007	7/2/2007	7/2/2007	7/2/2007	7/2/2007	7/2/2007	7/2/2007	7/2/2007	7/2/2007	
	Station	**TM1 Blank**	**TM1**	**TM1 Lab Dup**	**TM2**	**TM3**	**TM4**	**TM4 Field Dup**	**TM5**	**TM6**	**TM7**	**TM8**
Constituent	**RL**											
Aluminum (Al)	5.0	ND	9.9	10	7	7.4	7.4	9	8.1	6.5	ND	7.1
Antimony (Sb)	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic (As)	0.5	ND	0.76	0.81	0.7	0.7	0.76	0.74	0.81	0.72	0.81	0.8
Barium (Ba)	0.2	ND	24	24	27	25	19	19	13	11	11	13
Beryllium (Be)	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium (Cd)	0.1	ND	0.17	0.18	0.2	0.17	ND	ND	ND	ND	ND	ND
Calcium (Ca mg/L)	0.1	ND	24	24	27	26	23	23	22	22	24	22
Chromium (Cr)	0.5	ND	1	0.99	0.87	0.81	0.72	0.71	0.63	0.6	ND	ND
Cobalt (Co)	0.2	ND	0.37	0.37	0.35	0.26	0.29	0.29	0.35	0.36	0.35	0.21
Copper (Cu)	0.2	ND	6.5	6.5	6	5.9	6.1	6.2	6.2	6	6.2	5.8
Iron (Fe)	50	ND	280	280	200	190	160	140	160	130	56	63
Lead (Pb)	0.2	ND	1.3	1.3	0.76	0.69	0.49	0.42	0.46	0.38	ND	ND
Magnesium (Mg mg/L)	0.1	ND	3.5	3.5	3.5	3.5	3.1	3.1	3.1	3.2	3.1	3.2
Manganese (Mn)	0.2	ND	180	180	130	100	42	34	41	63	62	47
Molybdenum (Mo)	0.5	ND	1.4	1.4	1.8	1.6	1.6	1.7	1.6	1.6	1.6	1.6
Nickel (Ni)	0.2	ND	22	22	25	21	14	14	13	13	12	12
Selenium (Se)	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver (Ag)	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium (Tl)	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium (V)	0.2	ND	0.46	0.44	0.36	0.31	0.46	0.42	0.54	0.5	0.48	0.42
Zinc (Zn)	5.0	ND	10	9.8	11	10	ND	ND	ND	ND	ND	ND
Hardness as $CaCO_3$			74.3		81.8	79.3	70.2	70.2	67.7	68.1	72.7	68.1
Cd Acute Criteria			1.51		1.66	1.61	1.43	1.43	1.38	1.39	1.48	1.39
Cd Chronic Criteria			0.20		0.21	0.21	0.19	0.19	0.19	0.19	0.20	0.19
Cu Acute Criteria			10.2		11.1	10.8	9.6	9.6	9.3	9.4	10.0	9.4
Cu Chronic Criteria			7.0		7.5	7.3	6.6	6.6	6.4	6.5	6.8	6.5
Pb Acute Criteria			46.7		51.9	50.1	43.8	43.8	42.1	42.4	45.6	42.4
Pb Chronic Criteria			1.82		2.02	1.95	1.71	1.71	1.64	1.65	1.78	1.65

= Acute Violation
= Chronic Violation

Table C. 4. July 31, 2007 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

			For QA QC check						For QA QC check			
Date of Collection:		7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007
	Station	**TM1 Blank**	**TM1**	**TM1 Lab Dup**	**TM2**	**TM3**	**TM4**	**TM5**	**TM6**	**TM6 Field Dup**	**TM7**	**TM8**
Constituent	**RL**											
Aluminum (Al)	5.0	ND	8.1	6.9	5.2	6.1	ND	ND	ND	ND	ND	6.2
Antimony (Sb)	0.5	ND	0.51		ND	0.53	ND	ND	ND	ND	ND	0.51
Arsenic (As)	0.5	ND	0.83	0.84	0.76	0.8	0.96	0.98	1	1	1	1
Barium (Ba)	0.2	ND	24	24	23	22	20	17	16	16	16	14
Beryllium (Be)	0.2	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND
Cadmium (Cd)	0.1	ND	**0.2**	0.18	0.14	0.11	ND	ND	ND	ND	ND	ND
Calcium (Ca mg/L)	0.1	ND	19	19	22	21	22	22	22	22	24	23
Chromium (Cr)	0.5	ND	0.97	1	0.92	0.89	ND	ND	ND	ND	ND	0.65
Cobalt (Co)	0.2	ND	0.38	0.39	0.32	0.25	0.32	0.3	0.32	0.31	0.33	0.3
Copper (Cu)	0.2	ND	**7.6**	7.7	**6.5**	**6.8**	4.9	5.2	5.3	4.9	5	4.9
Iron (Fe)	50	ND	180	190	120	130	ND	ND	ND	ND	ND	ND
Lead (Pb)	0.2	ND	**1.5**	1.5	0.63	0.8	ND	ND	ND	ND	ND	ND
Magnesium (Mg mg/L)	0.1	ND	2.9	3	2.8	2.9	3	3	3	3	3	2.7
Manganese (Mn)	0.2	ND	190	190	170	130	50	8.1	19	18	30	42
Molybdenum (Mo)	0.5	ND	1.9	1.9	2	1.9	1.9	1.9	2	2.1	1.9	1.8
Nickel (Ni)	0.2	ND	24	25	20	18	11	10	10	11	11	9.4
Selenium (Se)	1.0	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND
Silver (Ag)	0.2	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND
Thallium (Tl)	0.5	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND
Vanadium (V)	0.2	ND	0.83	0.84	0.65	0.6	0.4	0.5	0.54	0.56	0.68	0.78
Zinc (Zn)	5.0	ND	8.2	7.9	6.6	5.7	ND	ND	ND	ND	ND	ND
Hardness as $CaCO_3$			59.4		66.5	64.4	67.3	67.3	67.3	67.3	72.3	68.5
Cd Acute Criteria			1.21		1.35	1.31	1.37	1.37	1.37	1.37	1.47	1.39
Cd Chronic Criteria			0.17		0.19	0.18	0.19	0.19	0.19	0.19	0.20	0.19
Cu Acute Criteria			8.2		9.1	8.9	9.3	9.3	9.3	9.3	9.9	9.4
Cu Chronic Criteria			5.7		6.3	6.1	6.4	6.4	6.4	6.4	6.8	6.5
Pb Acute Criteria			36.5		41.3	39.9	41.8	41.8	41.8	41.8	45.3	42.7
Pb Chronic Criteria			1.42		1.61	1.55	1.63	1.63	1.63	1.63	1.76	1.66

= Acute Violation
= Chronic Violation

Table C. 5. August 21, 2007 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

					For QA QC check						
Date of Collection:		8/21/2007	8/21/2007	8/21/2007	8/21/2007	8/21/2007	8/21/2007	8/21/2007	8/21/2007	8/21/2007	8/21/2007
	Station	**TM1 Blank**	**TM1**	**TM2**	**TM3**	**TM3 Field Dup**	**TM4**	**TM5**	**TM6**	**TM7**	**TM8**
Constituent	**RL**										
Aluminum (Al)	5.0	ND	ND	ND	14	ND	ND	ND	ND	ND	ND
Antimony (Sb)	0.5	ND	ND	ND	ND	0.52	ND	ND	ND	ND	ND
Arsenic (As)	0.5	ND	0.68	0.6	0.64	0.7	1.3	1.5	1.4	1.4	1.4
Barium (Ba)	0.2	ND	25	31	31	30	21	21	23	23	21
Beryllium (Be)	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium (Cd)	0.1	ND	0.13	ND	ND	ND	ND	ND	ND	ND	ND
Calcium (Ca mg/L)	0.1	ND	33	34	31	31	24	23	25	28	27
Chromium (Cr)	0.5	ND	0.52	ND	0.61	ND	ND	ND	ND	ND	ND
Cobalt (Co)	0.2	ND	0.41	0.38	0.29	0.28	0.41	0.43	0.47	0.47	0.4
Copper (Cu)	0.2	ND	5.8	4.8	5.2	4.9	4.3	4.3	3.7	3.4	2.9
Iron (Fe)	50	ND	72	68	120	51	ND	ND	ND	ND	ND
Lead (Pb)	0.2	ND	0.42	0.32	**0.58**	**0.24**	ND	ND	ND	ND	ND
Magnesium (Mg mg/L)	0.1	ND	3.5	3.4	3.3	3.4	3.1	3.1	3.2	3.2	3.2
Manganese (Mn)	0.2	ND	190	180	170	170	63	88	200	240	290
Molybdenum (Mo)	0.5	ND	3.3	2	1.7	1.7	2.3	2.3	2.2	2.2	2.1
Nickel (Ni)	0.2	ND	20	18	16	16	12	12	12	12	11
Selenium (Se)	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver (Ag)	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium (Tl)	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium (V)	0.2	ND	0.31	0.29	0.28	0.24	0.44	0.43	0.32	0.42	0.34
Zinc (Zn)	5.0	ND	8.3	6.3	5.7	5.3	ND	ND	ND	ND	ND
Hardness as $CaCO_3$			96.8	98.9	91.0	91.4	72.7	70.2	75.6	83.1	80.6
Cd Acute Criteria			1.95	1.99	1.84	1.85	1.48	1.43	1.53	1.68	1.63
Cd Chronic Criteria			0.24	0.24	0.23	0.23	0.20	0.19	0.20	0.22	0.21
Cu Acute Criteria			13.0	13.3	12.3	12.3	10.0	9.6	10.3	11.3	11.0
Cu Chronic Criteria			8.7	8.9	8.3	8.3	6.8	6.6	7.1	7.6	7.4
Pb Acute Criteria			62.3	63.8	58.3	58.6	45.6	43.8	47.6	52.8	51.0
Pb Chronic Criteria			2.43	2.49	2.27	2.28	1.78	1.71	1.85	2.06	1.99

= Acute Violation
= Chronic Violation

Table C. 6. September 4, 2007 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

									For QA QC check		
Date of Collection:		9/4/2007	9/4/2007	9/4/2007	9/4/2007	9/4/2007	9/4/2007	9/4/2007	9/4/2007	9/4/2007	9/4/2007
	Station	**TM1 Blank**	**TM1**	**TM2**	**TM3**	**TM4**	**TM5**	**TM6**	**TM7**	**TM7 Field Dup**	**TM8**
Constituent	**RL**										
Aluminum (Al)	5.0	ND	8.2	ND	ND	5.6	7.5	ND	ND	ND	ND
Antimony (Sb)	0.5	ND	0.53	ND	0.51	ND	ND	ND	ND	ND	ND
Arsenic (As)	0.5	ND	0.8	0.74	0.7	1.2	1.3	1.3	1.3	1.3	1.2
Barium (Ba)	0.2	ND	27	36	33	27	28	32	31	31	22
Beryllium (Be)	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium (Cd)	0.1	ND	0.13	ND	0.11	ND	ND	ND	ND	ND	ND
Calcium (Ca mg/L)	0.1	ND	40	39	39	29	28	28	32	32	31
Chromium (Cr)	0.5	ND	0.57	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt (Co)	0.2	ND	0.42	0.43	0.3	0.46	0.48	0.44	0.45	0.45	0.42
Copper (Cu)	0.2	ND	6	5.2	5.7	3.9	3.5	3.3	3.3	3.3	3.3
Iron (Fe)	50	ND	73	80	52	60	74	74	60	59	ND
Lead (Pb)	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium (Mg mg/L)	0.1	ND	3.9	3.9	3.8	3.6	3.6	3.6	3.6	3.7	3.7
Manganese (Mn)	0.5	ND	220	230	180	150	250	250	300	300	240
Molybdenum (Mo)	0.5	ND	2.8	3.3	3.3	2.5	2.5	2.2	2.2	2.2	2.2
Nickel (Ni)	0.2	ND	20	20	17	13	14	14	14	14	11
Selenium (Se)	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver (Ag)	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium (Tl)	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium (V)	0.2	ND	0.4	0.37	0.3	0.4	0.41	0.43	0.46	0.47	0.37
Zinc (Zn)	5.0	ND	7.4	ND	ND	ND	ND	56	ND	ND	ND
Hardness as $CaCO_3$			115.9	113.4	113.0	87.2	84.7	84.7	94.7	95.1	92.6
Cd Acute Criteria			2.33	2.28	2.27	1.76	1.71	1.71	1.91	1.92	1.87
Cd Chronic Criteria			0.27	0.27	0.27	0.22	0.22	0.22	0.24	0.24	0.23
Cu Acute Criteria			15.4	15.1	15.1	11.8	11.5	11.5	12.8	12.8	12.5
Cu Chronic Criteria			10.2	10.0	9.9	8.0	7.8	7.8	8.6	8.6	8.4
Pb Acute Criteria			75.8	74.1	73.8	55.6	53.9	53.9	60.9	61.2	59.4
Pb Chronic Criteria			2.96	2.89	2.87	2.17	2.10	2.10	2.37	2.38	2.32

= Acute Violation
= Chronic Violation

Table C. 7. September 12, 2007 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

				For QA QC check								
Date of Collection:		9/12/2007	9/12/2007	9/12/2007	9/12/2007	9/12/2007	9/12/2007	9/12/2007	9/12/2007	9/12/2007	9/12/2007	9/12/2007
	Station	**TM1 Blank**	**TM1**	**TM2**	**TM2 Field Dup**	**TM2 Lab Dup**	**TM3**	**TM4**	**TM5**	**TM6**	**TM7**	**TM8**
Constituent	**RL**											
Aluminum (Al)	5.0	ND	9.1	9.3	9.1	8.7	9.6	8.5	5.2	7.8	7.9	7.8
Antimony (Sb)	0.5	ND	0.54	0.55	ND	0.55	ND	ND	ND	ND	ND	ND
Arsenic (As)	0.5	ND	0.79	0.73	0.68	0.7	0.74	0.86	1.1	1.1	1	1.1
Barium (Ba)	0.2	ND	31	30	30	30	29	36	28	28	27	25
Beryllium (Be)	0.5	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
Cadmium (Cd)	0.1	ND	**0.54**	**0.27**	0.28	0.28	**0.22**	ND	ND	ND	ND	ND
Calcium (Ca mg/L)	0.1	ND	24	24	23	23	23	31	27	27	28	27
Chromium (Cr)	0.5	ND	0.69	0.62	0.66	0.65	0.71	ND	ND	ND	ND	0.56
Cobalt (Co)	0.2	ND	0.96	0.66	0.68	0.67	0.52	0.49	0.55	0.58	0.57	0.44
Copper (Cu)	0.2	ND	**9.7**	**7.9**	8.3	8.2	**7.6**	4.7	3.9	4.1	4.1	3.8
Iron (Fe)	50	ND	150	130	140	130	130	ND	77	80	76	71
Lead (Pb)	0.2	ND	1.4	0.93	1	0.95	1	0.24	0.26	0.29	0.28	0.33
Magnesium (Mg mg/L)	0.1	ND	3.5	3.1	3.1	3.2	3	3.5	3.2	3.3	3.3	2.9
Manganese (Mn)	0.2	ND	330	310	310	310	290	150	150	150	150	170
Molybdenum (Mo)	0.5	ND	2.1	2.1	2	2.1	2	3.2	2.6	2.5	2.5	2
Nickel (Ni)	0.2	ND	**43**	29	30	29	24	16	14	15	15	13
Selenium (Se)	1.0	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
Silver (Ag)	0.2	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
Thallium (Tl)	0.5	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
Vanadium (V)	0.5	ND	0.65	0.58	0.57	0.56	0.56	ND	0.51	0.5	ND	0.53
Zinc (Zn)	5.0	ND	26	16	15	16	12	ND	ND	ND	ND	ND
Hardness as $CaCO_3$			74.3	72.7	70.2		69.8	91.8	80.6	81.0	83.5	79.4
Cd Acute Criteria			1.51	1.48	1.43		1.42	1.85	1.63	1.64	1.69	1.61
Cd Chronic Criteria			0.20	0.20	0.19		0.19	0.23	0.21	0.21	0.22	0.21
Cu Acute Criteria			10.2	10.0	9.6		9.6	12.4	11.0	11.0	11.3	10.8
Cu Chronic Criteria			7.0	6.8	6.6		6.6	8.3	7.4	7.5	7.7	7.4
Pb Acute Criteria			46.7	45.6	43.8		43.6	58.8	51.0	51.3	53.0	50.2
Pb Chronic Criteria			1.82	1.78	1.71		1.70	2.29	1.99	2.00	2.07	1.95

= Acute Violation
= Chronic Violation

Table C. 8. March 6, 2008 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

				For QA QC check								
Date of Collection:		3/6/2008	3/6/2008	3/6/2008	3/6/2008	3/6/2008	3/6/2008	3/6/2008	3/6/2008	3/6/2008	3/6/2008	3/6/2008
	Station	**TM1 Blank**	**TM1**	**TM1 Field Dup**	**TM1 Lab Dup**	**TM2**	**TM3**	**TM4**	**TM5**	**TM6**	**TM7**	**TM8**
Constituent	**RL**											
Aluminum (Al)	10.0	ND	34	34	34	35	52	27	27	25	26	26
Antimony (Sb)	0.5	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
Arsenic (As)	0.5	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
Barium (Ba)	0.2	ND	25	24	24	24	20	23	23	23	24	24
Beryllium (Be)	0.2	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
Cadmium (Cd)	0.1	ND	**0.2**	ND		ND	ND	**0.32**	**0.3**	**0.3**	**0.33**	**0.29**
Calcium (Ca mg/L)	0.1	ND	15	16	16	15	14	17	17	17	18	18
Chromium (Cr)	2.0	ND	ND	ND		ND	ND	2.2	2.1	2.1	2.1	2.2
Cobalt (Co)	0.2	ND	0.41	0.4	0.4	0.48	0.35	0.49	0.47	0.43	0.42	0.43
Copper (Cu)	0.5	ND	**5.5**	5.6	5.8	**5.6**	4.4	5	5.1	5.1	5.1	5.2
Iron (Fe)	50	ND	150	140	150	150	170	160	160	150	160	160
Lead (Pb)	0.5	ND	0.75	0.72	0.77	0.81	0.65	0.71	0.71	0.67	0.66	0.69
Magnesium (Mg mg/L)	0.1	ND	2.8	2.8	2.8	2.8	2.7	3	3	3	3.1	3.1
Manganese (Mn)	0.5	ND	90	90	91	94	81	130	130	130	130	130
Molybdenum (Mo)	0.5	ND	0.61	ND		1.5	ND	0.69	0.59	0.57	0.89	0.61
Nickel (Ni)	0.2	ND	11	11	11	11	8.1	14	14	13	13	13
Selenium (Se)	2.5	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
Silver (Ag)	0.2	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
Thallium (Tl)	0.5	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
Vanadium (V)	0.2	ND	0.2	0.2	0.2	ND	0.3	0.24	ND	ND	0.21	0.27
Zinc (Zn)	10.0	ND	20	20	20	25	18	19	19	18	18	21
Hardness as $CaCO_3$			49.0	51.5		49.0	46.1	54.8	54.8	54.8	57.7	57.7
Cd Acute Criteria			1.01	1.06		1.01	0.95	1.12	1.12	1.12	1.18	1.18
Cd Chronic Criteria			0.15	0.16		0.15	0.14	0.16	0.16	0.16	0.17	0.17
Cu Acute Criteria			6.9	7.2		6.9	6.5	7.6	7.6	7.6	8.0	8.0
Cu Chronic Criteria			4.9	5.1		4.9	4.6	5.4	5.4	5.4	5.6	5.6
Pb Acute Criteria			29.5	31.1		29.5	27.5	33.4	33.4	33.4	35.3	35.3
Pb Chronic Criteria			1.15	1.21		1.15	1.07	1.30	1.30	1.30	1.38	1.38

= Acute Violation
= Chronic Violation

Table C. 9. August 1, 2008 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

			For QA QC check				For QA QC check					
Date of Collection:		8/1/2008	8/1/2008	8/1/2008	8/1/2008	8/1/2008	8/1/2008	8/1/2008	8/1/2008	8/1/2008	8/1/2008	8/1/2008
	Station	**TM1 Blank**	**TM1**	**TM1 Lab Dup**	**TM2**	**TM3**	**TM4**	**TM4 Field Dup**	**TM5**	**TM6**	**TM7**	**TM8**
Constituent	**RL**											
Aluminum (Al)	5.0	ND	22.00	22.00	19.00	20.00	11.00	10.00	ND	ND	ND	ND
Antimony (Sb)	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic (As)	0.5	ND	1.20	1.20	1.20	1.20	1.20	1.10	1.00	1.10	1.00	0.99
Barium (Ba)	0.5	ND	25.00	25.00	24.00	25.00	19.00	19.00	17.00	17.00	17.00	15.00
Beryllium (Be)	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium (Cd)	0.2	ND	**0.22**	0.21	ND	ND	ND	ND	ND	ND	ND	ND
Calcium (Ca mg/L)	0.1	ND	21.00	21.00	23.00	23.00	17.00	17.00	16.00	16.00	18.00	17.00
Chromium (Cr)	0.5	ND	2.10	2.10	2.10	1.80	1.20	1.20	0.67	0.68	0.69	0.58
Cobalt (Co)	0.2	ND	0.45	0.42	0.51	0.42	ND	ND	ND	0.22	0.24	0.22
Copper (Cu)	0.5	ND	**9.90**	10.00	**8.60**	**8.30**	**7.40**	7.20	**6.40**	**6.30**	**6.20**	**6.30**
Iron (Fe)	55	ND	680.00	670.00	640.00	630.00	370.00	370.00	110.00	140.00	170.00	72.00
Lead (Pb)	0.2	ND	**3.10**	3.20	**3.00**	**2.70**	1.20	1.20	0.39	0.47	0.57	0.28
Magnesium (Mg mg/L)	0.1	ND	3.30	3.20	3.20	3.30	2.70	2.80	2.50	2.60	2.70	2.70
Manganese (Mn)	0.5	ND	230.00	220.00	270.00	250.00	52.00	48.00	21.00	49.00	69.00	12.00
Molybdenum (Mo)	0.5	ND	2.30	2.30	2.90	2.70	1.60	1.70	1.70	1.70	1.70	1.90
Nickel (Ni)	1.0	ND	27.00	27.00	26.00	24.00	16.00	16.00	12.00	12.00	13.00	10.00
Selenium (Se)	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver (Ag)	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium (Tl)	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium (V)	0.2	ND	0.93	0.88	0.98	0.85	0.79	0.75	0.70	0.73	0.70	0.75
Zinc (Zn)	5.0	ND	11.00	12.00	8.40	9.30	ND	ND	ND	ND	ND	ND
Hardness as $CaCO_3$			66.0		70.6	71.0	53.6		50.2	50.7	56.1	53.6
Cd Acute Criteria			1.34		1.44	1.44	1.10		1.03	1.04	1.15	1.10
Cd Chronic Criteria			0.18		0.19	0.19	0.16		0.15	0.15	0.16	0.16
Cu Acute Criteria			9.1		9.7	9.7	7.5		7.0	7.1	7.8	7.5
Cu Chronic Criteria			6.3		6.7	6.7	5.3		5.0	5.0	5.5	5.3
Pb Acute Criteria			41.0		44.1	44.4	32.5		30.3	30.6	34.2	32.5
Pb Chronic Criteria			1.60		1.72	1.73	1.27		1.18	1.19	1.33	1.27

= Acute Violation
= Chronic Violation

APPENDIX D- TOTAL METALS DATA

Table D. 1. May 22, 2007 Survey

Ten Mile River Trace Metal Samples
All values are ug/L unless noted

										For QA QC check	
Date of Collection:		5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007
	Station	**TM1 Blank**	**TM1**	**TM2**	**TM3**	**TM4**	**TM5**	**TM6**	**TM7**	**TM8**	**TM8 Field Dup**
Constituent	RL										
Aluminum (Al)	5.0	9	**120**	31	**120**	**97**	**99**	**100**	**96**	**88**	79
Antimony (Sb)	0.5	ND	0.71			7.6					
Arsenic (As)	1.0	ND	ND								
Barium (Ba)	0.2	ND	19	18	19	17	17	18	17	17	18
Beryllium (Be)	0.2	ND									
Cadmium (Cd)	0.1	ND	0.23	0.13	0.3	0.26	0.37	0.41	0.38	0.37	0.39
Calcium (Ca mg/L)	0.1	ND	16	15	16	14	15	15	16	16	16
Chromium (Cr)	1.0	1.5	5.2	2.6	4.7	3.1	3.7	3.2	3.4	2.8	2.9
Cobalt (Co)	0.2	ND	0.58	0.4	0.54	0.42	0.46	0.49	0.47	0.42	0.41
Copper (Cu)	0.2	0.24	12	5.9	12	8.3	9	8.6	8.6	7.9	7.7
Iron (Fe)	50	ND	780	310	750	660	620	640	630	600	580
Lead (Pb)	0.2	ND	3.1	0.99	3	2.4	2.3	2.4	2.3	2.1	2.2
Magnesium (Mg mg/L)	0.1	ND	2.6	2.5	2.6	2.4	2.4	2.5	2.5	2.6	2.6
Manganese (Mn)	0.2	ND	150	130	150	130	150	170	170	170	170
Molybdenum (Mo)	0.5	ND	0.72	0.59	0.58	0.56	0.75	0.77	0.78	0.88	0.88
Nickel (Ni)	0.2	ND	16	14	15	14	15	16	16	16	16
Selenium (Se)	1.0	ND									
Silver (Ag)	0.2	ND	0.47		0.46				0.2		
Thallium (Tl)	0.5	ND									
Vanadium (V)	0.2	ND									
Zinc (Zn)	2.0	4.3	19	15	18	17	19	20	18	18	20

Table D. 2. June 19, 2007 Survey

Ten Mile River Trace Metal Samples
All values are ug/L unless noted

				for QA QC check				for QA QC check				
Date of Collection:		6/19/2007	6/19/2007	6/19/2007	6/19/2007	6/19/2007	6/19/2007	6/19/2007	6/19/2007	6/19/2007	6/19/2007	6/19/2007
	Station	**TM1 Blank**	**TM1**	**TM2**	**TM2 Lab Dup**	**TM3**	**TM4**	**TM5**	**TM5 Field Dup**	**TM6**	**TM7**	**TM8**
Constituent	RL											
Aluminum (Al)	5.0	ND	**94**	86		73	34	35	35	42	43	30
Antimony (Sb)	0.5	ND	0.57	1.4		0.67						
Arsenic (As)	1.0	ND										
Barium (Ba)	0.2	ND	24	24		25	16	17	16	16	16	16
Beryllium (Be)	0.2	ND										
Cadmium (Cd)	0.1	ND	0.32	0.39		0.35	0.17	0.22	0.18	0.21	0.21	0.19
Calcium (Ca mg/L)	0.1	ND	23	26		25	19	19	19	19	21	20
Chromium (Cr)	1.0	ND	4.9	4.3		3.6	1.9	1.9	2	1.9	2	1.8
Cobalt (Co)	0.2	ND	0.53									
Copper (Cu)	0.2	ND	12	11		10	6.3	6.5	6.5	6.4	9.7	6.1
Iron (Fe)	50	ND	920	790		790	620	620	640	590	580	530
Lead (Pb)	0.2	ND	5.3	4.5		4.1	2.2	2	2	2	2.1	1.7
Magnesium (Mg mg/L)	0.1	ND	3.3	3.2		3.3	3	2.9	2.9	3	3	3
Manganese (Mn)	0.2	ND	170	150		150	120	140	140	140	140	110
Molybdenum (Mo)	0.5	ND	1.3	1.4		1.3	1.1	1.1	1.1	1.1	1.1	1.1
Nickel (Ni)	0.2	ND	20	19		18	15	15	15	14	14	13
Selenium (Se)	1.0	ND										
Silver (Ag)	0.2	ND	0.54									
Thallium (Tl)	0.5	ND										
Vanadium (V)	0.2	ND										
Zinc (Zn)	2.0	ND	16	18		16	8	9.7	8.1	9.3	12	10

Table D. 3. July 2, 2007 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

			For QA QC check					For QA QC check				
Date of Collection:		7/2/2007	7/2/2007	7/2/2007	7/2/2007	7/2/2007	7/2/2007	7/2/2007	7/2/2007	7/2/2007	7/2/2007	7/2/2007
	Station	**TM1 Blank**	**TM1**	**TM1 Lab Dup**	**TM2**	**TM3**	**TM4**	**TM4 Field Dup**	**TM5**	**TM6**	**TM7**	**TM8**
Constituent	RL											
Aluminum (Al)	5.0		69		**94**	36	41	39	43	42	43	31
Antimony (Sb)	0.5								2.2			
Arsenic (As)	0.5											
Barium (Ba)	0.2		26		29	26	21	20	14	13	13	15
Beryllium (Be)	0.2											
Cadmium (Cd)	0.1		0.26		0.45	0.25		0.1	0.11	0.11		
Calcium (Ca mg/L)	0.1		24		28	26	24	24	23	23	24	24
Chromium (Cr)	0.5		3.3		4.5	2.6	2.1	2.2	2	1.7	2.1	1.6
Cobalt (Co)	0.2		0.52		0.51	0.3	0.37	0.36	0.47	0.47	0.46	0.34
Copper (Cu)	0.2		11		16	8.1	7.8	7.1	7	6.8	6.7	6.3
Iron (Fe)	50		790		730	580	420	400	470	430	390	310
Lead (Pb)	0.2		4.1		3.9	2.3	1.5	1.3	1.4	1.3	1.2	0.87
Magnesium (Mg mg/L)	0.1		3.4		3.4	3.3	3.2	3.2	3.1	3.1	3.2	3.2
Manganese (Mn)	0.2		190		140	110	95	90	140	150	150	150
Molybdenum (Mo)	0.5		1.4		1.8	1.6	1.7	1.7	1.7	1.6	1.6	1.6
Nickel (Ni)	0.2		26		29	24	17	16	16	15	15	14
Selenium (Se)	1.0											
Silver (Ag)	0.2		0.3		0.42							
Thallium (Tl)	0.5											
Vanadium (V)	0.2											
Zinc (Zn)	2.0		14		17	15	7.7	7.2	6.4	5.3	5.7	6.1

Table D. 4. July 31, 2007 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

			For QA QC check						For QA QC check			
Date of Collection:		7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007	7/31/2007
	Station	**TM1 Blank**	**TM1**	**TM1 Lab Dup**	**TM2**	**TM3**	**TM4**	**TM5**	**TM6**	**TM6 Field Dup**	**TM7**	**TM8**
Constituent	RL											
Aluminum (Al)	5.0		**180**		72	**120**	57	48	79	80	**97**	**130**
Antimony (Sb)	0.5		1.1		1.4							1.1
Arsenic (As)	0.5											
Barium (Ba)	0.2		28		26	26	23	19	20	19	19	18
Beryllium (Be)	0.2											
Cadmium (Cd)	0.1		0.44		0.34	0.3			0.14	0.11	0.15	0.12
Calcium (Ca mg/L)	0.1		21		24	23	24	23	24	23	27	26
Chromium (Cr)	0.5		6.8		3.5	3.4	1.7			2	2	2
Cobalt (Co)	0.2		0.84		0.44	0.44	0.41	0.37	0.47	0.45	0.51	0.43
Copper (Cu)	0.2		20		13	12	5.2	4.8	5.8	5.4	5.7	5.7
Iron (Fe)	50		**1100**		590	620	400	230	310	310	330	350
Lead (Pb)	0.2		8.4		3.3	3.8	0.92	0.46	0.99	0.85	1.1	1.9
Magnesium (Mg mg/L)	0.1		3.3		3.1	3.2	3.2	3.3	3.3	3.3	3.3	2.9
Manganese (Mn)	0.2		290		210	210	230	140	190	190	210	230
Molybdenum (Mo)	0.5		2		2.1	2	1.9	1.9	2	2	2	1.8
Nickel (Ni)	0.2		30		22	21	13	12	13	13	13	11
Selenium (Se)	1.0											
Silver (Ag)	0.2		1.1		0.32	0.33						
Thallium (Tl)	0.5											
Vanadium (V)	0.2		0.61									
Zinc (Zn)	2.0		20		13	13	16	3.2	5.6	5.4	7.8	9.3

Table D. 5. August 21, 2007 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

					For QA QC check						
	Date of Collection:	8/21/2007	8/21/2007	8/21/2007	8/21/2007	8/21/2007	8/21/2007	8/21/2007	8/21/2007	8/21/2007	8/21/2007
	Station	**TM1 Blank**	**TM1**	**TM2**	**TM3**	**TM3 Field Dup**	**TM4**	**TM5**	**TM6**	**TM7**	**TM8**
Constituent	RL										
Aluminum (Al)	5.0		**89**	**93**	43		57	48	51	57	36
Antimony (Sb)	0.5										
Arsenic (As)	0.5						1.3	1.5	1.4	1.2	1.5
Barium (Ba)	0.2		26	33	31		26	25	26	25	25
Beryllium (Be)	0.2										
Cadmium (Cd)	0.1		0.25	0.2	0.18						
Calcium (Ca mg/L)	0.1		35	37	33		27	25	25	29	28
Chromium (Cr)	0.5		3.3	3	2.2						
Cobalt (Co)	0.2		0.55	0.48	0.34		0.49	0.51	0.55	0.57	0.53
Copper (Cu)	0.2		9.8	9	6.8		4.4	3.9	4.2	4.1	3.3
Iron (Fe)	50		650	640	540		390	380	360	350	500
Lead (Pb)	0.2		4	3.2	2.3		1.3	0.48	0.58	0.62	0.5
Magnesium (Mg mg/L)	0.1		3.9	3.7	3.7		3.5	3.4	3.5	3.5	3.5
Manganese (Mn)	0.2		240	220	200		250	300	350	360	480
Molybdenum (Mo)	0.5		3.3	2	1.7		2.3	2.2	2.2	2.1	2.1
Nickel (Ni)	0.2		21	20	18		14	13	14	13	12
Selenium (Se)	1.0										
Silver (Ag)	0.2		0.3								
Thallium (Tl)	0.5										
Vanadium (V)	0.2										
Zinc (Zn)	2.0		13		9.2		3.8		4.3	8.1	4.2

Table D. 6. September 4, 2007 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

									For QA QC check		
	Date of Collection:	9/4/2007	9/4/2007	9/4/2007	9/4/2007	9/4/2007	9/4/2007	9/4/2007	9/4/2007	9/4/2007	9/4/2007
	Station	**TM1 Blank**	**TM1**	**TM2**	**TM3**	**TM4**	**TM5**	**TM6**	**TM7**	**TM7 Field Dup**	**TM8**
Constituent	RL										
Aluminum (Al)	5.0	ND	82	**120**	38	48	41	31	33	35	31
Antimony (Sb)	0.5	ND	0.61	0.54					1.9		
Arsenic (As)	0.5	ND				1.2	1.3	1.3	1.2	1.1	1.3
Barium (Ba)	0.2	ND	29	38	34	30	29	33	32	32	25
Beryllium (Be)	0.2	ND									
Cadmium (Cd)	0.1	ND	0.24	0.32	0.19						
Calcium (Ca mg/L)	0.1	ND	41	39	38	28	27	28	32	32	30
Chromium (Cr)	0.5	ND	2.6	3.7							
Cobalt (Co)	0.2	ND	0.56	0.57	0.35	0.52	0.52	0.49	0.51	0.49	0.48
Copper (Cu)	0.2	0.27	16	12	7.1	4.5	4.4	3.8	3.6	3.5	3.2
Iron (Fe)	50	ND	530	600	370	340	280	280	260	250	310
Lead (Pb)	0.5	ND	3.6	3.4	1.7	1	0.64	0.59	0.62	0.54	3.2
Magnesium (Mg mg/L)	0.1	ND	4.1	4	3.9	3.6	3.6	3.8	3.8	3.8	3.7
Manganese (Mn)	0.5	ND	240	250	200	210	290	300	330	320	350
Molybdenum (Mo)	0.5	ND	3	3.4	3.4	2.5	2.5	2.3	2.3	2.2	2.3
Nickel (Ni)	0.2	ND	22	23	18	14	14	15	14	14	12
Selenium (Se)	1.0	ND									
Silver (Ag)	0.2	ND	0.3	0.4							
Thallium (Tl)	0.5	ND									
Vanadium (V)	0.2	ND									
Zinc (Zn)	2.0	2.2	15	12	8.9	4.6	5.5	4.4	4.8	5.3	4.4

Table D. 7. September 12, 2007 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

				For QA QC check								
Date of Collection:		9/12/2007	9/12/2007	9/12/2007	9/12/2007	9/12/2007	9/12/2007	9/12/2007	9/12/2007	9/12/2007	9/12/2007	9/12/2007
	Station	**TM1 Blank**	**TM1**	**TM2**	**TM2 Field Dup**	**TM2 Lab Dup**	**TM3**	**TM4**	**TM5**	**TM6**	**TM7**	**TM8**
Constituent	RL											
Aluminum (Al)	5.0	5.9	**160**	**170**	**170**		**170**	**88**	62	77	85	86
Antimony (Sb)	0.5											
Arsenic (As)	0.5								1.3	1.2	1.2	1.3
Barium (Ba)	0.2	0.29	36	33	33		32	38	31	31	31	30
Beryllium (Be)	0.5											
Cadmium (Cd)	0.1		0.93	0.78	0.78		0.61	0.23	0.15	0.2	0.25	
Calcium (Ca mg/L)	0.1		25	24	25		24	34	28	28	30	29
Chromium (Cr)	0.5		5	5.1	5.1		4.4	3.3	2			
Cobalt (Co)	0.2		1.5	1	0.98		0.84	0.6	0.67	0.74	0.74	0.62
Copper (Cu)	0.2		25	23	24		18	8.8	5.7	6.1	5.9	5
Iron (Fe)	50		1000	800	810		820	520	510	530	540	740
Lead (Pb)	0.2		9.3	6.9	7		6.6	2.1	1.3	1.5	1.7	2.3
Magnesium (Mg mg/L)	0.1		3.5	3.3	3.3		3.2	3.7	3.5	3.5	3.5	3.1
Manganese (Mn)	0.2		430	350	350		360	230	280	290	300	330
Molybdenum (Mo)	0.5		1.9	1.7	1.7		1.8	3.1	2.5	2.5	2.3	1.9
Nickel (Ni)	0.2		53	36	35		29	18	16	17	19	13
Selenium (Se)	1.0											
Silver (Ag)	0.2		0.31	0.25	0.24						0.61	
Thallium (Tl)	0.5											
Vanadium (V)	0.2											
Zinc (Zn)	2.0		39	27	28		23	8.1	5.5	8.6	9.8	13

Table D. 8. March 6, 2008 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

				For QA QC check								
Date of Collection:		3/6/2008	3/6/2008	3/6/2008	3/6/2008	3/6/2008	3/6/2008	3/6/2008	3/6/2008	3/6/2008	3/6/2008	3/6/2008
	Station	**TM1 Blank**	**TM1**	**TM1 Field Dup**	**TM1 Lab Dup**	**TM2**	**TM3**	**TM4**	**TM5**	**TM6**	**TM7**	**TM8**
Constituent	RL											
Aluminum (Al)	10.0	ND	**95**	**100**		**120**	**120**	77	77	69	76	72
Antimony (Sb)	0.5	ND										
Arsenic (As)	0.5	ND										
Barium (Ba)	0.2	ND	26	25		25	23	23	24	25	25	25
Beryllium (Be)	0.2	ND										
Cadmium (Cd)	0.1	ND	0.29	0.24		0.35	0.28	0.35	0.38	0.39	0.41	**0.38**
Calcium (Ca mg/L)	0.1	ND	16	16		16	15	17	17	17	18	18
Chromium (Cr)	2.0	ND	3.8	4.5		4.9	4.2	4.3	4.2	4.8	4.2	4.2
Cobalt (Co)	0.2	ND	0.47	0.47		0.52	0.48	0.53	0.5	0.49	0.49	0.48
Copper (Cu)	0.5	ND	8.9	8.3		11	8.7	6.8	6.8	6.8	6.8	6.6
Iron (Fe)	50	ND	330	360		410	390	390	340	330	350	320
Lead (Pb)	0.5	ND	1.8	1.8		2.6	2.2	1.4	1.3	1.3	1.3	1.3
Magnesium (Mg mg/L)	0.1	ND	2.8	2.8		2.8	2.7	2.9	3	3	3.1	3
Manganese (Mn)	0.5	ND	99	98		100	100	140	140	140	140	140
Molybdenum (Mo)	0.5	ND		0.56				0.6	0.6	0.59	0.61	0.6
Nickel (Ni)	0.2	ND	12	11		13	10	14	14	14	14	14
Selenium (Se)	2.5	ND										
Silver (Ag)	0.2	ND	0.23	0.24		0.34	0.24					
Thallium (Tl)	0.5	ND										
Vanadium (V)	0.2	ND										
Zinc (Zn)	2.0	ND	23	23		24	22	22	23	22	22	24

Table D. 9. August 1, 2008 Survey

Ten Mile River Trace Metal Samples

All values are ug/L unless noted

			For QA QC check				For QA QC check					
Date of Collection:		8/1/2008	8/1/2008	8/1/2008	8/1/2008	8/1/2008	8/1/2008	8/1/2008	8/1/2008	8/1/2008	8/1/2008	8/1/2008
	Station	**TM1 Blank**	**TM1**	**TM1 Lab Dup**	**TM2**	**TM3**	**TM4**	**TM4 Field Dup**	**TM5**	**TM6**	**TM7**	**TM8**
Constituent	RL											
Aluminum (Al)	5.0	ND	**98**		**120**	**98**	59	59	59	64	62	51
Antimony (Sb)	0.5	ND										
Arsenic (As)	0.5	ND	1.30		1.40	1.50	1.40	1.20	1.40	1.30	1.10	1.30
Barium (Ba)	0.5	ND	27.00		27.00	27.00	24.00	23.00	24.00	21.00	21.00	21.00
Beryllium (Be)	0.2	ND										
Cadmium (Cd)	0.2	ND	0.41		0.45	0.39	0.22		0.22			
Calcium (Ca mg/L)	0.1	ND	22.00		24.00	24.00	18.00	17.00	18.00	17.00	18.00	19.00
Chromium (Cr)	0.5	ND	5.20		5.80	4.90	3.10	2.70	3.10	2.70	2.50	2.50
Cobalt (Co)	0.2	ND	0.60		0.66	0.56	0.29	0.28	0.29	0.36	0.37	0.34
Copper (Cu)	0.5	ND	16.00		18.00	14.00	9.50	9.30	9.50	7.60	7.60	7.00
Iron (Fe)	55	ND	**1100**		**1200**	**1100**	730	730	730	550	540	450
Lead (Pb)	0.2	ND	6.00		6.20	5.40	2.70	2.70	2.70	2.00	2.00	1.60
Magnesium (Mg mg/L)	0.1	ND	3.50		3.50	3.50	2.90	2.80	2.90	2.80	2.70	2.90
Manganese (Mn)	0.5	ND	240.00		290.00	270.00	190.00	180.00	190.00	190.00	200.00	180.00
Molybdenum (Mo)	0.5	ND	2.30		2.90	2.70	1.70	1.60	1.70	1.60	1.60	1.80
Nickel (Ni)	1.0	ND	30.00		30.00	27.00	19.00	19.00	19.00	16.00	16.00	16.00
Selenium (Se)	1.0	ND										
Silver (Ag)	0.2	ND	0.49		0.55	0.42	0.22	0.21	0.22			
Thallium (Tl)	0.5	ND										
Vanadium (V)	0.2	ND	0.76		0.73	0.54	0.55	0.60	0.55	0.45	0.41	0.34
Zinc (Zn)	2.0	ND	19.00		18	16	11	12	11			8.6