MILLERS RIVER WATERSHED
SMART MONITORING PROGRAM 2005-2010

Technical Memorandum CN 428.0

Warren Kimball and MaryAnn Dipinto conduct water quality monitoring on the Millers River, Royalston

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All photos included in this document were taken by Therese Beaudoin. MassDEP. CERO.
SMART monitoring logo designed by Robert Kimball and Barbara Kimball.

LIST OF FIGURES

LIST OF LATIN NAMES

Latin Name	Common name	Latin Name	Common name
Ardea herodias	great blue heron	*Lysimachia ciliata*	fringed loosestrife
Branta canadensis	Canada goose	*Megaceryle alcyon*	belted kingfisher
Callitriche sp.	Starwort	*Myriophyllum* sp.	milfoil
Cambaridae family	freshwater crayfishes	*Nerodia sipedon*	Northern water snake
Carex crinita	fringed sedge	*Polygonum* sp.	smartweed
Castor canadensis	North American beaver	*Pontedaria cordata*	pickerelweed
Chara sp.	muskgrass	*Potamogeton* sp	pondweed
Cicuta sp.	water hemlock	*Procyon lotor*	raccoon
Elodea sp.	waterweed	*Rana sylvatica*	wood frog
Gramineae family	true grasses	*Rorippa* sp.	water cress
Lemna sp.	duckweed	*Sagittaria* sp.	arrowhead
Lithobates catesbeianus	American bullfrog	*Scirpus* sp.	sedges
Lithobates pipiens	Northern leopard frog	*Vallisneria* sp.	American eelgrass
Lobelia cardinalis	cardinal flower	*Wolffia* sp.	watermeal

LIST OF ACRONYMS

% sat	percent oxygen saturation
305(b)	Section 305(b), Clean Water Act
7Q10	streamflow that spans 7 consecutive days and occurs once every 10 years
BRP	Bureau of Resource Protection
BWR	Bureau of Water Resources
ºC	degree Celsius
CERO	CEntral Regional Office
CFR	Coldwater Fish Resource
cfs	cubic feet per second
CSO	Combined Sewer Overflow
DO	dissolved oxygen
DWM	Division of Watershed Management
ºF	degree Fahrenheit
in.	inch
m	meter
MA	Massachusetts
MassDEP	Massachusetts Department of Environmental Protection
µS/cm	microsiemen per centimeter
mi^2	square mile
MGD	million gallons per day
mg/L	milligrams per liter
NH	New Hampshire
NH_3-N	ammonia nitrogen
NOAA	National Oceanic and Atmospheric Administration
NO_3NO_2-N	nitrate-nitrite nitrogen
NTU	Nephelometric Turbidity Unit
NWS	National Weather Service
POR	Period of Record
POTW	Privately Owned Treatment Works
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
SMART	Strategic Monitoring and Assessment for River basin Teams
SOP	standard operating procedure
SSolids	total suspended solids
SU	Standard Unit
SWMA	State Wildlife Management Area
T	temperature
TDS	total dissolved solids
TMDL	Total Maximum Daily Load
TN	total nitrogen
TP	total phosphorus
USGS	United States Geological Survey
WES	Wall Experiment Station
WPCF	Water Pollution Control Facility
WWTP	wastewater treatment plant

INTRODUCTION

The purpose of this technical memo is to present observations and data collected in the Millers watershed by the Strategic Monitoring and Assessment for River basin Teams (SMART) program from 2005 through 2010, highlighting how the program supports and augments programs of the Massachusetts Department of Environmental Protection (MassDEP) Bureau of Resource Protection (BRP, now the Bureau of Water Resources, BWR) Central Regional Office (CERO) and the Division of Watershed Management (DWM).

Overview of Monitoring Plan

Bimonthly water quality monitoring began in March 2000. The sampling plan matrix for the years 2005 through 2010 is presented in Table 1. The location of sampling stations is presented in Figure 1. Sampling components at all stations included:

- *in situ* measurements: dissolved oxygen (DO), percent oxygen saturation, pH, specific conductivity, temperature (T), depth and total dissolved solids (TDS);
- physical/chemical constituents: total alkalinity, chlorides, hardness, total suspended solids (TSS), turbidity;
- nutrients: ammonia-nitrogen (NH_3-N), nitrate-nitrite-nitrogen (NO_3_NO_2-N), total nitrogen (TN), and total phosphorus (TP);
- flow measurements (at existing USGS flow gaging stations); and
- general field observations.

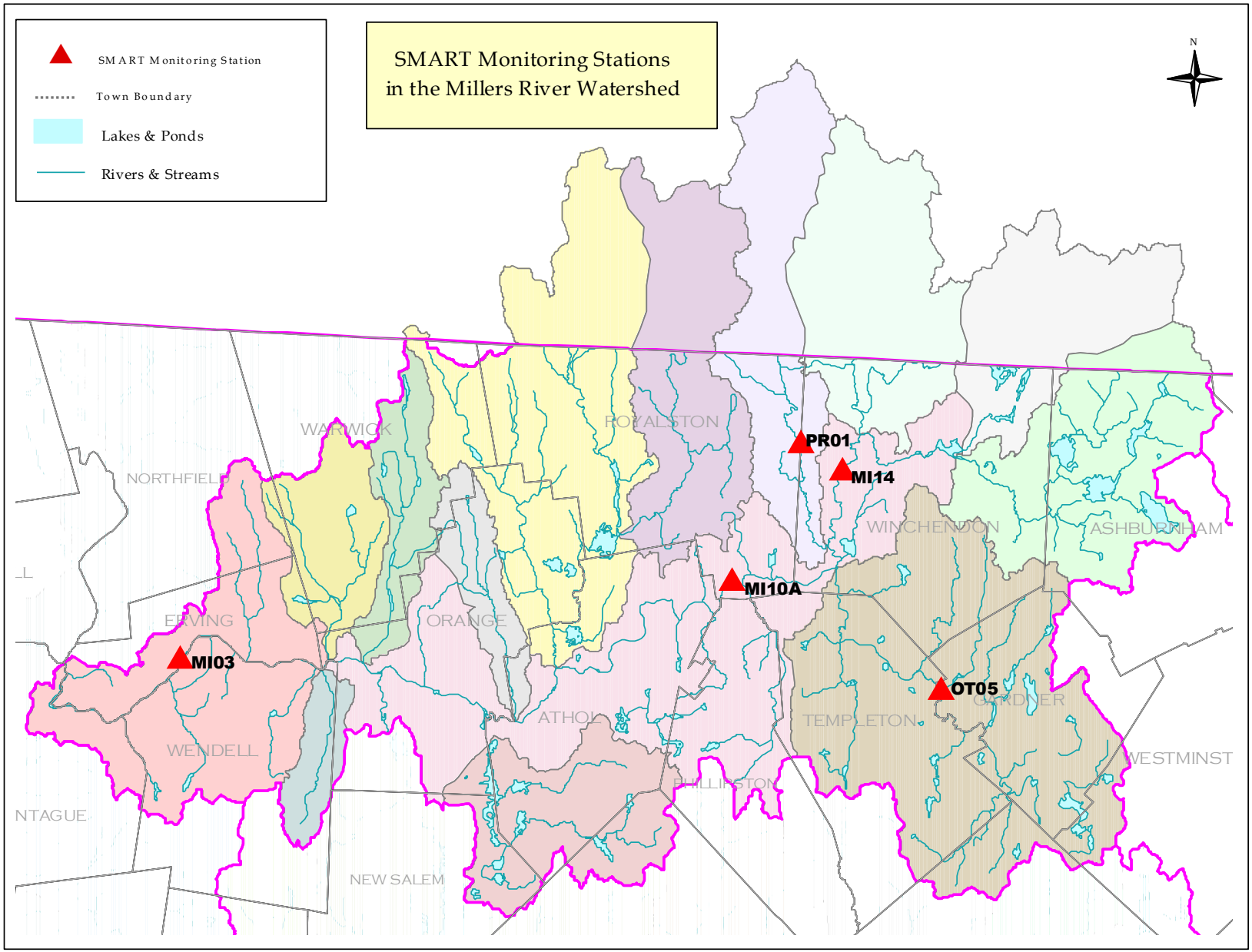
Table 1 Millers Basin SMART Sampling Summary – 2005 - 2010

Location and Segment Numbers	Station Name	Station Type	Dates Sampled[1]
Millers River @ Sibley Road, Winchendon MA35-02	MI14	Impact	2005: 1/18/05, 3/8/05, 5/11/05, 6/14/05, 7/13/05, 8/9/05, 9/14/05, 11/2/05 2006: 2/14/06, 4/5/06, 6/13/06, 8/8/06, 10/10/06 2007: 1/16/07, 3/20/07, 5/15/07, 7/17/07, 9/11/07, 11/6/07 2008: 2/20/08, 4/22/08, 6/17/08, 8/19/08, 10/21/08 2009: 2/3/09, 3/17/09, 5/19/09, 7/21/09, 9/22/09, 11/16/09 2010: 2/17/10, 8/24/10, 10/19/10 [1]The SMART Monitoring program began in the Millers basin in March 2000.
Priest Brook @ USGS flow gaging station, Winchendon Road, Royalston MA35-10	PR01	Reference	
Otter River @ USGS flow gaging station, Bridge Street, Gardner MA35-07	OT05	Impact	
Millers River @ USGS flow gaging station, Blossom Street, Royalston MA35-03	MI10A	Impact	
Millers River @ USGS flow gaging station, Farley Road, Wendell MA35-05	MI14	Boundary	

Hydrology

The Millers River Watershed lies in both Massachusetts (MA) and New Hampshire (NH), encompassing part or all of 17 municipalities. Of the 389 square mile (mi^2) total drainage area, approximately 80% lies in MA (310 mi^2). From the outlet of Sunset Lake, Ashburnham, the Millers River flows approximately 46.5 miles (mi) to the Connecticut River in Gill, MA through largely hilly terrain. Eight dams lie on the mainstem, including the Birch Hill Flood Control Project and numerous hydropower structures. Other than these impoundments, the Millers River is characterized by swift flow and numerous rapids. The watershed is largely undeveloped and forested, with town centers and industry often located along the rivers, including Winchendon, Gardner, Templeton (Baldwinville), Athol, Orange and Erving. Annual precipitation ranges from 46 to 48 inches (in) over most of the watershed, with small areas in Ashburnham and Wendell receiving more (48 to 50 in),

Figure 1 MassDEP SMART Millers River Watershed Water Quality Station Locations



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and in Orange/Athol receiving less (44 to 46 in)(Ostiguy et al 2010). The Millers River, from its source to the Connecticut River confluence, is designated a Coldwater Fish Resource (CFR) (MassDFG 2013). Additional information can be found in *Millers River Watershed 2000 Water Quality Assessment Report* (Kennedy and Rojko 2004).

Quality Assurance/Quality Control

The Quality Assurance Project Plan (QAPP) for the SMART program is presented in CN 012.1: *Strategic Monitoring and Assessment for River basin Teams Quality Assurance Project Plan* (Beaudoin 2008). The QAPP presents data quality objectives, quality assurance procedures, and other program-specific information. This technical memorandum will report deviations from the procedures described in the QAPP.

Aerial photos were obtained from Google Earth (2011a, 2011b, 2011c, 2011d, 2011e) at a height of approximately 4,000 feet (ft).

PROJECT OBJECTIVES

The primary water quality objectives of the SMART monitoring program are:

- Document baseline water quality by: providing information on low flow/event flow variation, seasonal variation and frequency of selected constituents; and establishing reference distributions of key constituents for ecoregion delineation and "clean water" sites;
- Estimate loads of detected water constituents at key locations by: quantifying nitrogen loadings to coastal waters; and calculating phosphorous loads upstream/downstream of representative land use areas;
- Define long term trends in water quality by: documenting improvements associated with major abatement projects; and identifying trends at least-impacted stations (that may result from factors such as acid precipitation and climate change);
- Assess attainment of water quality uses by: comparing existing water quality with water quality standards; and by assessing use support for the fishable/swimmable goal;
- Provide support for other programs by: determining reference distributions for ecoregion stations; conducting trend analysis for the 305(b) reports[1] and basin plans; quantifying nutrient loadings for Total Maximum Daily Load allocations (TMDLs); obtaining data on nonpoint source loadings for more intensive Year 2 sampling; providing guidance for volunteer monitoring; collecting data for development of statistically-based water quality standards and for improvement of Combined Sewer Overflow (CSO) and Stormwater policies; and developing a long-term database on conditions at key locations for the development of new programs and basic research.

As stated in the Introduction, this document presents observations and data collected in the Millers Watershed under the SMART program from 2005-2010. An assessment of the data will be presented in future reports.

METHODS

Water quality sampling procedures are included in *Grab Collection Techniques for DWM Water Quality Sampling, Standard Operating Procedure* (MA DEP 1999b). Use of the *in situ* monitoring equipment followed procedures set forth in *CN 4.0 Water Quality Multi-probe Instrument Use, Standard Operating Procedure* (MA DEP 1999a). Physical/chemical and nutrient samples were analyzed at the Wall Experiment Station (WES), the MassDEP analytical laboratory located in Lawrence, Massachusetts. All samples were collected, transported, analyzed, and discarded according to chain-of-custody procedures.

In addition to the measurements and analytes noted above, field observations were recorded at each station on standardized field sheets, photographs, and field notebooks. Field observations included date/time, location, crewmembers, snow cover, canopy cover, water odors, colors, sheens, foams, estimated water quantity and velocity, weather conditions, observed uses, wildlife, aquatic algae and macrophytes, potential pollution sources, and unusual conditions. Number and type of samples were recorded, as well as the last set of *in situ* data collected. A summary of field observations collected during this sampling period are presented in through Table 6 after the station descriptions.

Each station selected for the SMART Monitoring program is described according to key characteristics associated with water quality at that location, as follows:

- Reference: a reference station is located in a stream segment that is minimally influenced by anthropogenic activities;
- Impact: an impact station is located where several sources of pollution come together and can be used to calibrate a mass balance model, or where critical reactions take place such as at an oxygen sag point; and
- Boundary: a boundary station is located at a pour point i.e., where water leaves a designated river basin, or at a state line.

Field sheets, raw data files, chain of custody forms, lab reports, and other metadata used in this report are managed and maintained by the MassDEP DWM in the Water Quality Access Database in Worcester, MA. The validation of the water quality data included data entry into DWM databases, data entry quality control checks, analysis for outliers, blank

[1] The 305(b) reports are the biannual reports to the U. S. Congress on water quality that are required under Section 305(b) of the Clean Water Act.

contamination, duplicates, precision, and holding time violations, followed by project level review (MassDEP 2005). The project coordinator, as identified in the QAPP for the SMART program (CN 012.2), reviews the data for reasonableness, completeness and acceptability (Beaudoin 2008).

Due to resource limitations at the WES laboratory, SMART samples were collected only for nutrient analyses from January through February 1, 2005 and May 18 through May 25, 2005; these were frozen and analyzed at a later date. During these periods, samples were not collected for alkalinity, hardness, total suspended solids and chloride analyses, while turbidity samples were analyzed at the DWM laboratory (instead of WES). These analyses were not conducted on samples collected on September 13, 2006 as well. In 2010, the WES lab was closed from March through June during the construction phase of the new lab space; SMART monitoring was not conducted during this time.

STATION OBSERVATIONS

Station MI14 – Millers River at Sibley Road, Winchendon, MA (river mile 35.141)

Figure 2 Google Earth view of Station MI14 area

Figure 3 Station MI14 upstream

Station MI14 is located on the Millers River in Winchendon, MA within the Worcester Plateau ecoregion. From 2005-2010, the station was sampled 30 times, and access was gained from the eastern shore upstream of the former Sibley Road Bridge, by wading in or using a sampling pole on most dates. On one event, samples were collected from the top of the eastern bridge abutment via sampling pole, due to flooding at the sampling site (2/20/2008). Both locations are representative of water quality conditions in this reach. On 2 sampling events, the river was inaccessible due to adverse conditions (plunging air temperature, 1/18/2005) and snow and ice shelves that extended over the channel (2/3/2009, 2/17/2010). In 2005, two additional events were conducted in cooperation with the DWM Year 2 Monitoring program (6/14/2005 and 8/9/2005). Station MI14 serves as an impact station as it is located downstream of numerous point and nonpoint sources of pollution, as described below.

Land uses near this station included forest, sand/gravel extraction, residential, and a large downstream flood control project, Birch Hill Dam which impounds the river in this reach (Figure 2) during flood management operations; for more information see Birch Hill Flood Control Project) (USACE 2013, Google Earth 2011a). The western side of the Millers River corridor in this area lies within the Birch Hill State Wildlife Management Area (SWMA); see northquabbinwoods for a description of the BHSWMA (North Quabbin Woods, 2011) and Birch Hill Wildlife Management Area for a map (MassWildlife 2011). Massachusetts State Wildlife Management Areas (SWMA) were "designed to forever ensure the survival, health and viability of all our native wildlife communities" (MassWildlife, 2013). The Massachusetts Department of Fish and Game stocks this reach of the Millers River with trout (Norris 2010), and fishermen were sometimes seen in the reach above and below this sampling site. The Winchendon Waste Water Treatment Plant (WWTP) discharge is located 1.6 miles upstream, and Winchendon Center lies an additional 2.5 miles above this. There are no permitted large water withdrawals upstream.

The river was a run in this area, approximately 70 feet wide, typically less than 3 feet deep and roughly uniform (in depth) across the channel throughout the year (Figure 3). Deciduous and evergreen trees provided shade along the stream corridor, but the canopy did not cover the channel. The bottom was typically sand, with sparse to moderate cover with sedges (*Scirpus* sp.). Other aquatic macrophytes observed at Station MI14 included *Pontedaria cordata* (pickerelweed*), Potamogeton* sp. (pondweed) and *Vallisneria* sp. (American eelgrass). Although the observation of periphyton was often limited by the angle of light on the water surface and/or the deeply tannic color of the water column (33% of events), "puffs of green algae" in moderate density was noted on 9/22/2009, when the water level was much lower than typically observed, and filamentous algae on 5/29/2009. Evidence of North American beaver (*Castor canadensis)* activity was noted in this area frequently throughout this time period. The belted kingfisher (*Megaceryle alcyon*), a piscivorous bird, was observed in this stretch. Frogs (species unknown) were heard and seen on numerous events; bullfrogs (*Lithobates catesbeianus)* and wood frogs ((*Rana sylvatica*) were recorded at this site. Dense populations of mosquitoes (described as "voracious") were common after rain events as well as seasonal swarms of blackflies.

Approximately 53% of observations indicated a clear water column, with highly turbid conditions noted on one event (7/17/2007). Water color was typically reddish. The station was characterized by a lack of water odors ("pleasant, musky odor", effluent and musty were each observed once). Sheens were also typically absent during this time period, with manganous sheens noted twice. Foam was noted on 43% of the sampling events, in very sparse to sparse density. Minor quantities of trash were infrequently observed (5 of 30 events), including 1 car tire and few floatables.

Station PR01 – Priest Brook at Winchendon Road, Royalston, MA (river mile 4.206)

Figure 4 Google Earth view of Station PR01 area

Figure 5 Station PR01 upstream

Station PR01 is located on Priest Brook in Royalston, MA within the Worcester Plateau ecoregion. From 2005-2010, the station was sampled 33 times, and the stream was accessed from shore near the USGS flow gaging station downstream of Winchendon Road. Samples were collected by wading in or with a sampling pole. Station PR01 serves as a reference station, minimally influenced by anthropogenic activities.

The land use surrounding this area is primarily forest and wetland, with very little development (Figure 4) (Google Earth 2011b). From Fitzwilliam, New Hampshire, Priest Brook flows through forestland and several palustrine wetlands. There are no municipal or industrial discharges or water supply withdrawals in the Priest Brook watershed. Most of the Priest Brook corridor lies within the Birch Hill SWMA, as well as the flood control zone for the Birch Hill Dam project. The Massachusetts Department of Fish and Game stocks Priest Brook with trout (Norris 2010).

The river at this location was a run, approximately 20 feet wide shaded with nearly complete canopy cover of a mixture of conifers and deciduous trees, although the area at and upstream of the bridge is mainly open sky (Figure 5). The stream bottom consisted of a mixture of gravel and cobble with some sand and muck; numerous boulders are scattered in the channel upstream. The most commonly noted periphyton was dense moss covering all visible submerged rock surfaces. Aquatic macrophytes included *Chara* sp. (muskgrass), Gramineae (grasses), *Myriophyllum* sp. (milfoil), *Pontedaria cordata* (pickerelweed), *Potamogeton* sp. (pondweed), *Scirpus* sp. (sedges) and *Vallisneria* sp. (American eelgrass). A beaver dam (*Castor canadensis*) was observed above the Winchendon Road Bridge frequently during this time period. *Lithobates catesbeianus* (bullfrogs) were recorded at this site. Dense populations of mosquitoes are common after rain events as well as seasonal swarms of blackflies.

The water column was clear on most dates sampled in this time period, with two episodes of slight turbidity. The water column was characterized by a red/brown color and a lack of odor. The presence of foam was common, although typically sparse, and sheens were never observed. Trash was typically absent from the stream channel.

Station OT05 – Otter River at Turner Road/Bridge Street, Templeton/Gardner, MA (river mile 6.490)

Figure 6 Google Earth view of Station OT05 area

Figure 7 Station OT05 upstream

Station OT05 is located on the Otter River in Gardner, MA within the Worcester Plateau ecoregion. From 2005-2010, the station was sampled 33 times, and the river was accessed from the northern shore upstream of the Bridge Street Bridge. Samples were collected by wading in or with a sampling pole. Station OT05 is an impact station as it is located downstream of significant point and nonpoint sources of pollution, as described below.

Land uses near and upstream of OT05 included forest, sand/gravel extraction, and minor residential development (Figure 6) (Google Earth 2011c). The Massachusetts Department of Fish and Game stocks the Otter River with trout (Norris 2010). The Gardner Water Pollution Control Facility (WPCF) discharge is located 3.5 miles upstream, and Gardner center lies in the same area. A small dam is located approximately 300 feet upstream of Station OT05.

At this station, the river flows over a short rapids through a channel approximately 20 feet wide and mostly shaded (Figure 7). The bottom consisted of gravel and cobble, with some sand and a few boulders. Periphyton was present on most sampling events, often moderate in coverage; moss was the most commonly observed. Filamentous algae was also frequently noted, sometimes densely covering wetted rocks. Aquatic macrophytes were present only along the periphery of the stream channel, and included sparse grasses (Graminae), *Polygonum* sp. (smartweed), *Scirpus* sp. (sedges) and *Vallisneria* sp. (American eelgrass). The presence of *Castor canadensis* (beaver) was recorded, as well as *Procyon lotor* (raccoon) tracks at the channel edge. Dense populations of mosquitoes are common after rain events.

The water column at this station ranged from clear to highly turbid, but was typically clear to slightly turbid. The water color was reddish on all sampling events. The water column commonly lacked odor; effluent odors were noted frequently. Foam was present on all but two events, and sheens were entirely absent. Trash was absent on more than half of the monitoring dates, with minor trash noted on most of the rest (beer can, broken glass, bricks).

Station MI10A – Millers River at Blossom Street, South Royalston, MA (river mile 27.662)

Figure 8 Google Earth view of Station MI10A area

Figure 9 Station MI10A upstream

Station MI10A is located on the Millers River in Royalston, MA within the Worcester Plateau ecoregion. From 2005-2010, the station was sampled 32 times, and the river was accessed from the northern shore at the United States Geological Survey (USGS) gaging station on Blossom Street, downstream of the King Street Bridge. On February 3, 2009, the river was inaccessible due to bank-to-bank ice coverage. Samples were collected by wading in or with a sampling pole. Station MI10A serves as an impact station as it is located downstream of significant point and nonpoint sources of pollution, as described below.

Land uses near and upstream of this station include forest, residential, and a large downstream flood control project which alters the river flow through this reach under specific conditions (Figure 8)(Google Earth 2011d). Much of the proximal watershed up- and downstream of this station lies within the Otter River State Forest and the Birch Hill SWMA. The Massachusetts Department of Fish and Game stocks this reach of the Millers River with trout (Norris 2010). Upstream discharges (below Station MI14) include Gardner, Seaman Paper Company (Templeton), and Templeton. Few water withdrawals are located in the area.

The river is a run in this area, approximately 95 feet wide, and the channel is typically too deep to wade (Figure 9). Deciduous trees provide shade along the stream corridor edges only; the channel is almost entirely open to the sun. The bottom consisted mainly of boulder, with cobble, gravel and sand present (when visible), often with a thin layer of silt. Aquatic macrophyte growth was sparse, and plants noted here included *Callitriche* sp. (starwort), *Carex crinita* (fringed sedge), Graminae (grasses), *Lemna* sp. (duckweed), *Lobelia cardinalis* (cardinal flower), *Potamogeton* sp. (pondweed), *Rorippa* sp. (water cress), *Scirpus* sp. (sedge), *Vallisneria* sp. (American eelgrass), and *Wolffia* sp. (water meal). Periphytic growth ranged from none to very dense, and consisted mainly of filamentous algae; moss and film/slime were also observed. Wildlife noted in this reach included *Castor canadensis* (beaver*),* Cambaridae (crayfish), and fish ("minnows"). Dense populations of mosquitoes are common after rain events. Adult caddisflies, damselflies and dragonflies were abundant during summer sampling events; stonefly exuviae were also present.

The water column noted at this station was typically clear to slightly turbid. Water color was brown and/or red on all dates. The station was characterized by a lack of water odors during this time period, "fishy", "musty" and "eutrophic pond" were also noted on individual events. Moderate to dense foam was also typical in this reach; sheens were not observed. Trash was usually absent here; when seen, it was in minor quantities only.

Station MI03 – Millers River at Farley Road, Erving/Wendell, MA (river mile 5.876)

Figure 10 Google Earth view of Station MI03 area

Figure 11 Station MI03 upstream

Station MI03 is located on the Millers River in Wendell, MA within the Worcester Plateau ecoregion. From 2005-2010, the station was sampled 33 times, and the river was accessed from the western shore at the USGS gaging station off Farley Road, downstream of the Farley Bridge. Samples were collected by wading in or with a sampling pole. Station MI03 serves as a boundary station i.e., upstream of the confluence with the Connecticut River.

Land uses near and upstream of this station include forest, residential, roadways, and town centers (Erving, Orange, Athol; Figure 10) (Google Earth 2011e). The Massachusetts Department of Fish and Game stocks this reach of the Millers River with trout (Norris 2010). Upstream discharges (downstream of Station MI10A) include South Royalston WWTP, L. S. Starrett Company (Athol), Athol WWTP, Orange WWTP, the Erving Center WWTP, and the Farley Privately Owned Treatment Works (POTW). As the station was moved to the eastern side of the river to be outside of the (potential) influence of the Farley POTW, the closest of these is the Erving WWTP, located approximately 3.3 miles upstream. The Erving Paper company has two large (>100,000 million gallons per day, MGD) withdrawals in that area, including a groundwater well and a surface water intake. Several small non-community water supplies are located in the same area.

The river is a run in this area, bounded by rapids up- and downstream (Figure 11). The channel is approximately 110 feet wide and typically too deep to wade across. Deciduous trees provide shade along the stream corridor edges only; the channel is almost entirely open to the sun. The bottom consisted mainly of boulder and cobble, with gravel, sand and traces of silt. Aquatic macrophytes were sparse and mostly found in the shallows near the shoreline. Plants noted here included *Callitriche* sp. (starwort), *Cicuta* sp. (water hemlock), *Elodea* sp. (waterweed), Graminae (grasses), *Lemna* sp. (duckweed), *Lobelia cardinalis* (cardinal flower), *Lysimachia ciliata* (fringed loosestrife), *Polygonum* sp. (smartweed), *Pontedaria cordata* (pickerelweed), *Potamogeton* sp. (pondweed), *Sagittaria* sp. (arrowhead), *Scirpus* sp. (sedges) and *Vallisneria* sp. (American eelgrass). Periphytic growth was typically absent at this station but, when observed, included moss (moderate coverage). Evidence of beaver activity (*Castor canadensis)* was noted in this area. Stoneflies (adults, exuviae and nymphs) were seasonally abundant at this station; adult damselflies, dragonflies and caddisflies (adults and cases) were also noted. Other water-related wildlife recorded at this station included *Ardea herodias (*great blue heron), *Branta canadensis* (Canada goose), *Lithobates pipiens* (Northern leopard frog), minnows and mussels of unknown species, *Nerodia sipedon* (northern water snake*)*, and *Procyon lotor* (raccoon). This stretch of the Millers River is stocked annually with trout (MassDFG 2013; Norris 2010). Fly fishermen were observed in this stretch of the Millers River during numerous sampling events, and the Mass Division of Fisheries and Wildlife stocking truck was seen here on 5/15/2007; much of the trash found at this station was related to fishing (line, artificial bait, bait containers).

The water column was clear on most sampling events (approximately 80%), and slightly turbid on the rest. Water color was typically red/brown and free of odors. Foam, generally very sparse or sparse, was noted in this area on most sampling events; sheens were absent throughout this time period. Trash was frequently observed in a minor quantity, and included cigarette butts, floatables, fishing –related items (line, bait containers, bobbers), broken plastic chairs, and vacuum cleaner parts.

Table 2 Summary of Observations at Station MI14, Millers River, Winchendon 2005-2010

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
1/18/2005	Station not sampled; extreme conditions								
3/8/2005	Sand/mud	Tire	None	Red	None	Sparse	None	Clear	Wet
5/11/2005	Gravel/sand	Tire	None	Deep red	None	Sparse	None	Clear	Dry
6/14/2005	Sand/silt/mud	None	None	Red	Musty	None	None	Clear	Wet
7/13/2005	Sand	None	None	Deep red	None	Foam	Manganous	Clear	Dry
8/9/2005	Sand/silt	Unobservable	Unobservable	Red	None	Sparse	None	Slight	Dry
9/14/2005	Sand/silt/mud	None	None	Red	None	None	None	Moderate	Dry
11/2/2005	Unobservable	Unobservable	Unobservable	Red	None	Very sparse	None	Clear	Wet
2/14/2006	Sand	None	None	Red	"Musky", "pleasant"	Very sparse	None	Clear	Wet
4/5/2006	Sand	None	None	Red	None	None	None	Clear	Wet
6/13/2006	Sand	None	None	Red	None	Very sparse	None	Slight	Dry
8/8/2006	Sand	None	None	Deep red	Effluent	None	None	Slight	Wet
10/10/2006	Sand	None	None	Red	None	None	None	Clear	Dry
1/16/2007	Sand/silt	None	None	Red/light yellow	None	Sparse	None	Clear	Wet
3/20/2007	Sand	None	None	Red	None	None	None	Clear	Dry
5/15/2007	Sand	Tire	None	Red	None	None	None	Clear	Dry
7/17/2007	Sand	None	None	Red	None	None	None	Highly turbid	Dry
9/11/2007	Sand	Tire	None	Red	None	None	None	Slight	Wet
11/6/2007	Unobservable	Unobservable	Unobservable	Red	None	None	None	Unobservable	Wet
2/20/2008	Unobservable	Unobservable	Unobservable	Red	None	None	None	Clear	Wet
4/22/2008	Sand	None	None	Tea	None	Very sparse	Manganous	Clear	Dry
6/17/2008	Unobservable	Unobservable	Unobservable	Red	None	None	None	Moderate	Wet
8/19/2008	Unobservable	Unobservable	Unobservable	Red	None	Sparse	None	Slight	Wet
10/21/2008	Sand	None	None	Red	None	Very sparse	None	Clear	Dry
2/3/2009	Station not sampled on this date; not accessible due to snow/ice								
3/17/2009	Sand	None	None	Red	None	None	None	Slight	Dry
5/19/2009	Sand/silt	None	Filamentous	Red	None	None	None	Slight	Dry
7/21/2009	Unobservable	Unobservable	Unobservable	Deep red	Musty	None	None	Unobservable	Wet
9/22/2009	Sand	Tire, few floatables	Moderate: brown loose floc	Red	None	Very sparse	None	Clear	Dry
11/16/2009	Unobservable	Unobservable	Unobservable	Red	None	Foam	None	Moderate	Wet
2/17/2010	Station not sampled on this date; not accessible due to snow/ice								
8/24/2010	Sand/silt	None	None	Deep red	None	None	None	Clear	Wet
10/19/2010	Unobservable	Unobservable	Unobservable	Red	None	None	None	Unobservable	Wet
-- : Data not available									

Table 3 Summary of Observations at Station PR01, Priest Brook, Royalston 2005-2010

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
1/18/2005	Unobservable	Unobservable	Unobservable	Red	None	Sparse	None	Clear	Wet
3/8/2005	Boulder/sand/mud	None	None	Red	None	None	None	Clear	Wet
5/11/2005	Boulder/cobble/gravel/sand	None	Moderate: green film; dense: moss	Red	None	Sparse	None	Clear	Dry
6/14/2005	Boulder/gravel/sand/silt/mud	None	Moderate: moss	Red	None	Foam	None	Clear	Wet
7/13/2005	Boulder/sand/silt/mud	None	Dense: brown filamentous; very dense: moss	Deep red	Musty	Foam	None	Clear	Dry
8/9/2005	--	--	Very dense: moss	Red	None	Sparse	None	Slight	Dry
9/14/2005	Cobble/gravel/sand	None	Very dense: moss	Red	None	None	None	Clear	Dry
11/2/2005	Boulder/cobble/gravel/sand/silt/mud	None	Moss	Red	None	Foam	None	Clear	Wet
2/14/2006	Boulder/gravel/sand/mud	None	Moss	Slight red	Musty	Very sparse	None	Clear	Wet
4/5/2006	Boulder/sand/mud	None	Dense: moss	Red	None	Moderate	None	Clear	Wet
6/13/2006	Boulder/gravel/sand	None	Very dense: moss	Kool-Aid red	None	Natural foam	None	Clear	Dry
8/8/2006	Boulder/sand/silt/mud	None	Dense: moss	Very dark red	None	None	None	Clear	Wet
10/10/2006	Unobservable; covered in leaves	None	Very dense: moss	Red	None	None	None	Clear	Dry
1/16/2007	Boulder/sand/mud	None	Dense: moss	Red	None	Sparse	None	Clear	Wet
3/20/2007	Boulder/sand/mud	None	Dense: moss	Red	None	Very sparse	None	Clear	Dry
5/15/2007	Unobservable	None	Very dense: moss	Red	None	Sparse	None	Clear	Dry
7/17/2007	Boulder/cobble/sand/silt	None	Very dense: moss	Red	None	None	None	Clear	Dry
9/11/2007	Boulder/sand/silt/mud	None	Very dense: moss	Red	None	None	None	Clear	Wet
11/6/2007	Unobservable	Unobservable	Unobservable	Red	None	Sparse	None	Unobservable	Wet
2/20/2008	Unobservable	Unobservable	Unobservable	Red	None	Sparse	None	Clear	Wet
4/22/2008	Boulder/gravel/sand/silt	None	Moderate: moss	Tea	None	Sparse	None	Clear	Dry
6/17/2008	Boulder/gravel/sand/silt	None	Very dense: moss	Red	None	Sparse	None	Slight	Wet
8/19/2008	Boulder/gravel/sand/mud	None	Dense: moss	Red	None	Sparse	None	Clear	Wet
10/21/2008	Unobservable	None	Very dense: moss	Tea	Mpme	None	None	Clear	Dry
2/3/2009	Unobservable	Unobservable	None	Red	None	None	None	Clear	Dry
3/17/2009	Boulder/gravel/sand	None	Very dense: moss	Red	None	Moderate	None	Clear	Dry
5/19/2009	Boulder/cobble/gravel/sand	None	Dense: moss	Red	None	Sparse	None	Clear	Dry
7/21/2009	Unobservable	Unobservable	Unobservable	Deep red	Musty	Sparse	None	Unobservable	Wet
9/22/2009	Unobservable	Unobservable	Unobservable	Deep red	None	Sparse	None	Clear	Dry
11/16/2009	Boulder/cobble/gravel/sand/mud	Minor; plastic bag	Sparse, moss	Red	None	Moderate	None	Clear	Wet
2/17/2010	Unobservable	Unobservable	Unobservable	Red	None	None	None	Unobservable	Wet
8/24/2010	Boulder/cobble/sand/silt/mud	None	Very dense: moss	Deep red	None	None	None	Clear	Wet
10/19/2010	Unobservable; covered in leaves, moss	None	Very dense: moss	Red	None	Moderate	None	Clear	Wet

-- : Data not available

Table 4 Summary of Observations at Station OT05, Otter River, Gardner/Templeton 2005-2010

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
1/18/2005	Unobservable; bottom covered in ice	None	Unobservable	Red	None	Foam	None	Clear	Wet
3/8/2005	Cobble/gravel/sand	None	None	Red	Effluent	Foam	None	Clear	Wet
5/11/2005	Boulder/cobble/gravel/sand	Minor: beer can	Moderate green filamentous; moderate moss	Red	None	Sparse	None	Clear	Dry
6/14/2005	Cobble/gravel/sand	None	Sparse: moss	Red	None	Foam	None	Clear	Wet
7/13/2005	Cobble/gravel/sand	None	Very dense: moss	Deep red	Musty	Foam	None	Clear	Dry
8/9/2005	--	--	Sparse: moss	Red	Musty	Foam	None	Moderate	Dry
9/14/2005	Boulder/cobble/gravel/sand/silt; highly embedded	Minor: bricks, broken glass	Very dense dark green filamentous; moderate moss	Red	Cow manure	Foam	None	Slight	Dry
11/2/2005	Cobble/gravel/sand	Bricks	None	Red	None	Foam	None	Clear	Wet
2/14/2006	Boulder/cobble/gravel/sand	None	None	Sligth red/light yellow	Strong effluent	Sparse	None	Clear	Wet
4/5/2006	Boulder/cobble/gravel/sand	None	Moderate: green filamentous	Faint red/light yellow	None	Sparse	None	Clear	Wet
6/13/2006	Cobble/gravel/sand	None	None	Red	None	Moderate	None	Moderate	Dry
8/8/2006	Unobservable	None	Unobservable	Brown/red	None	Moderate	None	Highly turbid/murky	Wet
10/10/2006	Boulder/cobble/gravel/sand	None	Dense brown filamentous; very dense moss	Red	Strong effluent, raw sewage	Moderate to dense	None	Slight	Dry
1/16/2007	Boulder/cobble/gravel/sand	None	Unobservable	Red	None	Moderate	None	Clear	Wet
3/20/2007	Cobble/gravel/sand	None	Sparse: moss	Red	None	Sparse	None	Slight	Dry
5/15/2007	Unobservable	None	Unobservable	Red	None	Sparse	None	Clear	Dry
7/17/2007	Cobble/gravel/sand	None	Very dense: moss	Red	None	Moderate	None	Slight	Dry
9/11/2007	Boulder/cobble/gravel/sand/silt	Minor	Moderate green filamentous; moderate moss	Red	Effluent	Moderate	None	Slight	Wet
11/6/2007	Cobble/gravel/sand	Bricks	Sparse: moss	Red	None	Sparse	None	Clear	Wet
2/20/2008	Cobble/gravel/sand	None	None	Red	None	Foam	None	Clear	Wet
4/22/2008	Cobble/gravel/sand	Few bricks	Dense green filamentous; dense moss	Red	None	Sparse	None	Slight	Dry
6/17/2008	Unobservable	Unobservable	Unobservable	Red	Effluent	Moderate	None	Moderate	Wet
8/19/2008	Unobservable	Unobservable	Unobservable; very dense filamentous where visible	Red	None	Sparse	None	Unobservable	Wet
10/21/2008	Cobble/gravel/sand/silt	Bricks	Dense: moss	Red	None	Foam	None	Unobservable	Dry
2/3/2009	Cobble/gravel/sand	None	Very dense: grey/brown film	Red	None	None	None	Clear	Dry
3/17/2009	Cobble/gravel/sand	Minor: bricks	Sparse: filamentous	Light yellow	None	Sparse	None	Slight	Dry
5/19/2009	Boulder/cobble/gravel/sand	None	Filamentous; sparse moss	Red	Effluent	Sparse	None	Slight	Dry
7/21/2009	Unobservable	None	Moderate: green filamentous	Deep red	Effluent	Sparse	None	Slight	Wet
9/22/2009	Cobble/gravel/sand	Minor: bricks	Very dense green filamentous; very dense moss	Red	Effluent, "funky"	Sparse	None	Moderate	Dry
11/16/2009	Unobservable	Minor: bricks	Moderate: green film	Red	Effluent	Foam	None	Slight	Wet
2/17/2010	Cobble/gravel/sand	None	Moderate: dark green filamentous	Red	None	None	None	Clear	Wet
8/24/2010	Cobble/gravel/sand/silt	Minor: few bricks	Moderate: moss	Slight red	Eutrophic pond	Moderate	None	Moderate	Wet
10/19/2010	Unobservable	Minor: few bricks	Dense: green film	Slight red	Strong effluent	Sparse	None	Highly turbid/murky	Wet

-- : Data not available

Table 5 Summary of Observations at Station MI10A, Millers River, Royalston 2005-2010

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
1/18/2005	Unobservable	Unobservable	Unobservable	Red	None	None	None	Clear	Wet
3/8/2005	Boulder/cobble/gravel/sand	Trash	None	Light yellow	None	Sparse	None	Clear	Wet
5/11/2005	Boulder/cobble/gravel/sand	None	Moderate: green filamentous	Red	None	Moderate	None	Clear	Dry
6/14/2005	Unobservable	Unobservable	Unobservable	Red	None	Moderate to dense	None	Clear	Wet
7/13/2005	Unobservable	None	Moderate: brown filamentous	Deep red	None	Foam	None	Slight	Dry
8/9/2005	--	--	--	Brown	None	Sparse	None	Slight	Dry
9/14/2005	Boulder/cobble/gravel/sand/silt	Minor: bottles, tire rim	Sparse: green filamentous; very dense: film; sparse: moss	Red	None	Foam	None	Slight	Dry
11/2/2005	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Clear	Wet
2/14/2006	Unobservable	Unobservable	Unobservable	Clear	None	Moderate	None	Clear	Wet
4/5/2006	Boulder/cobble/gravel/sand	None	Moderate: moss	Slight red/light yellow	None	Moderate	None	Clear	Wet
6/13/2006	Unobservable	None	None	Red	None	Moderate	None	Moderate	Dry
8/8/2006	Boulder/gravel/sand/silt/mud	None	Filamentous	Red	None	Very dense	None	Clear	Wet
10/10/2006	Boulder/cobble/gravel/sandsilt	None	Very dense: filamentous	Red	None	Dense	None	Clear	Dry
1/16/2007	Unobservable	Unobservable	Unobservable	Red/light yellow	None	Moderate	None	Clear	Wet
3/20/2007	Boulder/cobble/gravel/sand	None	None	Red	None	Moderate	None	Clear	Dry
5/15/2007	Boulder/cobble/gravel/sand/silt	None	Very dense: filamentous	Red	None	Moderate	None	Clear	Dry
7/17/2007	Boulder/cobble/gravel/sand/silt	None	Very dense: brown filamentous	Red	Fishy	Moderate	None	Clear	Dry
9/11/2007	Boulder/cobble/gravel/sand/silt	None	Dense: brown filamentous	Red	None	Moderate	None	Clear	Wet
11/6/2007	Unobservable	Unobservable	Unobservable	Unobservable	None	Moderate	None	Unobservable	Wet
2/20/2008	Unobservable	Unobservable	Unobservable	Red	None	Foam	None	Unobservable	Wet
4/22/2008	Boulder/cobble/gravel/sand/silt	None	Green filamentous	Red	None	Moderate to dense	None	Clear	Dry
6/17/2008	Boulder/cobble/gravel/sand/silt	Very minor: cigarette butt	Green filamentous	Red	None	Moderate to dense	None	Slight	Wet
8/19/2008	Unobservable	Unobservable	Unobservable	Red	None	Dense	None	Unobservable	Wet
10/21/2008	Unobservable	None	Brown filamentous	Red	None	Moderate	None	Slight	Dry
2/3/2009	Station not sampled; no access								
3/17/2009	Unobservable	None	None	Red/light yellow	None	Moderate	None	Slight	Dry
5/19/2009	Unobservable	Minor: fishing line, floatables	None	Red	None	Moderate to dense	None	Slight	Dry
7/21/2009	Unobservable	Unobservable	Unobservable	Deep red	Musty	Moderate	None	Unobservable	Wet
9/22/2009	Boulder/cobble/gravel/sand/silt	Unobservable	Very dense: green filamentous; very dense: moss	Red	Eutrophic pond	None	None	Moderate	Dry
11/16/2009	Unobservable	Unobservable	Sparse: brown film	Red	None	Foam	None	Slight	Wet
2/17/2010	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Unobservable	Wet
8/24/2010	Boulder/cobble/gravel/sand/silt	None	Sparse: bright geen filamentous	Slight red	None	Foam	None	Slight	Wet
10/19/2010	Unobservable	None	Moderate: moss	Red	None	Dense	None	Slight	Wet
-- : Data not available									

Table 6 Summary of Observations at Station MI03, Millers River, Erving/Wendell 2005-2010

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
1/18/2005	Unobservable	Unobservable	Unobservable	Red	None	None	None	Clear	Wet
3/8/2005	Boulder/cobble/gravel/sand	None	None	Light yellow	None	None	None	Clear	Wet
5/11/2005	Boulder/cobble/gravel/sand	Cigarette butts, floatables	None	Slight red	None	Sparse	None	Clear	Dry
6/14/2005	Unobservable	None	Sparse: brown film	Light yellow	Effluent	Sparse	None	Slight	Wet
7/13/2005	Unobservable	None	Moderate: brown film	Dark tan	Effluent	None	None	Slight	Dry
8/9/2005	Rock/sand	None	Moderate: brown film; sparse: loose floc; sparse: moss	Dark tan	Effluent	Foam	None	Slight	Dry
9/14/2005	Unobservable	None	Sparse: green filamentous; moderate: brown film; moderate: brown loose floc	Brown	Effluent	Foam	None	Slight	Dry
11/2/2005	Unobservable	Floatables	Unobservable	Red	None	Sparse	None	Clear	Wet
2/14/2006	Unobservable	Unobservable	Unobservable	Light yellow	None	None	None	Clear	Wet
4/5/2006	Sand	None	None	Slight red	None	Moderate	None	Clear	Wet
6/13/2006	Boulder/sand	Minor: broken chairs, bait can/lid, cigarette butts	None	Red	None	Foam	None	Clear	Dry
8/8/2006	Sand/silt/mud	Minor: (1) beer can	None	Red	Slight musty	Foam	None	Clear	Wet
10/10/2006	Boulder/cobble/gravel/sand/silt	Clothes, beer cans/bottles, vacuum cleaner parts, fishing line	None	Red	Musty	Moderate to dense	None	Clear	Dry
1/16/2007	Boulder/cobble/gravel/sand	Vacuum cleaner parts, beer cans	None	Red	None	Moderate	None	Clear	Wet
3/20/2007	Boulder/cobble/gravel/sand/silt	Vacuum cleaner parts,miscellaneous small objects	None	Red	None	None	None	Clear	Dry
5/15/2007	Boulder/cobble/gravel/sand	Broken glass, vacuum cleaner parts, miscellaneous floatables	None	Red	None	Very sparse	None	Clear	Dry
7/17/2007	Boulder/cobble/gravel/sand/silt	Broken plastic chair, fishing line	None	Red	Eutrophic pond, strong	Moderate	None	Clear	Dry
9/11/2007	Boulder/cobble/gravel/sand/silt	Minor	Moderate: film	Very slight red	None	Sparse	None	Clear	Wet
11/6/2007	Boulder/cobble/gravel/sand	Floatables	None	Red	None	Sparse	None	Clear	Wet
2/20/2008	Unobservable	Unobservable	Unobservable	Red	None	Foam	None	Unobservable	Wet
4/22/2008	Boulder/cobble/gravel/sand/silt	Bait containers, fishing line, vacuum cleaner parts, floatables, cigarette butts	Dense: moss	Red	None	Sparse	None	Clear	Dry
6/17/2008	Cobble/sand/silt	Minor	None	Red	None	Sparse	None	Clear	Wet
8/19/2008	Boulder/cobble/gravel/sand	None	None	Red	None	Sparse	None	Slight	Wet
10/21/2008	Boulder/cobble/gravel/sand/silt	None	None	Red	None	Moderate	None	Clear	Dry
2/3/2009	Boulder/cobble/gravel/sand	None	None	Red	None	None	None	Clear	Dry
3/17/2009	Boulder/cobble/gravel/sand	None	None	Slight red	None	None	None	Clear	Dry
5/19/2009	Boulder/cobble/gravel/sand	Minor: floatables, broken bottle, bait container, cigarette butts	None	Red	None	Sparse	None	Clear	Dry
7/21/2009	Boulder/cobble/gravel/sand	None	None	Deep red	Musty	Sparse	None	Clear	Wet
9/22/2009	Boulder/cobble/gravel/sand	Minor	None	Slight red	None	Very sparse	None	Clear	Dry
11/16/2009	Boulder/cobble/gravel/sand	Minor: broken glass, bait containers	None	Red	None	Foam	None	Clear	Wet
2/17/2010	Unobservable	None	None	Red	None	None	None	Clear	Wet
8/24/2010	Boulder/cobble/gravel/sand/silt	None	Moderate: moss	Clear	None	Sparse	None	Slight	Wet
10/19/2010	Unobservable	None	None	Slight red	None	Very sparse	None	Clear	Wet

-- : Data not available

SURVEY CONDITIONS

Stream discharge and precipitation data are used to determine hydrologic conditions and, consequently, if water quality surveys should be described as dry- or wet weather-influenced events. Precipitation data for each monitoring event were obtained from the National Oceanic and Atmospheric Administration (NOAA). The presence/absence of precipitation during the five days prior to each sampling event was based on the National Weather Service (NWS) data located on their website NOAA Climatological Data Publications (NOAA 2015). The weather station in Ashburnham, MA was the most proximal to all of the Millers sampling stations with a continuous record from 2005 through 2010; precipitation data collected here were utilized in this report. On average, precipitation varies little across the watershed, approximately 46 to 48 inches/year, with localized areas in Ashburnham and Wendell receiving more (48 to 50 inches), and in Orange/Athol receiving less (Ostiguy et al 2010).

During dry weather, trace amounts of precipitation may fall, but there is no measurable change in stream flow. The USGS operates five real time stream gaging stations in the Millers River Watershed that are applicable to this water quality data set, as shown below:

- Millers River near Winchendon, MA (USGS 2013a),
- Priest Brook near Winchendon, MA (USGS 2013b),
- Otter River at Otter River, MA (USGS 2013c),
- Millers River at South Royalston, MA (USGS 2013d) and
- Millers River at Erving, MA (USGS 2013e).

Data from these stations can be found at Current Conditions For Massachusetts: Streamflow

The period of record (POR) mean streamflow values are the mean of daily mean values for each day for 97-98 years of record (10/1/1915-9/30/2013) at the USGS Millers River gage at Erving, MA (USGS station number 01166500), recorded in cubic feet per second (cfs). The daily data are reported at USGS Surface-Water Daily Statistics For Massachusetts (USGS 2013f). The monthly mean discharge values are found at USGS Surface-Water Monthly Statistics For Massachusetts (USGS 2013g).

Wet weather is defined as precipitation within a five-day antecedent period that leads to more than a slight increase in stream discharge at the five stations listed above (i.e., flow). Under dry weather conditions, trace amounts of precipitation may fall, but no measurable change in stream flow occurs. The discharge values were also examined relative to the 7Q10 low flow (streamflow that spans 7 consecutive days and occurs, on average, once every 10 years) which is 46.8 cfs at the USGS gaging station on the Millers River at Erving, MA (Wandle and Fontaine 1984). At some of the Millers flow gaging stations, precipitation-related stream fluctuations were sometimes difficult to distinguish from manipulated fluctuations.

Table 7 (precipitation) and Table 8 (stream discharge) contain information on survey conditions during each sampling event. Both the precipitation and the stream discharge data were used to estimate hydrological conditions during water quality sampling. Air temperature at each station is expressed in degrees Fahrenheit (°F).

January 18, 2005 – This winter monitoring event was preceded by a 5-day period in which over 1 inch (in.) of precipitation was recorded at the National Weather Station gage in Ashburnham. Discharge at local gages rose through January 15, then decreased, but not to pre-storm levels. Samples collected during this event reflect wet weather/runoff conditions. Air temperature during the sampling event ranged from 2 to 19 ºF under sunny skies. Snow covered the ground throughout the watershed; snow and ice shelves extended over the channel at all stations. The Millers River at Winchendon was not sampled due to plunging air temperatures.

March 8, 2005 – Approximately 0.14 in. of precipitation was recorded at Ashburnham on March 3, 2005; only trace amounts were recorded from March 4-8. Rain fell throughout the morning, during monitoring at the first three stations (MI03, OT05 and MI10A), then changed to snow by noon (PR01 and MI14). An increase in discharge was noted at area flow gages from mid-day, March 7th through the monitoring event. The National Climatic Data Center report for March 2005 reports that maximum daily temperatures at Birch Hill Dam, Royalston from March 3-8 ranged from 23 to 50°F, and snow on the ground decreased from 11 inches to 6 inches, both of which indicate snowmelt conditions. Therefore, data reflect wet weather/runoff conditions. Air temperature during monitoring activities ranged from 32 to 37ºF.

May 11, 2005 – In the five-day period preceding this monitoring event, a storm brought 0.75 in. rainfall to the area (5/7-5/8). Discharge at the Millers watershed gages increased from May 7-9, then flows decreased to pre-storm levels by the

time of the sampling event. Data reflect dry weather conditions. Air temperature ranged from 60 to 80ºF with sunny skies throughout the event. Watershed trees were budding, with some foliage out.

June 14, 2005 – On June 9, 1.80 in. of rainfall were recorded at Ashburnham, as well as 0.03 in. on June 13-14. Discharge at area gages rose through June 10, then decreased slowly, but had not returned to pre-storm levels by the commencement of monitoring activities. Data collected on this date reflect wet weather/runoff conditions. Air temperature ranged from 79 to 82ºF. Mostly sunny skies at Station MI03 (first station) became overcast by the second station (OT05) and remained cloudy. Mosquito swarms were observed at all stations. Foliage was completely out throughout the watershed.

July 13, 2005 – Within the 5 days prior to this monitoring event, 1.87 in. of precipitation fell (7/9-7/10). Discharge rose from July 8 through 10, then decreased steadily to pre-storm levels by July 13. Data collected during this event reflect dry weather conditions. Air temperature ranged from 69 to 72ºF, and cloud cover ranged from mostly cloudy to overcast.

August 9, 2005 – This summer sampling event took place during a dry period, and discharge at watershed gages steadily decreased in the five days preceding. Data collected reflect dry weather conditions. Air temperature ranged in the 60's and 70's (ºF) under overcast skies.

September 14, 2005 – No precipitation was recorded in the area in the five days preceding this late summer monitoring event; discharge decreased steadily throughout this period. Data represent dry weather conditions. Air temperature ranged from 71 to 84ºF and cloud cover from mostly sunny to clear, with elevated humidity.

November 2, 2005 – Autumn monitoring in the Millers watershed also fell within a dry period (0.09 in. rainfall recorded at Ashburnham on 11/2 began after monitoring activities were concluded). However, heavy rains brought several inches of precipitation to the area from October 25-26, causing flooding throughout Central Massachusetts. High water levels and receding floodwaters were noted at stations throughout the watershed. Due to field observations of high water levels and receding discharge at area gages, data reflect wet weather/runoff conditions. Air temperature ranged from 51 to 53 °F under skies varying from mostly sunny to mostly cloudy. Deciduous foliage was mostly down throughout the watershed.

February 14, 2006 – In the five days before this winter event, at least 0.67 in. of precipitation (13 in. as snowfall) were recorded at Ashburnham (2/12- 2/14). Snow on the ground rose from trace amounts to 9 in. on 2/13, decreasing to 7 in. on 2/14. At Birch Hill Dam, Royalston, snow on the ground was absent on 2/12, 4 in. on 2/13, and 3 in. on 2/14. Maximum daily temperatures ranged from 14 to 33°F at Ashburnham, but field measurements showed higher values. Mean daily discharge at the Millers River gage in Erving decreased steadily in the 5 days preceding sampling and rose slightly on 2/14; a similar pattern was observed at the Millers River gage at South Royalston. Data reflect wet weather/runoff conditions. Air temperature ranged from 31 to 40ºF; mostly cloudy skies at the beginning of monitoring activities cleared by late morning.

April 5, 2006 – A storm brought 1.12 in. of precipitation to the Millers watershed on April 4-5; although snow fell steadily throughout monitoring activities, only trace amounts accumulated due to the relatively high air temperature (max T at Ashburnham 4/5/06 was 42°F). Discharge at the Erving gage rose significantly with this storm. Data collected during this event reflect wet weather/runoff conditions. Air temperature ranged from 35 to 40ºF. Trees were not yet budding, despite a warm period earlier in the week (max daily temperatures ranged from 42 to 68°F at Birch Hill Dam).

June 13, 2006 – Little precipitation fell in the Millers watershed in the 5-day period before this late spring event (0.18 in. 6/8-6/10). Discharge at area gages generally rose through June 11, then decreased steadily through June 13. Data reflect dry weather conditions. Air temperature ranged from 68 to 76ºF and cloud cover varied from 0 to 20%.

August 8, 2006 – This summer sampling event occurred within a wet period, with 0.77 in. rain recorded on 8/4-8/5 and an additional 0.36 in. on the sampling date (some fell before monitoring activities commenced). Discharge at area gages generally followed the precipitation pattern, with some anomalies that were likely associated with man-made fluctuations. Data reflect wet weather/runoff conditions. Air temperature ranged from 72 to 75ºF; cloud cover varied from 0 to 65%.

October 10, 2006 – Autumn sampling in 2006 followed a dry period. Area gages generally decreased throughout the preceding 5 days, with some stations indicating non-natural fluctuations. Data reflect dry weather conditions. Air temperature ranged from 56 to 71ºF under skies ranging from mostly cloudy to overcast. Most of the foliage in the watershed had changed color, and some leaves were down.

January 16, 2007 – A storm front brought approximately 1 in. of precipitation to the area from January 14-16 (as measured at Ashburnham). Discharge at area gages rose from January 15 through sampling activities. Snow on the ground was absent at Birch Hill Dam throughout the five-day period preceding this event and no snowfall was recorded. Data reflect wet weather/runoff conditions. Air temperature ranged from 24 to 30ºF, and intermittent snow flurries fell throughout monitoring activities.

March 20, 2007 – This late winter event followed a storm that brought nearly 2 in. precipitation to the area on March 15-18 (11.5 in. as snow). Snowfall on the ground decreased from 11 to 10 in. from March 17 to 18, remaining at 10 in. through March 20th. Maximum daily temperature at Birch Hill Dam rose from 27°F on March 17 to 39°F on the sampling date (data were not available at Ashburnham). Discharge generally decreased at area gages from mid-day March 19th through the time of monitoring activities, to levels at or below pre-storm discharge. Mean daily discharge at the Erving gage steadily decreased from March 16-20. Specific conductivity was relatively low throughout the watershed, ranging from 55 to 156 µS/cm at most stations; only at the Otter River was specific conductivity elevated (298 µS/cm). Field observations note normal water levels i.e., typical for that station and time of year; only the water level at Priest Brook was approximately 0.5 in. above normal. Based on snow on the ground, discharge, specific conductivity and water level, data and observations collected on this date reflect dry weather conditions. Air temperature ranged from 35 to 45ºF; clear skies became mostly cloudy by late morning. Approximately 8 inches of snow remained on the ground at all stations. Trees were not in bud.

May 15, 2007 – During the five-day period preceding this spring event, 0.52 in. of precipitation fell at Ashburnham (on May 12). Discharge at area gages displayed fluctuations apparently associated with flow manipulation; a general pattern showed discharge decreasing from May 12/13 through monitoring activities to flows at/below pre-storm levels. Based on generally decreasing discharge, water quality data reflect dry weather conditions. Air temperature ranged from 56 to 64ºF under overcast skies with infrequent sprinkles. Foliage was mostly out throughout the watershed.

July 17, 2007 – Precipitation at Ashburnham totaled 0.83 in. from July 12-17; field observations noted “on/off thunderstorms over the last week”. Discharge at area gages generally decreased in this period. Data and observations reflect dry weather conditions. Air temperature ranged from 70 to 81ºF while cloud cover varied from <5 to 60%.

September 11, 2007 – This late summer event occurred within a storm front that brought 1.66 in. rain between Sept. 9-11; discharge at area gages generally reflects this pattern. Despite this precipitation, water levels in the watershed were lower than normal at all stations, with the exception of the Millers River in Winchendon (which may have been inundated by waters held back at Birch Hill Dam). Data reflect wet weather/runoff conditions. Air temperature ranged from 60 to 62ºF under foggy, drizzly and rainy skies.

November 6, 2007 – Autumn sampling occurred during a storm that brought 0.35 in. precipitation to the area; in the preceding five-day period, 0.40 in. was recorded at Ashburnham on Nov. 4. Discharge at area gages varied, but a pattern of increasing flows was observed at most gages. Data and observations reflect wet weather/runoff conditions. Air temperature ranged from 43 to 50ºF under rainy skies. Most of the foliage on area trees and shrubs was down.

February 20, 2008 – Winter monitoring fell within a storm event that brought nearly an inch of precipitation to the watershed from Feb. 18-20; discharge generally rose at area gages during this time. Maximum daily temperature was generally above freezing in the five days preceding this event, and 52°F on Feb. 18-19 at Ashburnham. Snow measured on the ground at Ashburnham decreased from 15 to 9 in. on Feb. 17-19, but remained at 9 inches through the sampling date; a similar pattern was observed at Birch Hill Dam. Field notes cite pouring rain on Feb. 18 and overnight snow flurries before this event. High water levels were observed throughout the watershed. Data and observations reflect wet weather/runoff conditions. Air temperature ranged from 23 to 32ºF and cloud cover varied (35% to overcast).

April 22, 2008 – Spring monitoring took place within a dry period, with no precipitation recorded at the Ashburnham gage in the 5 preceding days, and discharge steadily decreased at area gages. Water quality data reflect dry conditions for this event. Air temperature ranged from 62 to 77ºF under mostly cloudy skies. Trees and shrubs were beginning to bud; wood frogs were noted near the Millers River in Winchendon.

June 17, 2008 – Nearly an inch of rain fell in the Millers watershed from June 15-17. Field notes reflect “rain overnight; thunderstorms, heavy at times”. Discharge data collected at area gages indicate increasing flows during the 24 hours preceding monitoring activities. Data and observations reflect wet weather/runoff conditions. Air temperature ranged from 66 to 72ºF; cloud cover varied from 35 to 75%. Foliage was fully developed throughout the watershed.

August 19, 2008 – More than a half inch of rainfall was recorded at Ashburnham in the five-day period before and during this summer monitoring event. Field notes recorded "storms last night into the present". However, only discharge at the Otter River gage reflected this precipitation pattern; the other watershed gages show that discharge decreased steadily from 8/12-8/19. Water levels were normal at all stations, again with the exception of the Otter River, where it was estimated to be approximately 0.5 ft above normal. E. coli values were above the median values for samples collected between 2007 and 2010 at all stations, as were the turbidity results. Based on precipitation, field conditions, E. coli and turbidity values, data collected during this event reflect wet weather/runoff conditions. Air temperature ranged from 69 to 72ºF; overcast skies brought drizzle and rain, sometimes heavy, during monitoring activities.

October 21, 2008 – This autumn event occurred during a dry period, with little recorded precipitation occurring on or within the 5 preceding days (0.09 in). Streamflow varied little in this time frame. Data reflect dry conditions. Air temperature ranged from 44 to 58ºF and cloud cover ranged from mostly cloudy to overcast.

February 3, 2009 – A storm on January 29, 2009 brought 1.13 in. of precipitation to the area (5.1 in. as snow). Twenty inches of snow was recorded on the ground at Ashburnham on January 29; this decreased to 18 in. on January 30, then to 17 in. on Feb. 2-3. The maximum daily temperature was above freezing on 2/2 and 2/3 (38 to 44°F). Discharge patterns varied at area gages but, in general, flow increased on January 29-30, then decreased through Feb. 3 to levels at or below pre-storm conditions. Due to no change in snow on the ground in the 24 hours before monitoring activities and an overall decrease in discharge, data collected on this date reflect dry weather conditions. Air temperature ranged from 30 to 34ºF; snow flurries occurred during monitoring activities. Snow and ice shelves extending over the channel prevented access at Stations MI10A and MI14 (Millers River at South Royalston and Winchendon).

March 17, 2009 – This late winter event fell within a dry period, with no precipitation reported at Ashburnham from March 12-17. No snow fell during this period. Snow on the ground decreased from 6 to 3 in. on from March 12-16 (3 in. remained on March 17), and maximum daily temperature ranged from 34 to 54°F. Discharge generally decreased from March 12 through the monitoring event at area gages; diurnal changes in discharge apparently reflected snowmelt conditions at the Priest Brook gage from March 12-15. Data collected on this date reflect dry weather conditions. Air temperature ranged from 36 to 53ºF under mostly sunny to clear skies. Trees and shrubs were not yet in bud.

May 19, 2009 – Over one half in. of precipitation was recorded in Ashburnham in the five-day period preceding this spring monitoring event. Stream discharge reflected precipitation patterns, in general, at watershed gages, returning to pre-storm flows by May 19. Data collected on this date reflect dry conditions. Air temperature ranged from 53 to 68ºF; with sunny skies throughout the monitoring effort. Foliage had mostly developed on deciduous trees and shrubs.

July 21, 2009 – A storm brought 0.66 in. rain to the Millers watershed on July 17, with an additional 0.10 in. on the day of this summer monitoring event. Streamflow generally rose at area gages on July 18, then decreased through July 21 but not to pre-storm levels. Data collected on this event reflect wet weather/runoff conditions. Air temperature ranged from 67 to 69ºF, with drizzle/rain reported at all stations.

September 22, 2009 – This early autumn event occurred during a dry period, with only trace precipitation recorded within the 5 preceding days. Streamflow at area gages generally decreased during this time frame. Data reflect dry weather conditions. Air temperature ranged from 64 to 70ºF under overcast skies. Foliage was just beginning to change on trees and shrubs throughout the watershed.

November 16, 2009 – A storm brought over 1.5 in. rainfall to the Millers Watershed on Nov. 14-15. Streamflow rose concurrently and data collected on this date reflect wet weather/runoff conditions. Air temperature ranged from 46 to 63ºF under mostly sunny to clear skies. All deciduous leaves were down on area trees and shrubs.

February 17, 2010 – This winter event followed a storm that brought over half an inch of precipitation (6.8 in. snow) to the area on Feb. 16-17. Maximum daily temperature at Ashburnham was at or below freezing from Feb. 12-17, ranging from 28 to 35°F. Ice and snow shelves extended out from the banks at all stations, and prevented access altogether at Station MI14 (Millers River at Winchendon). Streamflow gages were affected by ice at area gages. Data collected on this date reflect wet weather/runoff conditions. Air temperature ranged from 32 to 36ºF with humid conditions; cloud cover was generally overcast with some snow flurries.

August 24, 2010 – Summer 2010 sampling in the Millers watershed fell on the heels of a storm that brought the area 1.22 in. of precipitation (at Ashburnham) on August 23-24; discharge rose concurrently at watershed gages. Field notes state

“raining, often hard, since Sunday [August 22]”. Data collected on this date reflect wet weather/runoff conditions. Air temperature ranged from 65 to 74ºF under overcast skies.

October 19, 2010 – Autumn 2010 monitoring followed a large storm that brought over 2 inches of precipitation to the area on Oct 15-16. Discharge at local gages mirrored rainfall, and data collected on this event reflect wet weather/runoff conditions. Air temperature ranged from 37 to 55ºF; clear skies became overcast by the end of the monitoring effort. Deciduous foliage had mostly changed and fallen throughout the watershed.

Table 7 Millers Basin Precipitation Data Summary 2005-2010							
Survey Dates	**5 Days Prior***	**4 Days Prior**	**3 Days Prior**	**2 Days Prior**	**1 Day Prior**	**Sample Date**	**Wet/Dry Conditions****
1/18/2005	0.32	0.03	0.58	0	0.15	0	Wet
3/8/2005	0.14	T	0	T	0	T	Wet
5/11/2005	0	0.10	0.64	T	0	0	Dry
6/14/2005	1.80	0	0	0	0.02	0.01	Wet
7/13/2005	0	1.86	0.01	0	0	0	Dry
8/9/2005	0	0	0.01	0	0	0	Dry
9/14/2005	0	0	0	0	0	0	Dry
11/2/2005	0	0	0	0	0	0.09	Wet
2/14/2006	0	T	T	0.13	0.53	0.01	Wet
4/5/2006	0	0	0.13	0	0.80	0.32	Wet
6/13/2006	0.14	0.01	0.03	0	0	0	Dry
8/8/2006	T	0.02	0.75	0	T	0.36	Wet
10/10/2006	0.02	0	0	0	0	0	Dry
1/16/2007	0	0	0	0.02	0.25	0.70	Wet
3/20/2007	0.05	0.18	1.70	0.02	T	0.09	Dry
5/15/2007	0	0	0.52	0	0	0	Dry
7/17/2007	0.30	0	0.43	0	0.10	0	Dry
9/11/2007	0	0	0	1.07	0.39	0.20	Wet
11/6/2007	0	T	0	0.40	0	0.35	Wet
2/20/2008	0	0	0	0.68	0.23	0.03	Wet
4/22/2008	0	0	0	0	0	0	Dry
6/17/2008	0	0	0	0.13	0.05	0.75	Wet
8/19/2008	0	0.01	0.29	0.13	0	0.17	Wet
10/21/2008	0	0.09	0	0	0	0	Dry
2/3/2009	1.13	0	0.02	0	0	0.03	Dry
3/17/2009	0	0	0	0	0	0	Dry
5/19/2009	0	0.20	0	0.45	0	0	Dry
7/21/2009	0	0	0.66	0	0	0.10	Wet
9/22/2009	0	0	T	0	0	0	Dry
11/16/2009	0	0	0	0.14	1.38	0	Wet
2/17/2010	0	0	0	T	0.05	0.47	Wet
8/24/2010	0	0	0	0	1.05	0.17	Wet
10/19/2010	0	1.15	1.13	0	0	0	Wet

*Unofficial data from the NWS station at Ashburnham, MA available at NOAA Climatological Data Publications (NOAA 2015); data in inches of precipitation
** Based on precipitation, streamflow and other relevant data.
T= trace amount; an amount too small to measure

Table 8 Millers River at Erving, MA
USGS Flow Data Summary Discharge (cfs) 2005-2010

Survey Dates	5 Days Prior*	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Sample Date	Monthly Mean**	POR*** Mean
1/18/2005	754	1,750	2,200[e]	1,990[e]	1,650[e]	1,280[e]	920.8	591
3/8/2005	531[e]	509[e]	488[e]	468[e]	460	529	819.8	867
5/11/2005	1,060	968	1,010	1,020	977	874	909.7	818
6/14/2005	652	763	727	628	626	571	510.0	566
7/13/2005	804	1,220	1,340	1,160	919	721	694.6	278
8/9/2005	233	205	198	191	167	162	180.9	246
9/14/2005	116	125	117	105	104	100	115.3	225
11/2/2005	3,700	3,630	3,270	2,270	2,150	1,740	1,560	444
2/14/2006	2,280[e]	1,660[e]	1,300[e]	1,120[e]	1,020[e]	1,080[e]	1,411	572
4/5/2006	288	313	335	354	548	805	463.9	1,850
6/13/2006	1,280	1,500	1,540	1,580	1,510	1,320	983.1	558
8/8/2006	178	221	259	240	229	243	221.7	239
10/10/2006	337	323	259	232	216	199	630.4	321
1/16/2007	1,480	1,250	1,030	943	1,040	1,270	897.0	596
3/20/2007	1,190	1,360	1,160	1,150	1,070	985	971.7	1,440
5/15/2007	449	527	577	592	548	461	770.1	817
7/17/2007	333	277	256	247	239	173	206.6	260
9/11/2007	43	43	42	47	77	164	92.5	228
11/6/2007	259	245	259	299	326	420	396.9	523
2/20/2008	2,550	2,620	2,690	3,530	4,300	3,870	2,264	584
4/22/2008	1,590	1,360	1,200	1,020	908	796	1,836	1,390
6/17/2008	248	209	179	202	211	456	407.2	534
8/19/2008	970	821	694	576	471	400	542.3	230
10/21/2008	222	228	228	229	216	205	412.3	447
2/3/2009	578[e]	600[e]	600[e]	578[e]	527[e]	471[e]	500.0	607
3/17/2009	1,930	1,830	1,650	1,510	1,410	1,330	1,136	1,230
5/19/2009	872	773	714	757	755	713	699.7	833
7/21/2009	409	366	441	579	616	544	1,132	260
9/22/2009	202	188	183	167	153	149	263.1	488
11/16/2009	477	450	421	503	772	824	759.0	545
2/17/2010	435[e]	466	410[e]	395[e]	422	411	706.6	584
8/24/2010	42	41	38	40	60	54	53.7	211
10/19/2010	134	404	675	825	741	617	368.5	395

*Gage # 01112500 data found at USGS 01166500 MILLERS RIVER AT ERVING, MA Daily Data; all data approved for publication, processing and review complete.
**Monthly mean discharge based on 97-98 year record (10/1/1915 – 9/30/2012) found at Surface-Water Monthly Statistics for Massachusetts USGS 01166500 MILLERS RIVER AT ERVING, MA
***POR Period of Record based on 97-98 year record (10/1/1915-12/31/2012) found at Surface-Water Data Statistics for Massachusetts USGS 01166500 MILLERS RIVER AT ERVING, MA
[e]=estimated value
7Q10 = 46.8 cfs @ USGS gaging station, Millers River at Erving, MA

RESULTS AND QUALITY ASSURANCE/QUALITY CONTROL

The results of SMART monitoring conducted in the Millers watershed from 2005 through 2010 are included below. Table 9 through Table 13 present *in-situ* multiprobe readings, including temperature, pH, dissolved oxygen, percent oxygen saturation, depth, specific conductivity, and total dissolved solids. Table 14 through Table 18 contain nutrient (ammonia-nitrogen, nitrate-nitrite nitrogen, total nitrogen, and total phosphorus), chlorides, hardness, total alkalinity, total suspended solids and turbidity data. Most results are expressed as milligrams per liter (mg/L). Exceptions include: depth in meters (m); temperature in degrees Celsius (ºC); pH in Standard Units (SU); conductivity in microsiemens per centimeter (µS/cm); dissolved oxygen saturation in percent (% sat); and turbidity, in Nephelometric Turbidity Units (NTU).

Field sheets, field notebooks, chain of custody forms, raw data files, lab reports and other metadata are maintained by the Division of Watershed Management (DWM) in Worcester, MA; data are stored electronically in the DWM water quality database. Detailed information regarding the data validation process is explained in the separate document, *CN 56.2. Standard Operating Procedure. Data Validation and Usability* (MassDEP 2005). Specific validation criteria used for 2005-2010 data include, but are not limited to: conformance to the SMART Monitoring Quality Assurance Project Plan (MassDEP 2008) and DWM standard operating procedures (SOPs), precision, accuracy, representativeness, holding times, sample preservation, frequency of field QC samples, contamination of field blanks, stability of multiprobe readings and documentation. The following data qualifiers were applied as needed:

Multiprobe data qualifiers:

** = Missing data.
-- = No data.
= Censored data (data that have been discarded for some reason).
c = Greater than calibration standard used for pre-calibration, or outside the acceptable range about the calibration standard.
i = Inaccurate readings from multiprobe likely.
m = Method not followed; one or more protocols contained in the DWM Multi-probe SOP not followed.
r = Data not representative of actual field conditions.
s = Field sheet recorded data were used to accept data, not data electronically recorded in the Multi-probe surveyor unit, due to operator error or equipment failure.
u = Unstable readings.

Laboratory sample data qualifiers:

** = Missing data.
-- = No data.
= Censored data (data that have been discarded for some reason).
[ ] = A result reported inside brackets has been censored, but is shown for informational purposes.
b = Blank contamination in lab reagent blanks and/or field blank samples.
d = Precision of field duplicates (as RPD) did not meet project data quality objectives identified for program or in QAPP.
e = Not theoretically possible. Specifically, used for bacteria data where colonies per unit volume for *E. coli* bacteria is greater than fecal coliform bacteria.
h = Holding time violation (usually indicating possible bias low).
j = 'Estimated' value; used for lab-related issues where certain lab QC criteria are not met and re-testing is not possible (as identified by the WES lab only). Also used to report sample data where the sample concentration is less than the reporting detection limit (RDL) and greater than the method detection limit (MDL) (RDL > x > MDL). Also used to note where values have been reported at levels less than the MDL.
m = Method SOP not followed, only partially implemented or not implemented at all, due to complications with sample matrix (e.g. sediment in sample, floc formation), lab error (e.g. cross-contamination between samples), additional steps taken by the lab to deal with matrix complications, lost/unanalyzed samples, and missing data.

Table 9 MassDEP SMART 2005-2010. Station MI14. *In Situ* Multiprobe Data.

Date	OWMID	Time	Depth	Temp	pH	Cond@ 25C	TDS	DO	SAT
		(24hr)	(m)	(C)	(SU)	(us/cm)	(mg/l)	(mg/l)	(%)
1/18/2005	**	**	**	**	**	**	**	**	**
3/8/2005	SM-6166	12:48	0.7	0.8	6.3	142	92	14.2 i	100 i
5/11/2005	SM-1311	1:03	0.7	15.3	6.1	95	61	9.4	95
6/14/2005	SM-1357	11:58	0.7	24.6	6.1	96	61	6.9 i	85 i
7/13/2005	SM-1391	11:02	0.5	22.8 s	6.1 s	95 s	61 s	7.5 s	88 s
8/9/2005	SM-1427	11:30	0.4	23.4	6.3	120	77	6.5	77
9/14/2005	SM-1473	11:29	0.4	20.6 s	6.2 s	121 s	77 s	6.7 i, s	75 i, s
11/2/2005	SM-1543	12:12	1.1	8.1	5.7	77	50	11.5	97
2/14/2006	SM-1613	1:16	0.9	1.2	6.0	84	55	14.0	99
4/5/2006	SM-1683	12:25	0.8	5.2	6.2	102	67	12.6	99
6/13/2006	SM-1753	12:27	1.2	18.5	5.8	75	49	9.0	96
8/8/2006	SM-1823	12:33	0.7	22.9	6.4	106	69	7.2	84
10/10/2006	SM-1893	12:20	0.9	13.1	6.4	129	84	8.7	83
1/16/2007	SM-1963	11:56	1.2	1.4 u	6.1 u	86 u	56 u	13.4 u	95 u
3/20/2007	SM-2033	12:30	0.9	0.9	6.1	94	61	13.8	97
5/15/2007	SM-2103	12:11	0.6	14.8	6.3	101	66	9.4	92
7/17/2007	SM-2173	12:28	0.7	22.5	6.5	133	86	7.2	83
9/11/2007	SM-2243	12:28	0.8	17.2	6.5	165	107	6.3	65
11/6/2007	SM-2313	12:13	0.8	7.3	6.2	86	56	## u, i	## u, i
2/20/2008	SM-2383	12:50	2.3	0.2	5.4	94	61	14.9	103
4/22/2008	SM-2453	12:37	0.8	14.4	6.1	96	62	10.0	98
6/17/2008	SM-2559	12:12	0.9	18.9	6.4	134	87	8.1	88
8/19/2008	SM-2665	12:36	0.8	21.0	6.2	94	61	7.9	88
10/21/2008	SM-2747	12:34	0.5	8.5	6.3	112	73	10.3	88
2/3/2009	**	**	**	**	**	**	**	**	**
3/17/2009	SM-2877	12:03	1.1	2.7	6.0	102	66	13.1	97
5/19/2009	SM-2949	12:03	0.7	13.2 u	6.3 u	101 u	66 u	10.4 u	99 u
7/21/2009	SM-3021	11:56	0.6	21.3	6.3	95	62	## i	## i
9/22/2009	SM-3093	12:12	0.3	14.9	6.2	123	80	9.4	93
11/16/2009	SM-3165	11:55	0.9	8.1	6.3	84	55	11.7	99
2/17/2010	**	**	**	**	**	**	**	**	**
8/24/2010	SM-3309	12:57	0.2	19.2	7.0	232	151	8.7	94
10/19/2010	SM-3381	12:14	0.7	8.0	6.1	100	65	10.0 u	85 u

Table 10 MassDEP SMART 2005-2010. Station PR01. *In Situ* Multiprobe Data.

Date	OWMID	Time	Depth	Temp	pH	Cond@ 25C	TDS	DO	SAT
		(24hr)	(m)	(C)	(SU)	(us/cm)	(mg/l)	(mg/l)	(%)
1/18/2005	SM-6123	12:08	0.2	-0.1	5.4	--	--	13.0 u	89 u
3/8/2005	SM-6165	12:10	0.3	0.0	5.4	58	38	11.1 i	76 i
5/11/2005	SM-1308	12:16:	0.2	14.9	5.2	47	30	7.7	77
6/14/2005	SM-1354	11:27	0.3	24.8	5.4	54	34	2.5 i	30 i
7/13/2005	SM-1388	10:24	0.2	22.2 s	5.2 s	48 s	31 s	3.5 s	41 s
8/9/2005	SM-1424	10:58	0.4	23.7	5.4	55	35	3.4	41
9/14/2005	SM-1470	10:50	0.3	19.6 s	5.7 s	56 s	36 s	5.2 i, s	58 i, s
11/2/2005	SM-1540	11:43	0.5	7.6	4.7	42	27	9.3	78
2/14/2006	SM-1610	12:36	0.5	0.2	5.0	43	28	12.0	82
4/5/2006	SM-1680	11:56	0.5	3.4	5.0	45	29	11.2	84
6/13/2006	SM-1750	11:56	0.5	18.3	5.0	43	28	6.2	66
8/8/2006	SM-1820	11:58	0.5	23.0	5.6	47	31	4.8	56
10/10/2006	SM-1890	11:51	0.4	11.0	5.5	56	37	7.5	68
1/16/2007	SM-1960	11:25	0.4	1.0 u	5.3 u	39 u	25 u	12.3 u	87 u
3/20/2007	SM-2030	11:54	0.4	0.1	5.7	55	36	12.6	86
5/15/2007	SM-2100	11:39	0.4	13.9	5.4	45	29	7.8	75
7/17/2007	SM-2170	11:54	0.4	22.1	5.8	51	33	4.4	50
9/11/2007	SM-2240	11:49	0.3	17.1	6.0	55	36	5.1	53
11/6/2007	SM-2310	11:43	0.5	6.0	5.5	72	47	## i	## i
2/20/2008	SM-2380	12:09	0.7	-0.2	4.8	55	36	13.8	94
4/22/2008	SM-2450	12:05	0.4	13.2	5.3	40	26	8.6	82
6/17/2008	SM-2556	11:38	0.4	18.2	5.6	51	33	5.6	60
8/19/2008	SM-2662	12:04	0.3	20.1	5.5	47	30	5.8	64
10/21/2008	SM-2744	12:05	0.5	6.9	5.7	52	33	8.9	74
2/3/2009	SM-2814	11:24	0.3	-0.3	5.4	53	34	12.2	83
3/17/2009	SM-2874	11:29	0.5	0.7	5.2	55	36	12.6	88
5/19/2009	SM-2946	11:30	0.4	11.7	5.5	47	31	9.2	84
7/21/2009	SM-3018	11:30	0.3	20.2	5.8	43	28	## i	## i
9/22/2009	SM-3090	11:37	0.4	14.1	5.5	46	30	8.2	80
11/16/2009	SM-3162	11:22	0.5	7.9	5.3	43	28	9.7	82
2/17/2010	SM-3234	11:36	0.2	0.1	5.7	48	31	11.7	80
8/24/2010	SM-3306	12:22	0.2	17.9	5.9	50	32	4.8	51
10/19/2010	SM-3378	11:44	0.5	7.0	5.0	76	49	6.2	51

Table 11 MassDEP SMART 2005-2010. Station OT05. *In Situ* Multiprobe Data.

Date	OWMID	Time	Depth	Temp	pH	Cond@ 25C	TDS	DO	SAT
		(24hr)	(m)	(C)	(SU)	(us/cm)	(mg/l)	(mg/l)	(%)
1/18/2005	SM-6120	10:59	0.4	-0.1	6.2	153	100	## u	## u
3/8/2005	SM-6162	11:03	0.4	1.3	6.5	482	313	13.1 i	93 i
5/11/2005	SM-1304	10:43	0.1	15.2	6.3	278	178	9.1	92
6/14/2005	SM-1350	9:57	0.0	## m	## m	## m	## m	## m	## m
7/13/2005	SM-1384	9:15	0.1	22.5 s	6.2 s	287 s	184 s	6.9 s	81 s
8/9/2005	SM-1420	9:25	0.1	23.8	6.3	422	270	6.9	83
9/14/2005	SM-1466	9:26	0.1	20.3 s	6.7 s	550 s	352 s	7.6 i, s	85 i, s
11/2/2005	SM-1536	10:37	0.2	8.7	6.1	221	143	10.6	92
2/14/2006	SM-1606	11:14	0.2	0.3	6.1	285	185	13.2	91
4/5/2006	SM-1676	10:42	0.2	4.7	6.2	269	175	12.4	96
6/13/2006	SM-1746	10:44	0.2	19.0	6.0	213	139	7.9	85
8/8/2006	SM-1816	10:54	0.1	22.4	6.7	328	213	7.6	87
10/10/2006	SM-1886	10:44	0.1	13.1	6.3	359	233	9.2	87
1/16/2007	SM-1956	10:23	0.3	1.6 u	6.4 u	267 u	173 u	12.8 u	92 u
3/20/2007	SM-2026	10:40	0.1	0.5	6.2	298	193	13.0	90
5/15/2007	SM-2096	10:32	0.1	14.7	6.5	320	208	9.2	90
7/17/2007	SM-2166	10:39	0.2	21.6	6.7	322	210	7.4	84
9/11/2007	SM-2236	10:40	0.1	17.2	7.1	614	399	8.2	86
11/6/2007	SM-2306	10:37	0.2	7.0	6.6	305	198	## i	## i
2/20/2008	SM-2376	10:51	0.2	-0.2	5.9	265	172	13.7	93
4/22/2008	SM-2446	10:43	0.2	14.0	6.5	335	218	9.7	94
6/17/2008	SM-2552	10:24	0.1	17.8	6.6	372	242	8.3	87
8/19/2008	SM-2658	10:57	0.2	20.8	6.5	280	182	7.7	86
10/21/2008	SM-2740	10:59	0.1	8.7	6.6	380	247	10.4	90
2/3/2009	SM-2810	10:26	0.0	-0.1	6.2	425	276	13.2	90
3/17/2009	SM-2870	10:26	0.1	2.4	6.0	342	222	12.6	92
5/19/2009	SM-2942	10:20	0.1	11.8	6.3	260	169	9.8	90
7/21/2009	SM-3014	10:27	0.2	20.4	6.2	253	164	## i	## i
9/22/2009	SM-3086	10:15	0.1	15.4	6.7	361	235	9.5	95
11/16/2009	SM-3158	10:20	0.2	8.9	6.4	246	160	10.9	94
2/17/2010	SM-3230	10:25	0.1	0.2	6.3	497	323	12.9	89
8/24/2010	SM-3302	11:09	0.2	18.0	7.2	455	296	8.5	90
10/19/2010	SM-3374	10:26	0.2	8.3	6.4	274	178	11.0	93

Table 12 MassDEP SMART 2005-2010. Station MI10A. *In Situ* Multiprobe Data.

Date	OWMID	Time	Depth	Temp	pH	Cond@ 25C	TDS	DO	SAT
		(24hr)	(m)	(C)	(SU)	(us/cm)	(mg/l)	(mg/l)	(%)
1/18/2005	SM-6122	11:36	0.2	-0.1	6.2	46	30	9.5 u	65 u
3/8/2005	SM-6164	11:40	0.6	0.1	6.4	219	143	14.0 i	96 i
5/11/2005	SM-1306	11:33	0.4	14.8	6.3	151	97	9.3	93
6/14/2005	SM-1352	10:45	0.2	24.9	6.3	159	102	6.2 i	76 i
7/13/2005	SM-1386	9:51	0.4	23.3 s	6.2 s	149 s	96 s	7.1 s	84 s
8/9/2005	SM-1422	10:17	0.2	24.0	6.6	210	134	7.4	89
9/14/2005	SM-1468	10:15	0.2	20.8 s	6.6 s	209 s	133 s	7.7 i, s	87 i, s
11/2/2005	SM-1538	11:11	0.7	8.1	5.7	117	76	10.8	92
2/14/2006	SM-1608	11:58	0.8	0.3	6.0	141	92	13.9	96
4/5/2006	SM-1678	11:19	0.5	5.2	6.4	147	95	12.5	99
6/13/2006	SM-1748	11:23	0.8	18.1	5.8	114	74	8.7	92
8/8/2006	SM-1818	11:28	0.4	24.1	6.8	187	121	7.8	93
10/10/2006	SM-1888	11:18	0.3	12.9	6.7	179	117	10.4	98
1/16/2007	SM-1958	10:56	0.7	1.6 u	6.2 u	124 u	81 u	13.3 u	95 u
3/20/2007	SM-2028	11:22	0.8	0.1	6.1	156	102	13.7	94
5/15/2007	SM-2098	11:09	0.4	15.4	6.6	152	99	9.4	94
7/17/2007	SM-2168	11:23	0.3	23.5	6.9	210	136	8.0	94
9/11/2007	SM-2238	11:19	0.2	18.6	7.0	286	186	7.9	84
11/6/2007	SM-2308	11:12	0.5	7.0	6.6	144	93	## i	## i
2/20/2008	SM-2378	11:33	0.7	0.0	5.7	148	96	14.9	102
4/22/2008	SM-2448	11:24	0.5	14.6	6.4	147	95	9.9	97
6/17/2008	SM-2554	11:10	0.3	18.6	6.6	201	131	8.6	92
8/19/2008	SM-2660	11:32	0.4	21.4	6.4	149	97	7.8	88
10/21/2008	SM-2742	11:34	0.3	7.7	6.7	190	123	11.2	94
2/3/2009	SM-2812	**	**	**	**	**	**	**	**
3/17/2009	SM-2872	10:59	0.6	2.4	6.1	163	106	13.1	96
5/19/2009	SM-2944	11:00	0.6	13.1	6.4	159	104	10.1	96
7/21/2009	SM-3016	11:01	0.5	21.6	6.4	144	94	## i	## i
9/22/2009	SM-3088	10:57	0.4	14.6	6.8	210	137	10.2	100
11/16/2009	SM-3160	10:55	0.5	8.4	6.4	123	80	11.7	100
2/17/2010	SM-3232	11:00	0.3	0.1	6.3	183	119	13.4	92
8/24/2010	SM-3304	11:48	0.3	19.5	7.3	362	235	8.4	92
10/19/2010	SM-3376	11:12	0.6	8.4	6.3	163	106	## u	## u

Table 13 MassDEP SMART 2005-2010. Station MI03. *In Situ* Multiprobe Data.

Date	OWMID	Time	Depth	Temp	pH	Cond@ 25C	TDS	DO	SAT
		(24hr)	(m)	(C)	(SU)	(us/cm)	(mg/l)	(mg/l)	(%)
1/18/2005	SM-6119	10:02	0.5	-0.1	6.1	70	45	15.7	107
3/8/2005	SM-6161	10:00	0.1	1.0	6.6	176	115	14.9 i	105 i
5/11/2005	SM-1301	9:23	0.3	14.8	6.7	134	86	9.9	99
6/14/2005	35-1173	10:24	0.8	25.8	6.8	153	99	7.9	97
7/13/2005	SM-1381	9:54	0.2	23.6	6.8	128	83	8.4	100
8/9/2005	SM-1417	10:09	0.4	24.5	7.5	194	126	8.5	102
9/14/2005	SM-1463	9:39	0.3	21.3	7.7	254	165	9.5 i	107 i
11/2/2005	SM-1533	9:41	0.6	7.9	6.0	92	60	12.1	102
2/14/2006	SM-1603	9:56	0.5	-0.1	6.2	118	77	14.9	102
4/5/2006	SM-1673	9:35	0.5	5.8	7.1	128	83	12.9	103
6/13/2006	SM-1743	12:04	0.4	18.1	6.3	101	66	9.6	101
8/8/2006	SM-1813	9:40	0.3	23.3	7.3	184	120	8.6	100
10/10/2006	SM-1883	9:40	0.8	12.1	7.0	177	115	11.2	104
1/16/2007	SM-1953	9:23	0.3	2.0 u	6.0 u	90 u	59 u	13.8 u	100 u
3/20/2007	SM-2023	9:40	0.4	0.3	6.3	130	84	14.6	101
5/15/2007	SM-2093	9:37	0.2	14.5	6.6	130	85	10.1	100
7/17/2007	SM-2163	9:38	0.7	22.4	7.4	180	117	8.8	101
9/11/2007	SM-2233	9:41	0.3	19.2	7.5	292	190	8.9	96
11/6/2007	SM-2303	9:39	0.2	7.2	6.9	170	111	## i	## i
2/20/2008	SM-2373	9:46	2.3	-0.2	5.9	120	78	16.1	110
4/22/2008	SM-2443	9:42	0.5	14.6	6.8	119	78	10.8	106
6/17/2008	SM-2549	9:25	0.4	18.6	6.9	148	96	9.6	102
8/19/2008	SM-2655	9:36	0.4	20.8	7.0	138	89	8.8	98
10/21/2008	SM-2737	10:05	0.2	7.8	7.2	187	122	12.1	101
2/3/2009	SM-2807	9:26	0.3	-0.3	6.4	176	114	14.8	100
3/17/2009	SM-2867	9:24	0.6	2.3	6.3	130	85	13.8	100
5/19/2009	SM-2939	9:19	0.2	12.9	6.6	128	83	10.8	102
7/21/2009	SM-3011	9:30	0.4	21.4	6.8	145	94	## i	## i
9/22/2009	SM-3083	9:09	0.6	15.0	7.4	215	140	10.8	108
11/16/2009	SM-3155	9:18	0.3	8.6	6.8	104	67	12.2	104
2/17/2010	SM-3227	9:17	0.2	0.0	6.5	142	92	14.4	98
8/24/2010	SM-3299	10:10	0.3	19.0	8.0	336	218	9.4	102
10/19/2010	SM-3371	9:17	0.4	8.0	6.8	151	98	12.3	104

Table 14 MassDEP SMART 2005-2010. Station MI14. Chemistry Data.

Date	OWMID	Time	Alkalinity	Hardness	Chloride	E. coli	Ssolids	Turb	TN	NH3-N	NO3-NO2-N	TPhos
		(24hr)	(mg/l)	(mg/l)	(mg/l)	(MPN/100ml)	(mg/l)	(NTU)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
1/18/2005	**	**	**	**	**	**	**	**	**	**	**	**
3/8/2005	SM-1166	12:45	6	11	29	**	1.9	1.8	0.73	0.31	0.17	0.027
5/11/2005	SM-1309	12:55	4	9.5	21	**	2.8	1.2	0.59b	0.09	0.05	0.018
6/14/2005	SM-1355	11:50	4	9.0	21	**	4.8	3.6b	##b	0.06	0.08	0.048b
7/13/2005	SM-1389	10:50	5	9.1	22	**	3.6	1.9	0.50	<0.02	0.10	0.033
8/9/2005	SM-1425	11:20	9j	13	23j	**	3.5j	3.1j	0.79b,j	0.02j	0.21	0.047j
9/14/2005	SM-1471	11:15	6	12	##d	**	1.7	2.4	0.60	0.04b	0.19	0.087
11/2/2005	SM-1541	12:05	<2	8.3	14	**	1.6	1.0	0.39	0.02	0.06	0.018
2/14/2006	SM-1611	1:05	3	7.7	17	**	<1.0	0.7	0.34	0.03	0.15	0.012
4/5/2006	SM-1681	12:15	3	9.0	22	**	5.6	2.6	0.44	0.04	0.12	0.029
6/13/2006	SM-1751	12:15	2	6.6	15	**	2.9	1.2	0.36	0.02	0.05	0.021
8/8/2006	SM-1821	12:18	7	11	22h	**	1.9	2.5	0.64	0.03	0.14	0.039
10/10/2006	SM-1891	12:12	9	11	26	**	1.3	1.8	0.65	<0.02	0.23	0.071
1/16/2007	SM-1961	11:45	2	7.8	17	**	1.2	1.1h	0.38	0.02	0.14	0.018
3/20/2007	SM-2031	12:18	3	8.9	19	**	2.1	1.2	0.44	0.10	0.15	0.014
5/15/2007	SM-2101	12:02	5	11	20	**	2.2	1.3	0.45	0.14	0.08	0.018
7/17/2007	SM-2171	12:20	9	15	25	##b	1.9	2.1	0.63	0.04	0.15	0.034
9/11/2007	SM-2241	12:15	16	17	29	125	1.9	2.2	0.89	0.08	0.46	0.042
11/6/2007	SM-2311	12:10	3	7.9	16	613	13	2.2	0.55	0.07	0.10	0.041
2/20/2008	SM-2381	12:40	2	8.9	19	26	<1.0	0.8	0.33	0.02	0.10	0.009
4/22/2008	SM-2451	12:27	4	10	22	14	2.8	1.3	0.42	0.17	0.03	0.018
6/17/2008	SM-2557	12:04	5	13	26	488	3.6	3.5	0.82	0.24	0.14	0.042
8/19/2008	SM-2663	12:25	**	11	16	108	3.1	3.3	0.46	0.03	0.05	0.025
10/21/2008	SM-2745	12:26	5	13	22	22	1.4	1.3	0.48	0.07	0.08	0.033
2/3/2009	**	**	**	**	**	**	**	**	**	**	**	**
3/17/2009	SM-2875	11:58	2	9.6	23	44	1.0	0.8	0.33	0.07	0.09	0.009
5/19/2009	SM-2947	11:47	4	11	17	76	2.2d	1.3	0.39	0.08	0.06	0.018
7/21/2009	SM-3019	11:50	6	11	20	127	2.4	1.9	0.50	0.03	0.07	0.026
9/22/2009	SM-3091	12:02	11	14	22	36	1.5	1.6	0.71	0.12	0.27	0.022
11/16/2009	SM-3163	11:43	3	9.0	18	90	2.0	1.5	0.41	0.05	0.03	0.018
2/17/2010	SM-3235	**	**	**	**	**	**	**	**	**	**	**
8/24/2010	SM-3307	12:48	31	23b	39	54	<1.0	2.2	2.0	0.09	1.6	0.018
10/19/2010	SM-3379	12:06	3	11	19	26	2.1	1.7	0.51	<0.02	0.10	0.021

Table 15 MassDEP SMART 2005-2010. Station PR01. Chemistry Data.

Date	OWMID	Time	Alkalinity	Hardness	Chloride	E_coli	Ssolids	Turb	TN	NH3-N	NO3-NO2-N	TPhos
		(24hr)	(mg/l)	(mg/l)	(mg/l)	(MPN/100ml)	(mg/l)	(NTU)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
1/18/2005	SM-1123	12:05	**	**	**	**	**	**	0.24h	<0.02h	<0.02h	0.012h
3/8/2005	SM-1165	12:05	2	6.8	10	**	<1.0	0.7	0.33	0.05	0.06	0.018
5/11/2005	SM-1307	12:10	<2	5.6	9	**	3.2	1.1	0.36b	<0.02	<0.02	0.016
6/14/2005	SM-1353	11:20	<2	6.3	11	**	4.9	1.9b	##b	0.02	<0.02	0.054b
7/13/2005	SM-1387	10:20	<2	6.0	8	**	2.1	1.0	0.55	<0.02	0.02	0.039
8/9/2005	SM-1423	10:45	2j	6.3	8j	**	2.9j	2.3j	0.66b,j	0.03j	0.02	0.044j
9/14/2005	SM-1469	10:40	5	7.1	##d	**	1.7	1.8	0.47	0.02b	<0.02	0.034
11/2/2005	SM-1539	11:30	<2	5.2	4	**	<1.0	0.4	0.27	<0.02	<0.02	0.014
2/14/2006	SM-1609	12:25	<2	4.8	6	**	<1.0	0.4	0.19	<0.02	0.04	0.009
4/5/2006	SM-1679	11:35	<2	4.7	7	**	2.0	1.0	0.33	0.04	0.04	0.022
6/13/2006	SM-1749	11:40	<2	4.3	7	**	1.1	0.7	0.30	<0.02	<0.02	0.037
8/8/2006	SM-1819	11:49	3	5.5	8h	**	2.7	1.5	0.51	<0.02	0.02	0.033
10/10/2006	SM-1889	11:40	3	7.1	11	**	<1.0	0.8	0.42	<0.02	<0.02	0.015
1/16/2007	SM-1959	11:15	<2	4.6	5	**	<1.0	0.5h	0.20	<0.02	0.03	0.009
3/20/2007	SM-2029	11:45	2	6.8	9	**	<1.0	0.8h	0.32	0.05	0.09	0.012
5/15/2007	SM-2099	11:30	<2	5.2	8	**	2.3	1.1h	0.33	<0.02	<0.02	0.019
7/17/2007	SM-2169	11:40	5	7.2	7	##b	11	1.5h	0.60	0.03	<0.02	0.042
9/11/2007	SM-2239	11:42	6	8.4	8	34	19	1.2h	0.40	<0.02	0.05	0.025
11/6/2007	SM-2309	11:32	3	10	12	13	<1.0	0.5h	0.35	<0.02	<0.02	0.010
2/20/2008	SM-2379	12:05	<2	6.1	7	3	1.3	0.5	0.21	<0.02	<0.02	0.005
4/22/2008	SM-2449	11:48	2	5.4	6	1	<1.0	0.7h	0.28	<0.02	<0.02	0.014
6/17/2008	SM-2555	11:30	<2	7.2	8	1050	3.2	2.2	0.62	0.03	<0.02	0.037
8/19/2008	SM-2661	11:55	**	6.5	6	72	1.2	1.4	0.47	<0.02	<0.02	0.019
10/21/2008	SM-2743	11:55	<2	7.3	8	6	<1.0	0.7h	0.31	<0.02	<0.02	0.014
2/3/2009	SM-2813	11:17	<2	7.2	7	1	<1.0	0.6	0.27	0.03	0.03	0.009
3/17/2009	SM-2873	11:25	<2	6.4	9	3	<1.0	0.4	0.18	<0.02	<0.02	0.007
5/19/2009	SM-2945	11:15	2	6.1	8	22	1.1d	0.7	0.34	<0.02	<0.02	0.015
7/21/2009	SM-3017	11:22	3	6.8	6	33	1.6	1.5	0.50	<0.02	<0.02	0.031
9/22/2009	SM-3089	11:22	4	6.4	5	16	1.3	1.0	0.39	<0.02	<0.02	0.020
11/16/2009	SM-3161	11:12	<2	5.4	7		<1.0	0.5	0.28	<0.02	<0.02	0.012
2/17/2010	SM-3233	11:25	2	**	6	3	<1.0	0.8	0.33	0.05	0.06	0.011
8/24/2010	SM-3305	12:17	3	9.0b	7	26	9.1	1.9	0.60	<0.02	<0.02	0.039
10/19/2010	SM-3377	11:36	<2	12	12	64	<1.0	0.6	0.44	<0.02	<0.02	0.012

Table 16 MassDEP SMART 2005-2010. Station OT05. Chemistry Data.

Date	OWMID	Time	Alkalinity	Hardness	Chloride	E_coli	Ssolids	Turb	TN	NH3-N	NO3-NO2-N	TPhos
		(24hr)	(mg/l)	(mg/l)	(mg/l)	(MPN/100ml)	(mg/l)	(NTU)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
1/18/2005	SM-1120	10:50	**	**	**	**	**	**	1.0h	0.21h	0.48h	0.072h
3/8/2005	SM-1162	10:55	9	36	120	**	19	2.4	2.0	0.52	1.1	0.16
5/11/2005	SM-1302	10:21	6	25	68	**	2.3	2.1	1.2b	0.06	0.65	0.053
6/14/2005	SM-1348	9:35	8	29	70	**	11	7.2b	##b	0.16d	1.1	0.14b
7/13/2005	SM-1382	9:00	6	29	68	**	8.6	8.8	2.2	0.07d	1.3	0.11
8/9/2005	SM-1418	9:05	7j	51	92j	**	5.4j	12.0j	5.2b,j	0.18j	3.6	0.10j
9/14/2005	SM-1464	9:15	20	82	##d	**	3.0	4.9	9.2	0.03b	8.0	0.070
11/2/2005	SM-1534	10:30	7d	23	47	**	1.9	2.1	1.2	0.05	0.80	0.062d
2/14/2006	SM-1604	11:00	4	23	68	**	1.3	1.5	1.0	0.12	0.71	0.074
4/5/2006	SM-1674	10:28	5	22	66	**	5.1	3.8h	1.1	0.05	0.78	0.098
6/13/2006	SM-1744	10:30	4	21	49	**	5.2	3.3h	0.99	0.05	0.59	0.058
8/8/2006	SM-1814	10:43	15	42	71h	**	9.1	10.0	3.3	0.06	2.5	0.088
10/10/2006	SM-1884	10:35	7	41	80	**	3.0	5.0	4.6	0.06	2.8	0.055
1/16/2007	SM-1954	10:10	5	22	64	**	4.1d	4.0d,h	1.2	0.16	0.79	0.10
3/20/2007	SM-2024	10:30	5d	25	70	**	2.0	1.7h	1.1	0.10	0.81	0.076
5/15/2007	SM-2094	10:20	9	37	75	**	3.7d	2.9h	2.4	<0.02	1.9	0.046
7/17/2007	SM-2164	10:32	17	41	74	##b	4.2d	5.3h	2.6	0.07	1.8	0.093
9/11/2007	SM-2234	10:27	46	110	110	291	4.1	2.7h	12.0	0.08	11.0	0.055
11/6/2007	SM-2304	10:25	12	38	62	58	1.5	3.3h	3.1	0.06	2.5	0.052
2/20/2008	SM-2374	10:45	4d	19	67	219	4.2	1.5	0.58	0.04	0.33	0.030
4/22/2008	SM-2444	10:30	8d	38	83	8	3.8	2.9h	2.0	0.08	1.5	0.044
6/17/2008	SM-2550	10:10	13	48	82	687	5.6	6.8	3.4	0.12	2.5	0.070
8/19/2008	SM-2656	10:45	**	33	62	155	5.5	6.5h	2.4	0.04	1.6	0.058
10/21/2008	SM-2738	10:50	8	51	80	22	3.0	6.0h	5.2	0.05	4.3	0.043
2/3/2009	SM-2808	10:20	6	34	110	93	1.8	1.9	2.2	0.20	1.7	0.17
3/17/2009	SM-2868	10:20	3	26	90	16	1.6	1.1	0.83	0.05	0.64	0.029
5/19/2009	SM-2940	10:05	6	25	63	44	##d	2.5	1.3	0.02	0.87	0.037
7/21/2009	SM-3012	10:17	8	29	59	56	6.6	6.1	2.2	0.04	1.3	0.070
9/22/2009	SM-3084	10:05	11	45	73	44	3.8	9.5	3.9	0.06	3.1	0.063
11/16/2009	SM-3156	10:08	6	28	61	179	2.7	3.5	1.8	0.10	1.1	0.043
2/17/2010	SM-3228	10:15	8	**	120	228	2.4d	2.9h	2.5	0.30	1.9	0.088
8/24/2010	SM-3300	11:00	31	82b	92	387	5.1	5.5	7.9	0.08	6.9	0.060
10/19/2010	SM-3372	10:15	7	36	60	44	3.5d	5.3h	1.8	0.02	1.3	0.037

Table 17 MassDEP SMART 2005-2010. Station MI10A. Chemistry Data.

Date	OWMID	Time	Alkalinity	Hardness	Chloride	E_coli	Ssolids	Turb	TN	NH3-N	NO3-NO2-N	TPhos
		(24hr)	(mg/l)	(mg/l)	(mg/l)	(MPN/100ml)	(mg/l)	(NTU)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
1/18/2005	SM-1122	11:30	**	**	**	**	**	**	0.40h	0.05h	0.12h	0.021h
3/8/2005	SM-1164	11:35	7	19	49	**	2.9	2.2	0.87	0.21	0.39	0.054
5/11/2005	35-1148	11:31	**	**	**	26e	**	**	**	**	**	**
5/11/2005	SM-1305	11:30	4	15	35	**	7.6	2.1	0.58b	0.04	0.18	0.034
6/14/2005	35-1218	12:45	**	**	**	77	**	**	**	**	**	**
6/14/2005	SM-1351	10:30	7	16	37	**	9.0	4.7b	##b	0.15	0.22	0.094b
7/13/2005	SM-1385	9:45	6	15	34	**	5.1	3.8	0.86	0.08	0.26	0.068
8/9/2005	SM-1421	10:02	8j	25	44j	**	6.2j	4.1j	1.6b,j	0.08j	0.89	0.064j
9/14/2005	SM-1467	10:00	8	23	##d	**	1.5	2.4	1.2	0.03b	0.72	0.068
11/2/2005	SM-1537	11:00	4	12	22	**	2.4	1.3	0.61	0.04	0.20	0.030
2/14/2006	SM-1607	11:50	3	13	31	**	1.1	0.9	0.48	0.05	0.23	0.026
4/5/2006	SM-1677	11:05	5	15	32	**	2.5	2.1	0.82	0.09	0.38	0.044
6/13/2006	SM-1747	11:05	2	10	25	**	3.8	2.0	0.50	0.05	0.15	0.091
8/8/2006	SM-1817	11:15	9	22	39h	**	2.2	3.4	1.1	0.03	0.54	0.057
10/10/2006	SM-1887	11:10	8	24	39	**	2.2	2.4	1.0	<0.02	0.55	0.040
1/16/2007	SM-1957	10:47	3	12	26	**	1.7	1.8h	0.55	0.03	0.29	0.038
3/20/2007	SM-2027	11:10	3	14	34	**	1.9	1.5h	0.60	0.09	0.30	0.029
5/15/2007	SM-2097	11:00	17	16	33	**	4.3	1.8h	0.68	0.04	0.30	0.032
7/17/2007	SM-2167	11:10	10	27	45	##b	2.0	2.8h	1.2	0.08	0.57	0.060
9/11/2007	SM-2237	11:08	21	41	51	166	2.0	1.6h	1.2	0.06	0.60	0.038
11/6/2007	SM-2307	11:00	6	17	28	88	6.2	2.5h	0.86	0.02	0.45	0.040
2/20/2008	SM-2377	11:30	2	12	35	37	2.6	1.7	0.43	0.03	0.18	0.021
4/22/2008	SM-2447	11:12	4	15	33	14	3.0	1.4h	0.54	0.04	0.19	0.026
6/17/2008	SM-2553	10:47	9	25	41	285	4.4	3.0	1.2	0.12	0.67	0.056
8/19/2008	SM-2659	11:25	**	17	30	79	2.9	3.9	0.87	0.04	0.33	0.039
10/21/2008	SM-2741	11:25	7	23	38	17	1.7	2.1h	1.4	0.14	0.82	0.028
3/17/2009	SM-2871	10:55	2	14	38	140	1.1	0.8	0.42	0.04	0.20	0.019
5/19/2009	SM-2943	10:40	5	17	35	68	3.2d	2.0	0.64	0.04	0.22	0.036
7/21/2009	SM-3015	10:52	6	17	32	225	4.1	3.3	0.76	0.03	0.21	0.048
9/22/2009	SM-3087	10:47	9	26	45	74	1.3	1.3	1.4	0.03	0.99	0.032
11/16/2009	SM-3159	10:42	5	14	27	121	2.6	2.1	0.70	0.06	0.28	0.028
2/17/2010	SM-3231	10:55	6	**	39	30	1.3	1.7	1.0	0.19	0.57	0.041
8/24/2010	SM-3303	11:37	27	54b	68	105	2.1	3.0	2.3	0.08	1.6	0.040
10/19/2010	SM-3375	10:50	5	21	32	99	9.8	2.6	0.78	0.02	0.26	0.041

Table 18 MassDEP SMART 2005-2010. Station MI03. Chemistry Data.

Date	OWMID	Time	Alkalinity	Hardness	Chloride	E_coli	Ssolids	Turb	TN	NH3-N	NO3-NO2-N	TPhos
		(24hr)	(mg/l)	(mg/l)	(mg/l)	(MPN/100ml)	(mg/l)	(NTU)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
1/18/2005	SM-1119	9:50	**	**	**	**	**	**	##d,h	0.04h	0.16h	0.023h
3/8/2005	SM-1161	9:45	6	18	38	**	2.0	1.2	0.71	0.15	0.35	0.036
5/11/2005	SM-1300	9:15	5	15	29	**	2.7	1.4	0.43b	<0.02	0.16	0.024
6/14/2005	35-1195	10:25	5	**	**	100	5.5	1.9	0.95	0.04	(blank)	0.068
7/13/2005	SM-1380	9:45	4	15	27	**	4.0	2.3	0.66	<0.02	0.20	0.050
8/9/2005	SM-1416	10:05	11	29	35	**	1.4j	1.8j	0.96	<0.02	0.55	0.042j
9/14/2005	SM-1462	9:35	16	42	57	**	1.7	1.9	1.3	<0.02	0.67	0.046
11/2/2005	SM-1532	9:30	3	11	16	**	1.8	1.2	0.52	<0.02	0.13	0.023
2/14/2006	SM-1602	9:50	3	12	24	**	1.3	0.8h	0.38	0.02	0.24	0.018
4/5/2006	SM-1672	9:25	5	16	24	**	2.9	1.8h	0.56	0.03	0.32	0.032
6/13/2006	SM-1742	9:20	2	12	21	**	3.8	1.7h	0.45	0.02	0.14	0.032
8/8/2006	SM-1812	9:35	13	25	36h	**	1.4	1.6	0.99	<0.02	0.58	0.037
10/10/2006	SM-1882	9:30	11	26	36	**	<1.0	1.5h	0.80	0.02	0.38	0.028
1/16/2007	SM-1952	9:15	2	11	17	**	2.3	1.4h	0.40	0.03	0.20	0.027
3/20/2007	SM-2022	9:25	4	14	26	**	3.0	1.8h	0.51	0.10	0.23	0.027
5/15/2007	SM-2092	9:20	5	17	27	**	2.5	1.2h	0.46	<0.02	0.20	0.023
7/17/2007	SM-2162	9:43	14	27	35	##b	1.3	1.4h	0.83	0.02	0.35	0.036
9/11/2007	SM-2232	9:25	21	45	53	101	3.0	1.0h	1.4	0.14	0.78	0.024
11/6/2007	SM-2302	9:20	10	23	32	1120	2.7	1.9h	0.83	0.08	0.40	0.034
2/20/2008	SM-2372	9:30	5	11	24	27	4.8	1.6	0.38	0.02	0.14	0.019
4/22/2008	SM-2442	9:25	4	14	23	34	2.0	1.0h	0.35	<0.02	0.12	0.017
6/17/2008	SM-2548	9:10	5	21	29	980	5.2	2.5	0.81	0.05	0.38	0.044
8/19/2008	SM-2654	9:25	**	19	27	129	2.8	3.4h	0.65	<0.02	0.22	0.031
10/21/2008	SM-2736	9:37	8	29	35	115	1.3	1.1h	0.86	<0.02	0.50	0.020
2/3/2009	SM-2806	9:15	6	21	37	43	3.1	1.0	0.68	0.10	0.35	0.028
3/17/2009	SM-2866	9:15	2	14	29	260	1.6	0.8	0.40	0.02	0.18	0.015
5/19/2009	SM-2938	9:00	4	15	25	41	2.8d	1.4	0.54	<0.02	0.22	0.025
7/21/2009	SM-3010	9:15	8	19	30	79	3.1	2.2	0.70	0.02	0.27	0.036
9/22/2009	SM-3082	8:55	15	34	38	488	2.0	1.0	0.89	<0.02	0.56	0.027
11/16/2009	SM-3154	9:05	6	15	21	1050	2.6	1.7	0.61	0.05	0.25	0.025
2/17/2010	SM-3226	9:05	6	**	27	86	1.6	1.1h	0.70	0.10	0.38	0.017
8/24/2010	SM-3298	9:55	31	72b	49	34	31	2.4h	1.3	0.03	0.60	0.044
10/19/2010	SM-3370	9:00	6	22	28	148	3.0	2.2h	0.60	<0.02	0.19	0.026

REFERENCES

Beaudoin, T. 2008 (unpublished). *CN 012.1: Strategic Monitoring and Assessment for River basin Teams Quality Assurance Project Plan. 2008-2012.* Massachusetts Department of Environmental Protection. Central Regional Office. Worcester, MA.

Google Earth. 2011a. "MI14". 42º40'20.89"N and 72º05'34.57"W. Imagery September 21, 2010. Retrieved January11, 2011.

Google Earth. 2011b. "PR01". 42º40'57.88"N and 72º06'53.87"W. Imagery September 21, 2010. Retrieved January 11, 2011.

Google Earth. 2011c. "OT05". 42º35'17.53"N and 72º02'27.49"W. Imagery September 21, 2010. Retrieved January 11, 2011.

Google Earth. 2011d. "MI10A". 42º37'47.57"N and 72º09'01.20"W. Imagery September 21, 2010. Retrieved January 11, 2011.

Google Earth. 2011e. "MI03". 42º35'51.29"N and 72º26'15.58"W. Imagery September 7, 2010. Retrieved January 11, 2011.

Kennedy, L.E. and A. M. Rojko. March 2004. CN *089.0: Millers River Watershed: 2000 Water Quality Assessment Report.* Report 35-AC-1. Massachusetts Department of Environmental Protection. Division of Watershed Management. Worcester, MA. Available at http://www.mass.gov/eea/agencies/massdep/water/watersheds/water-quality-assessments.html#2

MassDEP. 2005. *CN 56.2. Standard Operating Procedure. Data Validation and Usability.* Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MassDEP. 1999a. *CN 4.0 Water Quality Multi-probe Instrument Use, Standard Operating Procedure.* Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MassDEP. 1999b. *Grab Collection Techniques for DWM Water Quality Sampling, Standard Operating Procedure.* Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MassDFG. 2013 [online]. *Coldwater Fish Resources. Millers River Watershed.* Massachusetts Department of Fish and Game, Division of Fisheries and Wildlife. Westborough, MA. Retrieved December 11, 2013. Available at http://www.mass.gov/eea/agencies/dfg/dfw/wildlife-habitat-conservation/coldwater-fishery-resources-millers-river-watershed.html

MassDFG. 2013 [online]. *Trout Stocked Waters - Connecticut Valley District.* Massachusetts Department of Fish and Game, Division of Fisheries and Wildlife. Westborough, MA. Retrieved December 23, 2013. Available at http://www.mass.gov/eea/agencies/dfg/dfw/hunting-fishing-wildlife-watching/fishing/ct-valley-district-waters.html

MassWildlife. 2013. *MassWildlife Activities.* Massachusetts Department of Fish and Game, Division of Fisheries and Wildlife. Westborough, MA. Retrieved December 11, 2013. Available at http://www.mass.gov/eea/agencies/dfg/dfw/about-masswildlife/activities.html

MassWildlife. 2011. *Mass Wildlife Land Maps. Wildlife Land Viewer.* Massachusetts Department of Fish and Game, Division of Fisheries and Wildlife. Westborough, MA. Retrieved December 8, 2015. Available at http://maps.env.state.ma.us/dfg/masswildlifelands/

NOAA. 2015 [online]. *Climatological Data Publications. Massachusetts.* NOAA Satellite and Information Service. National Climatic Data Center. Image and Publications System. Retrieved May 15, 2013. Available at http://www.ncdc.noaa.gov/IPS/cd/cd.html;jsessionid=1CB121D95499F2E6677D736184136915?_page=0&jsessionid=1CB121D95499F2E6677D736184136915&state=MA&_target1=Next+%3E

Norris, A. (Alicia.Norris@state.ma.us). 2010. *Re: Fisheries information request.* Fish stocking activities near five SMART stations in the Millers Watershed, Massachusetts. Massachusetts Department of Fish and Game, Division of Fisheries and Wildlife, Westborough, MA. Email to Therese Beaudoin, Massachusetts Department of Environmental Protection, Bureau of Resource Management, Worcester, MA dated 14 March 2010.

North Quabbin Woods.org. *Area Guide – Birch Hill Wildlife Management Area. North Quabbin Woods; project of the North Quabbin Community Coalition.* Royalston, MA. Retrieved January 5, 2011. Available at http://www.northquabbinwoods.org/birch_hill_wildlife.html

Ostiguy, Lance J., Weiskel, Peter K. and Stacey A. Archfield. 2010 [Online]. *Average Annual Precipitation, in Inches, for Massachusetts as Computed over the Period 1971-2000 Using the Parameter-Elevation Regressions on Independent Slopes (PRISM) Model. Appendix 1, Figure 1-2.* Retrieved February 16, 2011. Available at http://pubs.usgs.gov/sir/2009/5227/pdf/Appendix/sir2009-5227_appendix1_fig2.pdf

USACE. 2013 [online]. *Birch Hill Dam, Royalston, MA. Flood Risk Management*. U. S. Army Corps of Engineers. Royalston, MA. Retrieved December 11, 2013. Available at http://www.nae.usace.army.mil/Missions/Recreation/BirchHillDam.aspx

USGS. 2013a [online]. Discharge and gage height at the USGS Millers River gage near Winchendon, MA (USGS station number 01162000) from June 1916 to current year. Retrieved December 23, 2013. Available at http://waterdata.usgs.gov/ma/nwis/dv/?site_no=01162000&PARAmeter_cd=00060,00065

USGS. 2013b [online]. Discharge and gage height at the USGS Priest Brook gage near Winchendon, MA (USGS station number 01162500) from May 1916 to current year. Retrieved December 23, 2013. Available at http://waterdata.usgs.gov/ma/nwis/dv/?site_no=01162500&PARAmeter_cd=00060,00065

USGS. 2013c [online]. Discharge and gage height at the USGS Otter River gage at Otter River, MA (USGS station number 01163200) from December 1964 to current year. Retrieved December 23, 2013. Available at http://waterdata.usgs.gov/ma/nwis/uv/?site_no=01163200&PARAmeter_cd=00065,00060

USGS. 2013d [online]. Discharge and gage height at the USGS Millers River gage at South Royalston, MA (USGS station number 01164000) from July 1939 to current year. Retrieved December 23, 2013. Available at http://waterdata.usgs.gov/ma/nwis/uv/?site_no=01164000&PARAmeter_cd=00065,00060

USGS. 2013e [online]. Discharge and gage height at the USGS Millers River gage at Erving, MA (USGS station number 01166500) from July 1915 to current year. Retrieved December 23, 2013. Available at http://waterdata.usgs.gov/ma/nwis/uv/?site_no=01166500&PARAmeter_cd=00065,00060

USGS. 2013f [online]. USGS Surface-Water Daily Statistics for Massachusetts. USGS Millers River gage at Erving, MA (USGS station number 01166500). Mean of daily mean discharge values for each day for 97-98 years of record in cfs (Calculation period October 1, 1915 through September 30, 2013). Retrieved December 23, 2013. Available at http://waterdata.usgs.gov/ma/nwis/dvstat/?referred_module=sw&site_no=01166500&por_01166500_1=1269036,00060,1,1915-07-01,2009-03-15&format=html_table&stat_cds=mean_va&date_format=YYYY-MM-DD&rdb_compression=file&submitted_form=parameter_selection_list.

USGS. 2013g [online]. USGS Surface-Water Monthly Statistics for Massachusetts. USGS Millers River gage at Erving, MA. (USGS station number 01166500). Monthly mean discharge values for 93-94 years of record in cfs (Calculation period October 1, 1915 through September 30, 2013). Retrieved December 23, 2013. Available at http://waterdata.usgs.gov/ma/nwis/monthly/?referred_module=sw&site_no=01166500&por_01166500_1=1269036,00060,1,1915-07,2012-12&format=html_table&date_format=YYYY-MM-DD&rdb_compression=file&submitted_form=parameter_selection_list

Wandle, S. W. and Fontaine, R.A.. 1984 [Online]. *Gazetteer of Hydrologic Characteristics of Streams in Massachusetts-Coastal River Basins of the North Shore and Massachusetts Bay*. Water-Resources Investigations Report 84-4284. United States Geological Survey. Available at http://pubs.er.usgs.gov/publication/wri844284