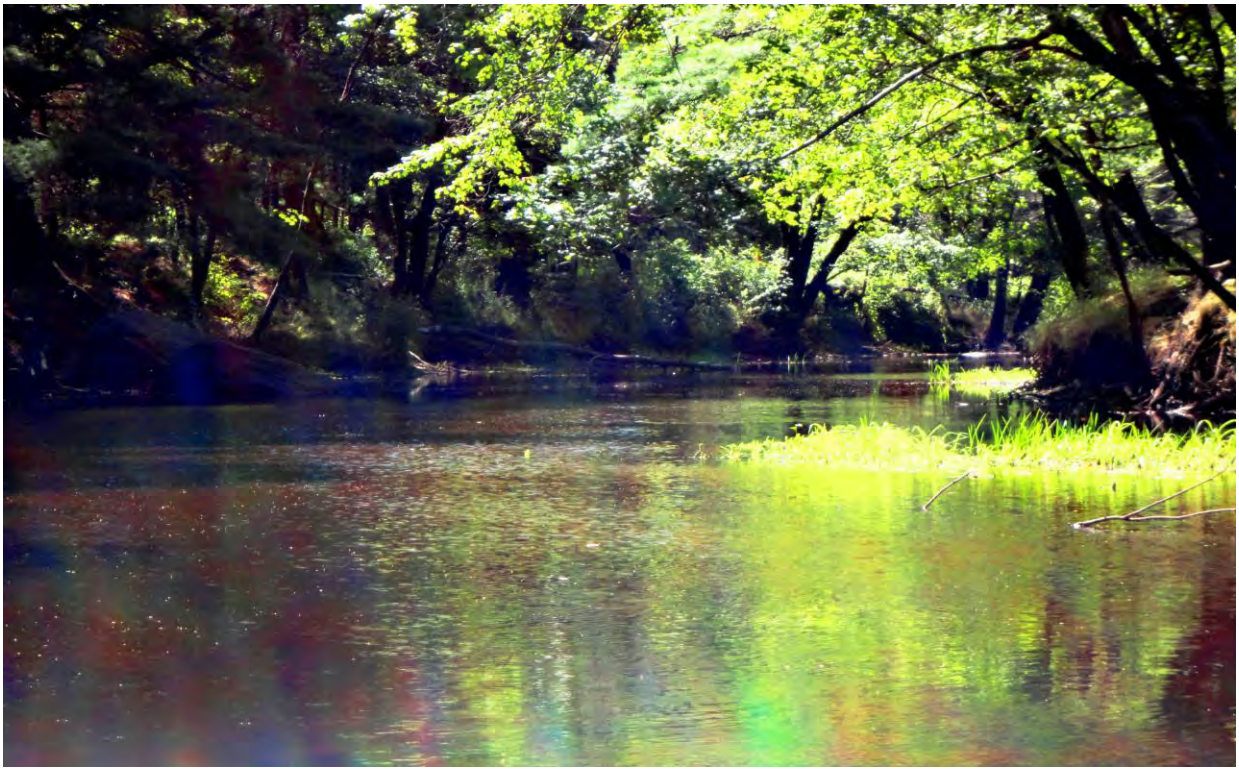
MILLERS RIVER WATERSHED
SMART MONITORING PROGRAM 2011-2013

Technical Memorandum CN 416.0



The Millers River near Sibley Road, Winchendon

Prepared By:
Therese Beaudoin
January 2016

Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
Matthew Beaton, Secretary
Massachusetts Department of Environmental Protection
Martin Suuberg, Commissioner
Bureau of Water Resources
Douglas Fine, Assistant Commissioner
Division of Watershed Management
Rebecca Weidman, Director
Watershed Planning Program
Kim Groff, Director

TABLE OF CONTENTS

LIST OF TABLES

Cover photo by Therese Beaudoin, MassDEP. 21 August 2012.
All photos in document taken by Therese Beaudoin. MassDEP. CERO.
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	*Pontedaria cordata*	pickerelweed
Branta canadensis	Canada goose	*Potamogeton* sp	pondweed
Castor canadensis	North American beaver	*Proserpinaca* sp.	mermaidweed
Gramineae family	true grasses	*Rorippa* sp.	water cress
Lobelia cardinalis	cardinal flower	*Scirpus* sp.	sedges
Lontra canadensis	North American river otter	*Vallisneria* sp.	American eelgrass
Ludwigia sp.	water primrose	*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
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_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 for the period including 2011 through 2013, 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 SMART monitoring program Years 2005-2010 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.

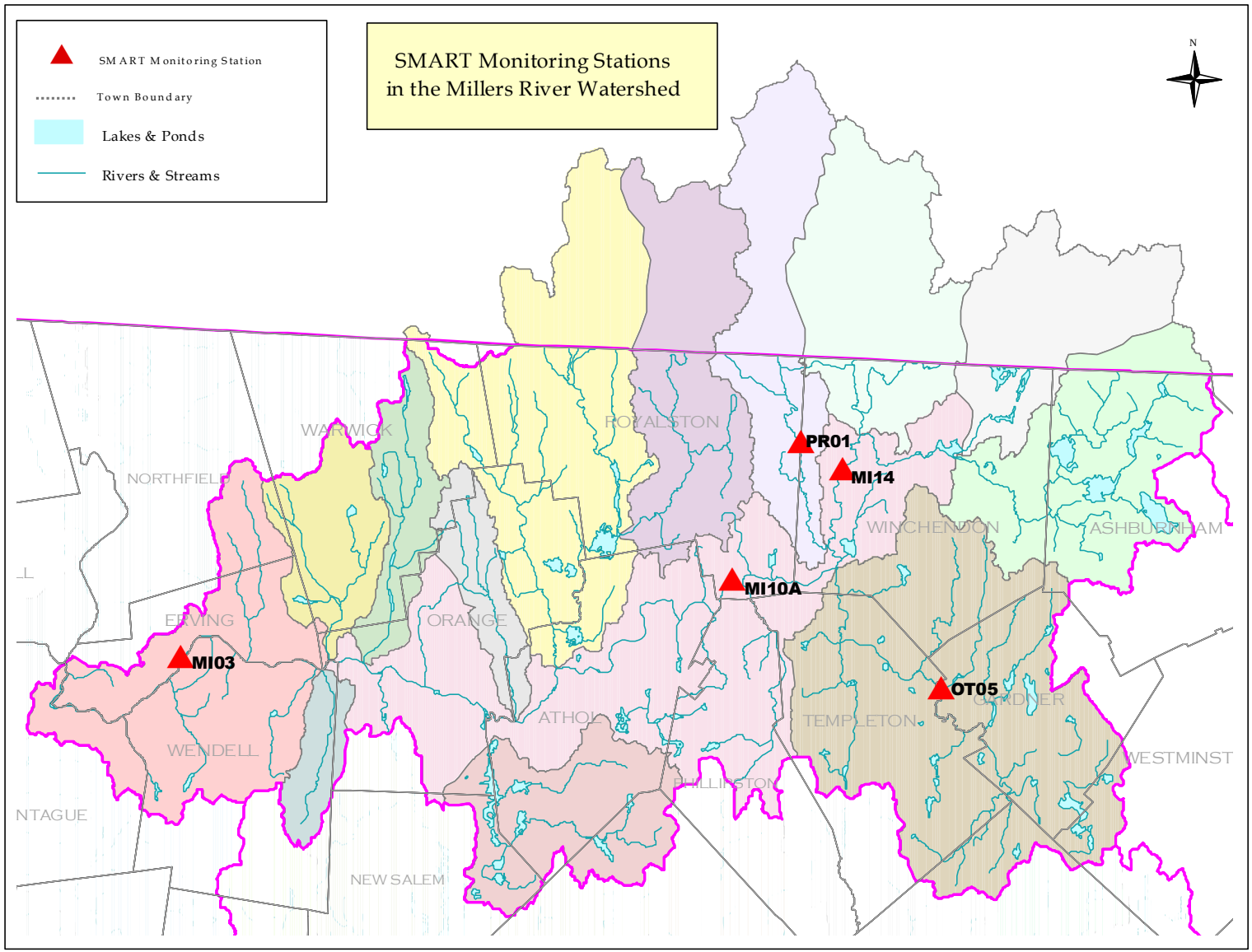
Table 1 Millers Basin SMART Sampling Summary – 2011 - 2013

Location and Segment Numbers	Station Name	Station Type	Dates Sampled[1]
Millers River @ Sibley Road, Winchendon MA35-02	MI14	Impact	2011: 1/25/11, 3/29/11, 5/16/11, 7/19/11, 9/20/11, 11/15/11 2012: 2/21/12, 4/10/12, 6/19/12, 8/21/12, 10/23/12 2013: 1/29/13, 3/25/13 [1]The SMART Monitoring program began in the Millers basin in March 2000 and ended in March 2013.
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 and New Hampshire, encompassing part or all of 17 municipalities. Of the 389 square miles (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 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

Figure 1 MassDEP SMART Millers River Watershed Water Quality Station Locations



the watershed, with small areas in Ashburnham and Wendell receiving more (48 to 50 in), and in Orange/Athol receiving less (44 to 46 inch) (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,* which can be found online at Millers WQAR 2000 *(*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 2011-2013. 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 Table 2 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.

[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.

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 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).

The SMART monitoring program was terminated in 2013, and the Millers watershed was only sampled twice that year.

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 2011-2013, the station was sampled 12 times, and the river was accessed from the eastern shore upstream of the former Sibley Road Bridge, by wading in or using a sampling pole. On 2 sampling events, the station was not sampled due to time constraints (1/25/2011) and lack of access due to snow and ice shelves that extended over the channel (1/29/2013). 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 2014, 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). 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 mostly sand. Other aquatic macrophytes observed at Station MI14 included members of the Gramineae family (grasses), *Pontedaria cordata* (pickerelweed*),* two species of *Potamogeton* (pondweed), *Scirpus* sp.(sedge), an unidentified submergent 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 (36% of events), a dense brown algal film on plants was observed on 8/21/2012, at a time when the water level was much lower than typical for this station and this time of year. Minnows and mussels were noted in this river stretch. Dense populations of mosquitoes were common after rain events.

Approximately 73% of observations indicated a clear water column; turbidity was unobservable on the other events due to turbulence and solar reflection. Water color was always red/deep red. The station was characterized by a lack of water odors. Very sparse to sparse foam was noted on 64% of the sampling events. Sheens were also absent; a sparse cover of pollen was observed on 5/16/2011. Trash was typically absent, although (1) tire was observed on 3 consecutive events (Feb through June 2012).

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 2011-2013, the station was sampled 13 times and the stream was accessed from shore near the United States Geological Survey (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 impacted by anthropogenic activities.

The land use surrounding this area is primarily forested 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 in the Priest Brook watershed or water supply withdrawals. 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/very dense moss covering all visible submerged rock surfaces. Aquatic macrophytes noted at this station included *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. On March 25, 2013 numerous snow slides made by North American river otter (*Lontra canadensis)*. Mosquitoes and black flies were seasonally abundant.

The water column was clear on most dates sampled in this time period, of a red/deep red color and a lack of odors and sheens. The presence of foam was common (69%), although usually very sparse/sparse. When the bottom was visible (often obscured by moss), trash was absent.

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 2011-2013, the station was sampled 13 times, and the river was accessed from the northern shore upstream of the Bridge Street Bridge and the USGS flow gaging station. Samples were collected by wading in or with a sampling pole. Station OT05 is an impact station as it is located downstream of numerous 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 dense in coverage; moss was the most commonly observed. Green filamentous algae was also frequently noted, as well as a green algal film on rocks. Aquatic macrophytes were present only along the periphery of the stream channel, and included sparse grasses (Gramineae family) and *Scirpus* sp. (sedges). Several geese (*Branta canadensis*) and unidentified species of duck were observed downstream. Dense populations of mosquitoes are common after rain events.

The water column at this station ranged from clear to moderately turbid, but was typically clear to slightly turbid. The water color was usually red and/or brown. The water column lacked odor in approximately half of the sampling events; effluent and musty odors were noted infrequently. Sparse foam was present on all but one event, and sheens were entirely absent. Minor quantities of trash were observed on most events (bricks, whiffle ball).

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 2011-2013, the station was sampled 11 times, and the river was accessed from the northern shore at the USGS gaging station on Blossom Street, downstream of the King Street Bridge. Samples were collected by wading in or with a sampling pole. On Jan. 25, 2011and Jan. 29, 2013, the river in this area was inaccessible due to bank-to-bank ice cover. Station MI10A serves as an impact station as it is located downstream of numerous 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. A small number of water withdrawals are located in the area, serving a few people.

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. Observations of the water column and bottom were limited by solar reflection and turbulence on half of the monitoring events conducted from 2011 through 2013. When visible, the bottom consisted mainly of boulder, with cobble, gravel and sand present (when visible). Aquatic macrophyte growth was sparse, and plants noted here included members of the Gramineae family (grasses), *Ludwigia* sp. (water primrose), *Proserpinaca* sp. (mermaidweed), *Rorippa* sp. (water cress), *Scirpus* sp. (sedge), and *Wolffia* sp. (water meal). Periphytic growth was only visible on five events, when coverage ranged from none (once) to very dense (twice), and consisted of filamentous algae; moss and algal film. Aquatic-related wildlife noted in this reach included *Castor canadensis* (beaver*)* and *Ardea herodias* (great blue heron). Dense populations of mosquitoes are common after rain events. Adult caddisflies and black flies were seasonally abundant.

The water column noted at this station was usually clear to slightly turbid; reddish in color; and lacking in odor. A moderate density of foam was also typical; sheens were not observed. Trash (a few bricks) was noted on a single event.

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 2011-2013, the station was sampled 13 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., where the Millers River watershed enters the Connecticut River watershed.

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). The closest of these that directly impacts water quality at this station is the Erving WWTP, located approximately 3.3 miles upstream. Although the Farley POTW discharges to the river just upstream of the Farley Bridge (and the sampling station), the current carries the flow downstream, preventing the discharge from mixing across the river channel at the point where monitoring is conducted. 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 members of the Gramineae family (grasses), *Lobelia cardinalis* (cardinal flower), *Ludwigia* sp. (water primrose), *Pontedaria cordata* (pickerelweed), a native species of *Potamogeton* sp. (pondweed) and *Scirpus* sp. (sedges). Periphytic growth was absent on half of the monitoring events conducted during this period but, when observed, was sparse and included moss, an algal film, and dark green filamentous algae. Evidence of beaver activity (*Castor canadensis)* was noted in this area. Exuviae of stoneflies and caddisfly cases were observed on the downstream side of rocks. 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; trash found at this station (on the banks and in the stream channel) was largely related to fishing (line, artificial bait, bait containers).

The water column was typically clear, red, and free of sheens. Foam, generally very sparse or sparse, was noted in this area on most sampling events. Trash was observed on only two events, in a minor quantity, and included fishing –related items and a few beer cans.

Table 2 Summary of Observations at Station MI14, Millers River, Winchendon 2011-2013

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
1/25/2011	Station not sampled on this date; time constraint								
3/29/2011	Unobservable	Unobservable	Unobservable	Red	None	None	None	Unobservable	Dry
5/16/2011	Unobservable	Unobservable	Unobservable	Deep red	None	Sparse	Sparse: pollen	Unobservable	Wet
7/19/2011	Boulder/gravel/sand; embedded	None	None	Red	None	None	None	Clear	Dry
9/20/2011	Sand	None	None	Deep red	None	Sparse	None	Clear	Dry
11/15/2011	Unobservable	Unobservable	Unobservable	Deep red	None	Sparse	None	Unobservable	Dry
2/21/2012	Gravel/sand; highly embedded	(1) highly embedded tire	None	Red	None	Very sparse	None	Clear	Dry
4/10/2012	Boulder/sand/silt	(1) tire	None	Red	None	None	None	Clear	Dry
6/19/2012	Sand	Minor: (1) tire	None	Red	None	Very sparse	None	Clear	Dry
8/21/2012	Cobble/gravel/sand/silt	None	Dense: brown film	Deep red	None	None	None	Clear	Dry
10/23/2012	Unobservable	Unobservable	Unobservable	Red	None	Very sparse	None	Clear	Dry
1/29/2013	Station not sampled on this date; not accessible due to snow/ice								
3/25/2013	Sand	None	None	Red	None	Very sparse	None	Clear	Wet
-- : Data not available									

Table 3 Summary of Observations at Station PR01, Priest Brook, Royalston 2011-2013

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
1/25/2011	Unobservable	Unobservable	Unobservable	Red	None	None	None	Clear	Wet
3/29/2011	Gravel/sand	None	Very dense: moss	Slight red	None	Sparse	None	Clear	Dry
5/16/2011	Unobservable	None	Dense, light green filamentous	Red	None	Sparse/ moderate	None	Clear	Wet
7/19/2011	Unobservable; covered by moss	None	Very dense: moss	Red	Musty, slight	None	None	Clear	Dry
9/20/2011	Unobservable; obscured by moss	None	Sparse: brown film on plants; very dense: moss	Deep red	None	Very sparse	None	Clear	Dry
11/15/2011	Unobservable; obscured by moss	None	Dense: moss	Deep red	Musty, slight	Moderate	None	Unobservable	Dry
2/21/2012	Unobservable; mostly obscured by moss	None	Very dense: moss	Red	None	Very sparse	None	Clear	Dry
4/10/2012	Unobservable; obscured by moss	None	Dense: moss	Red	None	None	None	Clear	Dry
6/19/2012	Boulder/cobble/gravel/sand	None	Very dense: moss	Red	None	Sparse	None	Clear	Dry
8/21/2012	Unobservable (covered in moss)	Unobservable; bottom covered in moss	Very dense: moss	Deep red	None	Very sparse	None	Moderate	Dry
10/23/2012	Unobservable	Unobservable	Unobservable; moss, where visible	Red	Musty, slight	Sparse	None	Clear	Dry
1/29/2013	Unobservable	Unobservable	Unobservable	Red	None	None	None	Clear	Wet
3/25/2013	Boulder/gravel/sand/silt	None	Dense: moss	Red	None	Sparse	None	Clear	Wet (snowmelt)

-- : Data not available

Table 4 Summary of Observations at Station OT05, Otter River, Gardner/Templeton 2011-2013

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
1/25/2011	Unobservable	Unobservable	None	Red	Strong effluent	None	None	Clear	Wet
3/29/2011	Cobble/gravel	Minor: few bricks	Sparse: bright green filamentous	Clear	None	Sparse	None	Clear	Dry
5/16/2011	Unobservable	Unobservable	Unobservable	Brown/red	None	Sparse	None	Unobservable	Wet
7/19/2011	Boulder/cobble/gravel/sand	None	Dense: moss	Brown/red	Strong musty	Sparse	None	Moderate	Dry
9/20/2011	Cobble/gravel/sand	Few bricks	Dense: moss	Deep red	None	Sparse	None	Clear	Dry
11/8/2011	Unobservable	Unobservable	Unobservable	Red	Musty, slight	Sparse	None	Unobservable	Wet
2/21/2012	Boulder/cobble/gravel; embedded	Minor: bricks	Very dense: brown film; sparse moss	Red	Effluent	Sparse	None	Slight	Dry
4/10/2012	Boulder/cobble/gravel/sand	None	Very dense: bright green filamentous; moderate moss	Red, slight	None	Sparse	None	Slight	Dry
6/19/2012	Boulder/cobble/gravel/sand	Minor: bricks, whiffle ball	Dense: moss	Rusty, deep	None	Sparse	None	Clear	Dry
8/21/2012	Boulder/cobble/gravel/sand	Minor: trash	Moderate: green filamentous; very dense green film; sparse moss	Red	Musty	Sparse, natural	None	Moderate	Dry
10/23/2012	Boulder/cobble/gravel/sand	Minor: few bricks	Very dense: green filamentous; moderate moss	Red	Effluent, strong	Sparse	None	Clear	Dry
1/29/2013	Unobservable	Unobservable	Unobservable	Red	None	Sparse	None	Unobservable	Wet
3/25/2013	Boulder/cobble/gravel/sand	None	Moderate: film; sparse moss	Red	None	Sparse	None	Clear	Wet
-- : Data not available									

Table 5 Summary of Observations at Station MI10A, Millers River, Royalston 2011-2013

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
1/25/2011	Station not sampled on this date; not accessible due to snow/ice								
3/29/2011	Unobservable	Unobservable	Unobservable	Slight red	None	Moderate	None	Clear	Dry
5/16/2011	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Clear	Wet
7/19/2011	Boulder/cobble/gravel/sand	None	None	Red	Musty	Moderate	None	Slight	Dry
9/20/2011	Unobservable	Unobservable	Unobservable	Deep red	None	Moderate	None	Clear	Dry
11/15/2011	Unobservable	Unobservable	Unobservable	Red	Musty, slight	Moderate	None	Unobservable	Dry
2/21/2012	Boulder/cobble/gravel	None	Sparse: green filamentous; Dense: brown film; Sparse: bright green loose floc; sparse: moss	Red	None	Moderate	None	Clear	Dry
4/10/2012	Unobservable	Unobservable	Very dense: olive green filamentous	Red, slight	None	Moderate - less than typical	None	Clear	Dry
6/19/2012	Boulder/cobble/gravel/sand	None	Sparse: moss	Rusty, deep	None	Moderate	None	Slight	Dry
8/21/2012	Boulder/cobble/gravel/sand/silt	Minor: bricks	Very dense: film, covered in silt	Red	Eutrophic pond	Dense	None	Slight	Dry
10/23/2012	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Unobservable	Dry
1/29/2013	Station not sampled on this date; not accessible due to snow/ice								
3/25/2013	Boulder/cobble/sand/mud	None	None	Red	None	Moderate	None	Clear	Dry
-- : Data not available									

Table 6 Summary of Observations at Station MI03, Millers River, Erving/Wendell 2011-2013

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
1/25/2011	Unobservable	Unobservable	Unobservable	Red	Slight musty	None	None	Unobservable	Wet
3/29/2011	Unobservable	None	Moderate: moss	Clear	None	Sparse	None	Clear	Dry
5/16/2011	Boulder/cobble/gravel/sand	None	Sparse: dark green filamentous	Red	None	Sparse	None	Clear	Wet
7/19/2011	Boulder/cobble/gravel/sand	Minor: few beer cans	None	Clear	Strong musty	Sparse	None	Clear	Dry
9/20/2011	Boulder/cobble/gravel/sand	None	None	Deep red	None	None	None	Clear	Dry
11/15/2011	Bolder/cobble/gravel/sand/silt	None	None	Red	None	Sparse	None	Clear	Dry
2/21/2012	Boulder/cobble/gravel/sand	None	None	Red	Effluent, slight	Sparse	None	Clear	Dry
4/10/2012	Boulder/cobble/gravel/sand/silt	None	None	Red, slight	Musty, strong	None	None	Clear	Dry
6/19/2012	Boulder/cobble/gravel/sand/silt	Minor: fishing line, bait containers	None	Red	Eutrophic pond, strong	Sparse, northwest side of channel	None	Clear	Dry
8/21/2012	Boulder/cobble/gravel/sand/silt	None	None	Red	Eutrophic pond, slight	Very sparse	None	Clear	Dry
10/23/2012	Unobservable	None	Sparse: clear film	Red	None	Sparse, natural	None	Clear	Dry
1/29/2013	Unobservable	Unobservable	Unobservable	Red	None	Unobservable	Unobservable	Clear	Wet
3/25/2013	Unobservable	Unobservable	Sparse: moss	Red	None	None	None	Clear	Dry
-- : 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 2015).

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 sampling. When these were inconclusive, additional data were used to determine if conditions reflected wet weather/runoff or dry weather, including air temperature, snowfall and snow on the ground, specific conductivity, turbidity, *E. coli* et cetera. Air temperature at each station is expressed in degrees Fahrenheit (°F).

January 25, 2011 – This winter monitoring event was preceded by a 5-day period in which 0.42 in. of precipitation (6.9 in. as snow) was recorded at the National Weather Station gage in Ashburnham, with an additional 0.7 in. of snow on Jan. 25 that largely fell prior to monitoring activities. Discharge at the Millers River and Priest Brook gages in Winchendon and the Otter River in Gardner/Templeton show little overall variation in discharge from Jan. 19 through Jan. 25. The Millers River gages in South Royalston and Erving were impacted by ice and no data are available for this time period. The maximum daily temperature at the Ashburnham weather station ranged from 9 to 27°C from Jan. 21-25. Although ambient conditions were not conductive to snow melt, the precipitation within the 24-hour period up to and including monitoring activities indicates that samples collected during this event reflect wet weather conditions. Air temperature during the sampling event ranged from 9 to 25 ºF under overcast skies with occasional snow flurries. A blanket of snow at least 18 in. thick covered the ground throughout the watershed. Station MI14 on the Millers River in Winchendon was not sampled due to time constraints. Station MI10A on the Millers River in Royalston was not sampled on this date; the river was covered in ice and snow from bank to bank.

March 29, 2011 – Only trace precipitation was recorded at Ashburnham in the five days preceding this early spring

event. Discharge at area flow gages decreased more or less steadily during this period. The National Climatic Data Center records show that the maximum daily temperature at Ashburnham for March 24-29 ranged from 32 to 40°F; snow on the ground decreased from 1 in. to trace from March 25-26, with traces only remaining from March 27-29. Air temperature during monitoring activities ranged from 33 to 55ºF; clear skies became partly to mostly cloudy by 11 am. Buds had not yet formed on watershed trees and shrubs. Caddisfly adults were observed at the Millers River in Royalston.

May 16, 2011 – Nearly two inches of precipitation fell on the watershed in the 24 hours preceding this spring monitoring event. Discharge at all Millers watershed gages increased from mid-day, May 15 through monitoring activities on May 16. Data reflect wet weather/runoff conditions. Air temperature ranged from 50 to 55ºF under overcast skies; sprinkles were noted at the Otter River in Gardner. Foliage was completely developed on area trees and shrubs. Swarms of blackflies were observed just above the water level on the Millers River and Priest Brook in Royalston.

July 19, 2011 – A storm on July 14 brought 0.23 in. of rain to Ashburnham, followed by a four-day dry period. Light rain fell overnight before the commencement of monitoring activities (0.02 in.). In general, discharge at area gages decreased from July 12 through 19, with a small rise on July 14th noted at the Millers River in Royalston and Otter River gages. Data collected during this event reflect dry weather conditions. Air temperature ranged from 74 to 82ºF under clear skies.

September 20, 2011 – Little precipitation was recorded in the area in the five days preceding this late summer monitoring event (0.11 in. on 9/16/2011); although light rain was reported at the Orange (0.20 in.) and Fitchburg (0.06 in.) airports on the morning of Sept. 20, none was observed at the Ashburnham weather station. Discharge decreased steadily at all area gages from Sept. 15-20. As the precipitation observed did not result in a rise in discharge, data collected on this date represent dry weather conditions. Air temperature ranged from 57 to 59ºF under overcast skies with intermittent rain. Foliage had just begun to change along the stream corridors.

November 15, 2011 – A storm brought over an inch of precipitation to the area on Nov. 11. Discharge at area gages reflected rainfall, and were at or near pre-storm flows by the commencement of monitoring at the gages on Priest Brook and the Otter River; flows at the Millers River gages in Royalston and Erving had not yet fallen to pre-storm levels. Specific conductivity was relative low throughout the watershed, ranging from 36 µS/cm at Priest Brook to198 µS/cm at the Otter River. Visual turbidity was unobservable at most stations due to solar reflection, which prevented a clear view of the water column. In general, *E. coli* levels were low at all stations with the exception of the Otter River. There, the mean of the (3) *E. coli* samples was 342.7 cfu, which exceeds the median value of all *E. coli* samples collected from July 2007 through October 2010 (75.5 cfu), as well as the median of samples collected only under wet weather conditions during this period (199 cfu) as well as dry weather(44 cfu). At all other stations, *E. coli* values were below the median values for all samples, only dry weather samples, and only wet weather samples. Data collected at Station OT05 reflect wet weather/runoff conditions, while data from all other stations reflect dry weather conditions. Air temperature ranged from 58 to 60°F; intermittent to steady rain ended by 11 am. Deciduous foliage was mostly down throughout the watershed.

February 21, 2012 – In the five days before this winter event, little precipitation was recorded at Ashburnham (0.05 in.), and there was little snow on the ground throughout the watershed. Discharge at area gages varied little from Feb. 14-21. Data reflect dry weather conditions. Air temperature ranged from 28 to 39ºF; under mostly cloudy skies.

April 10, 2006 – This spring monitoring event followed a relatively dry period in the Millers watershed. Discharge at area gages changed little from April 3-10 with the exception of repeated, rapid fluctuations at the gage on the Millers River in Winchendon (likely to indicate artificial manipulation). Data collected during this event reflect dry weather conditions. Air temperature ranged from 49 to 55ºF under overcast skies. Trees and shrubs were beginning to bud.

June 19, 2012 – Late spring monitoring also followed a relatively dry period, with no precipitation in the area from June15-19; discharge at area gages decreased steadily in this period. Data reflect dry weather conditions. Air temperature ranged from 65 to 69ºF under cloudy skies. Foliage was completely developed on deciduous trees and shrubs.

August 21, 2012 – This summer sampling event followed several small storms on 8/16 and 8/18; discharge at area gages generally rose concurrently, decreasing to flows below pre-storm levels. Data reflect dry weather conditions. Air temperature ranged from 66 to 77ºF; mostly sunny skies cleared by late morning.

October 23, 2012 – Fall 2012 sampling followed a storm that brought nearly an inch of precipitation to the area on Oct. 19-20. Although the discharge pattern varied at area gages, with some stations indicating non-natural fluctuations, flows generally increased with the rain input, then decreased to levels at or below pre-storm flows by the sampling date. The water column was free of turbidity at most stations (unobservable at the Otter River due to solar reflection). Data reflect dry weather conditions. Air temperature ranged from 45 to 60ºF under skies that became overcast by late morning. Most of the foliage in the watershed had changed color and fallen.

January 29, 2013 – An overnight storm brought approximately 0.2 in. of precipitation (as 2 in. snow) to the area just before this winter monitoring event (as measured at Ashburnham); snowfall on the ground increased from 4 to 6 in. Ice and snow covered the channel at all sampling stations, preventing access completely at the Millers River in Winchendon and Royalston. Maximum daily air temperature for January 24-29 ranged from 10 to 24°F. Discharge at area gages lacked a consistent pattern (not available for the gage at the Millers River at Winchendon). Flows rose slightly from Jan. 28-29 at Priest Brook and Otter River, but decreased at the Millers River at Royalston and Erving, which may be associated with flood control measures at the Birch Hill Dam, Royalston. Based on precipitation, snowfall and snow on the ground, as well as discharge at the two gages with the least human manipulation, data reflect wet weather (without runoff) conditions. Air temperature ranged from -2 to 0ºC under cloudy skies.

March 25, 2013 – This early spring event followed a storm that brought 1.32 in. precipitation to the area on March 19-20 (11.8 in. as snow). Snowfall on the ground decreased from 21 on March 20 to 16 in. on March 25, while maximum daily temperature at Ashburnham rose from 30°F on March 20, indicating snowmelt. During the same period, discharge at Priest Brook rose sharply with daylight then decreased in its absence. Flows at the Otter River gage generally decreased from March 19-24, then rose through the morning of March 25. On the Millers River in Royalston and Erving, discharge decreased relatively steadily from March 18 through the morning of March 25. Field observations record approximately 6 inches of snow remained on the ground at the Otter River, Priest Brook, and the Millers River in Winchendon; at the Millers River in Royalston and Erving, most of the snow had melted, with bare patches visible in these areas. The water column was clear at all stations (based on visual observations). Based on snow on the ground, precipitation and field observations, data and observations collected on this date reflect dry weather conditions at the Millers River stations in Royalston and Erving, and wet/runoff conditions at the Millers River in Winchendon, the Otter River in Gardner/Templeton and Priest Brook. Air temperature ranged from 39 to 42ºF under cloudy skies. Trees were not yet in bud.

Table 7 Millers Basin Precipitation Data Summary 2011-2013

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1Day Prior	Sample Date	Wet/Dry Conditions**
1/25/2011	0.03	0.24	0.12	0	0	0.03	Wet
3/29/2011	0	T	0	0	0	0	Dry
5/16/2011	0.03	0	0	0	0.17	1.75	Wet
7/19/2011	0.23	0	0	0	0	0.02	Dry
9/20/2011	0	0.11	0	0	0	0	Dry
11/15/2011	0	1.20	0.01	0	0	0.01	Dry; Wet at OT05 only
2/21/2012	0	0.05	0	T	0	0	Dry
4/10/2012	0.09	0	0	0	0	0	Dry
6/19/2012	0.23	0	0	0	0	0	Dry
8/21/2012	0.17	0	0.12	0	0	0	Dry
10/23/2012	0	0.07	0.87	0	0	0	Dry
1/29/2013	0	0	0.01	0	0	0.20	Wet
3/25/2013	0.64	0	0	0	0	0	Dry MI10A, MI03; Wet MI14, OT05, PR01

*Unofficial data from the NWS station at Ashburnham, MA available at NWS Ashburnham, MA, as inches of water

** Based on precipitation, streamflow and other relevant data.

T= trace amount; an amount too small to measure

Table 8 Flow at the Millers River at Erving, MA

Survey Dates	5 Days Prior*	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Sample Date	Monthly Mean**	POR** Mean
1/25/2011	425 e	415 e	405 e	400 e	390 e	415 e	411.2	706
3/29/2011	2,980	2,030	1,540	1,280	1,140	1,240	2,542	1,560
5/16/2011	533	499	434	382	445	899	788.2	814
7/19/2011	165	157	151	143	148	138	219.8	250
9/20/2011	901	751	637	555	489	437	1,411	329
11/15/2011	1,350	1,680	1,710	1,620	1,600	1,440	1,355	554
2/21/2012	450	463	474	464	447	427	611.6	606
4/10/2012	250	232	203	194	191	189	381.4	1,760
6/19/2012	727	727	630	482	398	357	579.5	509
8/21/2012	202	178	153	137	126	106	100.1	217
10/23/2012	293	311	437	485	400	322	316.7	433
1/29/2013	262 eP	258 eP	249 eP	299 P	457 P	480 P	421.8	741
3/25/2013	1,020 P	944 P	876 P	783 P	744 P	712 P	948.8	1,390

*Gage # 01112500 data found at USGS 01166500 MILLERS RIVER AT ERVING, MA Daily Data; all data for 2011 and 2012 approved for publication, processing and review complete.

**Monthly mean discharge based on 97-98 year record (10/1/1915 – 11/30/2012) found at Surface-Water Monthly Statistics for Massachusetts USGS 01166500 MILLERS RIVER AT ERVING, MA

**POR*-Period of Record based on 97-98 years of 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

P=Provisional data subject to revision

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 2011 through 2013 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 2011-2013 data include, but are not limited to: conformance to the SMART Monitoring Quality Assurance Project Plan (MassDEP 2010) 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 2011-2013. 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)	(%)
1/25/2011	SM-3453	12:35 PM	**	**	**	**	**	**	**
3/29/2011	SM-3525	11:40 AM	1.1	2.5	5.9	90	59	13.6	100
5/16/2011	SM-3597	11:51 AM	1.0	13.6	6.1	100	65	9.6	93
7/19/2011	SM-3669	11:58 AM	0.3	23.5	6.3	145	94	7.3	86
9/20/2011	SM-3741	11:49 AM	0.5	14.8	6.3	94	61	9.1	90
11/15/2011	SM-3813	12:19 PM	1.3	8.6	6.1	67	44	11.4	98
2/21/2012	SM-3885	11:49 AM	0.7	2.0	6.3	85	55	13.1	95
4/10/2012	SM-3957	11:49 AM	##i	7.7	6.4	104	67	12.0	100
6/19/2012	SM-4029	12:30 PM	##i	19.8	6.3	88	57	8.1	89
8/21/2012	SM-4101	12:26 PM	##i	21.1	6.4	149	97	7.8	88
10/23/2012	SM-4173	11:56 AM	##i	10.3	6.1	99	65	10.2	91
1/29/2013	SM-4243	**	**	**	**	**	**	**	**
3/25/2013	SM-4315	11:55 AM	##i	2.5	6.3	105	68	13.5	99

Table 10 MassDEP SMART 2011-2013. 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)	(%)
1/25/2011	SM-3453	12:35 PM	0.3	0.0	5.3	57	37	11.2	77
3/29/2011	SM-3525	11:40 AM	0.4	2.1	5.0	47	30	12.5	90
5/16/2011	SM-3597	11:51 AM	0.3	12.8	5.1	41	27	7.9	74
7/19/2011	SM-3669	11:58 AM	0.3	23.4	5.5	52	34	4.9	58
9/20/2011	SM-3741	11:49 AM	0.3	13.1	5.6	42	27	7.6	73
11/15/2011	SM-3813	12:19 PM	0.3	8.3	5.5	36u	23u	10.1	86
2/21/2012	SM-3882	11:20 AM	0.4	0.6	5.8	45	30	12.5	87
4/10/2012	SM-3954	11:21 AM	##i	7.1	5.9	43	28	11.2	92
6/19/2012	SM-4026	11:57 AM	##i	18.7	5.7	42	27	6.9	74
8/21/2012	SM-4098	11:42 AM	##i	20.5	5.8	48	31	5.7	64
10/23/2012	SM-4170	11:27 AM	##i	9.4	5.3	63	41	9.0	79
1/29/2013	SM-4242	12:00 PM	0.0i	0.0	5.6	66	43	10.8	74
3/25/2013	SM-4314	11:27 AM	0.0i	0.4	5.6	52	33	12.5	86

Table 11 MassDEP SMART 2011-2013. 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)	(%)
1/25/2011	SM-3453	12:35 PM	0.1	0.0	6.3	417	271	12.5	85
3/29/2011	SM-3525	11:40 AM	0.1	2.9	6.4	284	184	13.1	97
5/16/2011	SM-3597	11:51 AM	0.2	13.2	6.2	274	178	9.0	86
7/19/2011	SM-3669	11:58 AM	0.1	23.3	7.1	462	300	7.8	92
9/20/2011	SM-3741	11:49 AM	0.0i	14.6	6.7	297	193	9.0	89
11/15/2011	SM-3813	12:19 PM	0.0i	9.4	6.5	198	129	10.7	93
2/21/2012	SM-3878	10:10 AM	0.2	1.7	6.6	283	184	12.9	93
4/10/2012	SM-3950	10:14 AM	##i	8.2	7.0	331	215	11.9	102
6/19/2012	SM-4022	10:45 AM	##i	18.8	6.7	287	187	7.9	85
8/21/2012	SM-4094	10:21 AM	##i	20.7	6.6	327	213	7.5	83
10/23/2012	SM-4166	10:20 AM	##i	11.0	6.5	278	181	9.5	86
1/29/2013	SM-4238	10:42 AM	0.0i	0.0	6.5	405	263	12.5	86
3/25/2013	SM-4310	10:09 AM	0.0i	2.3	6.5	349	227	12.8	93

Table 12 MassDEP SMART 2011-2013. 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)	(%)
1/25/2011	SM-3453	12:35 PM	**	**	**	**	**	**	**
3/29/2011	SM-3525	11:40 AM	0.7	2.9	5.9	138u	90u	13.3	98
5/16/2011	SM-3597	11:51 AM	0.5	13.6	6.3	153	99	9.4	91
7/19/2011	SM-3669	11:58 AM	0.2	25.1	7.0	236	154	7.8	95
9/20/2011	SM-3741	11:49 AM	0.4	14.8	6.5	151	98	9.2	91
11/15/2011	SM-3813	12:19 PM	0.7	8.3	6.2	104u	67u	11.3	96
2/21/2012	SM-3880	10:44 AM	0.4	1.6	6.6	139u	90u	13.3	95
4/10/2012	SM-3952	10:48 AM	##i	8.5	6.7	151	98	11.8	101
6/19/2012	SM-4024	11:24 AM	##i	20.0	6.6	139	90	8.0	88
8/21/2012	SM-4096	11:03 AM	##i	21.8	6.9	220	143	8.1	93
10/23/2012	SM-4168	10:57 AM	##i	10.9	6.5	159	103	10.3	93
1/29/2013	SM-4240	11:20 AM	**	**	**	**	**	**	**
3/25/2013	SM-4312	10:55 AM	##i	2.6	6.4	169	110	13.1	96

Table 13 MassDEP SMART 2011-2013. 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)	(%)
1/25/2011	SM-3453	12:35 PM	0.4	0.0	6.0	187	122	15.0	103
3/29/2011	SM-3525	11:40 AM	0.6	3.1	6.2	115	75	13.4	100
5/16/2011	SM-3597	11:51 AM	0.2	13.9	6.3	75	49	10.1	98
7/19/2011	SM-3669	11:58 AM	0.2	23.7	7.5	190	123	8.8	104
9/20/2011	SM-3741	11:49 AM	0.2	14.2	6.9	128	83	10.2	99
11/15/2011	SM-3813	12:19 PM	0.5	8.1	6.6	88	57	12.2	103
2/21/2012	SM-3875	9:05 AM	0.2	0.6	6.8	121	79	14.3	99
4/10/2012	SM-3947	9:05 AM	##i	8.0	7.0	150	98	12.4	105
6/19/2012	SM-4019	9:25 AM	##i	19.2	7.1	122	80	8.9	96
8/21/2012	SM-4091	9:17 AM	##i	21.6	7.4	211	137	8.7	99
10/23/2012	SM-4163	9:08 AM	0.3	10.5	6.8	139	90	11.0	99
1/29/2013	SM-4240	11:20 AM	**	**	**	**	**	**	**
3/25/2013	SM-4312	10:55 AM	##i	2.6	6.4	169	110	13.1	96

Table 14 MassDEP SMART 2011-2013. 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)
1/25/2011	SM-3451	**	**	**	**	**	**	**	**	**	**	**
3/29/2011	SM-3523	11:33	2	9.1	18	8	1.4	0.8	0.34	0.08	0.08	0.011
5/16/2011	SM-3595	11:42	4	11	20	240	5.5	2.2	0.44	0.06	0.04	0.027
7/19/2011	SM-3667	11:51	11	18	26	161	1.3	2.4	0.83	0.05	0.46	0.027
9/20/2011	SM-3739	11:45	5	12	19	47	1.9	1.8	0.56	0.02	0.15	0.021
11/15/2011	SM-3811	12:16	3	7.9	11	5	<1.0d	1.1	0.34	<0.02	0.05	0.013
2/21/2012	SM-3883	11:41	4	9.6	16	4	1.1	0.9	0.39	0.05	0.15	0.010
4/10/2012	SM-3955	11:41	5	13	20	22	1.5	##h	0.46	0.13	0.13	0.011
6/19/2012	SM-4027	12:20	4	12	17	58	3.2	2.3	0.51	0.04	0.14	0.021
8/21/2012	SM-4099	12:09	9	17	30	152	##h	1.9	1.0	0.03	0.64	0.034
10/23/2012	SM-4171	11:51	3	11	20	50	2.8	1.7	0.54	<0.02	0.14	0.024
1/29/2013	SM-4243	**	**	**	**	**	**	**	**	**	**	**
3/25/2013	SM-4315	11:55	5	10	20	13	<1.0	0.9	0.39	0.08	0.11	0.009

Table 15 MassDEP SMART 2011-2013. 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)
1/25/2011	SM-3449	12:15	2	8.8	8	2	<1.0	0.6	0.30	0.03	0.03	0.008
3/29/2011	SM-3521	11:03	<2	6.1	8	<1	<1.0	0.4	0.16a	<0.02	<0.02	0.007
5/16/2011	SM-3593	11:12	2	5.7	6	231	4.1	2.4	0.38	<0.02	<0.02	0.023
7/19/2011	SM-3665	11:20	4	7.6	7	38	4.1	2.1	0.71	<0.02	<0.02	0.050
9/20/2011	SM-3737	11:13	4	6.4	7	29	<1.0	1.0	0.41	<0.02	<0.02	0.017
11/15/2011	SM-3809	11:43	<2	5.4	5	5	<1.0d	0.5	0.20a	<0.02	<0.02	0.007
2/21/2012	SM-3881	11:10	3	6.6	8	1	1.3	0.8	0.23	<0.02	0.03	0.010
4/10/2012	SM-3953	11:12	<2	5.8	7	2	1.2	##h	0.27	<0.02	<0.02	0.014
6/19/2012	SM-4025	11:51	2	6.9	7	26	3.1	1.4	0.46	<0.02	<0.02	0.023
8/21/2012	SM-4097	11:30	3	8.7	8	118	##h	1.9	0.57	<0.02	<0.02	0.031
10/23/2012	SM-4169	11:19	<2	9.1	12	39	1.6	0.8	0.45	<0.02	<0.02	0.013
1/29/2013	SM-4241	11:50 AM	3	9.5	10	2	<1.0	0.7	0.29	<0.02	0.03	0.008
3/25/2013	SM-4313	11:18 AM	2	6.5	7	<1	<1.0	0.5	0.20	<0.02	<0.02	0.006

Table 16 MassDEP SMART 2011-2013. 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)
1/25/2011	SM-3444	11:05	15	50	96	>2419.6	1.8d	2.6	2.8	0.43	2.1	0.046
3/29/2011	SM-3516	9:55	6	30	71	121	1.3d	1.5h	0.93	0.08	0.60	0.020
5/16/2011	SM-3588	10:05	9	0.6	66	66	0.1	5.3h	1.3	0.17	0.64	0.071
7/19/2011	SM-3660	10:10	30	76	92	96	3.3	5.7h	6.3	<0.02	5.8	0.060
9/20/2011	SM-3732	10:08	14	41	69	44	4.0	4.4h	3.0	0.03	2.1	0.058
11/15/2011	SM-3804	10:33	6d	23	40	276	1.5d	2.8h	0.97	0.03	0.62	0.035d
2/21/2012	SM-3876	10:01	9	36	60	31	1.9	2.2	2.4	0.04	2.2	0.035
4/10/2012	SM-3948	10:05	17	51	68	10	2.6	##h	4.2	<0.02	3.6	0.035
6/19/2012	SM-4020	10:35	15	40	65	77	6.3	7.0	2.8	0.05	2.2	0.069
8/21/2012	SM-4092	10:15	19	53	70	59	##h	4.5	3.4	0.05	2.6	0.070
10/23/2012	SM-4164	10:10	13	38	62	21	3.1	3.5	2.1	0.02	1.7	0.042
1/29/2013	SM-4236	10:35 AM	19	54	82	32	1.4	2.9	3.8	0.09	3.0	0.034
3/25/2013	SM-4308	10:03 AM	8	34	83	4	1.1	1.5	1.6	0.12	1.2	0.024d

Table 17 MassDEP SMART 2011-2013. 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)
1/25/2011	SM-3447	**	**	**	**	**	**	**	**	**	**	**
3/29/2011	SM-3519	10:30	3	14	31	1	<1.0	0.6h	0.39	0.04	0.16	0.012
5/16/2011	SM-3591	10:40	7	18	32	387	7.8	1.7h	0.81	0.07	0.37	0.039
7/19/2011	SM-3663	10:47	12	30	46	64	1.2	2.8h	1.4	0.04	0.90	0.039
9/20/2011	SM-3735	10:45	9	20	34	30	2.8	2.5h	0.88	0.04	0.44	0.033
11/15/2011	SM-3807	11:11	4	12	19	47	2.3d	1.3	0.44	<0.02	0.14	0.016
2/21/2012	SM-3879	10:35	6	17	28	6	<1.0	1.2	0.74	0.03	0.51	0.018
4/10/2012	SM-3951	10:40	5	18	31	6	1.8	##h	0.76	0.02	0.36	0.023
6/19/2012	SM-4023	11:10	5	17	3	122	3.3	3.0	0.72	0.06	0.06	0.023
8/21/2012	SM-4095	10:51	13	30	45	133	##h	2.5	1.3	0.04	0.71	0.046
10/23/2012	SM-4167	10:47	6	20	32	53	3.6	2.3	0.77	<0.02	0.34	0.032
1/29/2013	SM-4239	SM-4239	**	**	**	**	**	**	**	**	**	**
3/25/2013	SM-4311	SM-4311	5	17	36	55	<1.0	1.1	0.53	0.04	0.30	0.011

Table 18 MassDEP SMART 2011-2013. 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)
1/25/2011	SM-3442	9:45	8	25	38	19	1.8	1.1	0.86	0.11	0.45	0.018
3/29/2011	SM-3514	8:40	3	**	24	91	1.5	0.7h	0.36	0.03	0.14	0.012
5/16/2011	SM-3586	9:00	6	18	24	461	4.9	1.9h	0.61	0.05	0.24	0.026
7/19/2011	SM-3658	8:52	14	33	34	33	1.4	1.4h	0.71	<0.02	0.36	0.026
9/20/2011	SM-3730	8:55	7	20	25	59	1.6	1.6h	0.65	<0.02	0.28	0.024
11/15/2011	SM-3802	9:15	4	12	13	52	1.3d	1.2h	0.32	<0.02	0.10	0.017
2/21/2012	SM-3874	8:50	6	17	22	34	<1.0	1.0	0.51	0.03	0.33	0.012
4/10/2012	SM-3946	8:50	11	24	27	249	2.6	##h	0.67	0.07	0.35	0.017
6/19/2012	SM-4018	9:15	7	18	23	64	2.3	1.8	0.63	<0.02	0.28	0.027
8/21/2012	SM-4090	9:10	18	36	40	52	##h	1.2	0.85	<0.02	0.45	0.025
10/23/2012	SM-4162	8:53	8	21	26	16	2.4	1.5	0.67	<0.02	0.34	0.021
1/29/2013	SM-4234	9:10 AM	10	25	31	248	<1.0	1.1	0.84	0.03	0.54	0.015
3/25/2013	SM-4306	8:56 AM	5	16	28	93	1.5	0.9	0.44	0.04	0.24	0.011

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 11 Jan 2011.

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

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

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

Google Earth. 2011e. "MI03". 42º35'51.29"N and 72º26'15.58"W. Imagery September 7, 2010. Retrieved 11 Jan 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. 2015 [online]. *Coldwater Fish Resources List.* French and Quinebaug Watersheds. Massachusetts Department of Fish and Game, Division of Fisheries and Wildlife. Westborough, MA. Retrieved August 11, 2015. Available at http://www.mass.gov/eea/agencies/dfg/dfw/wildlife-habitat-conservation/coldwater-fish-resources-list.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. *Wildlife Management Area Maps.* Massachusetts Department of Fish and Game, Division of Fisheries and Wildlife. Westborough, MA. Retrieved January 5, 2011. Available at http://www.mass.gov/eea/docs/dfg/dfw/habitat/maps-wma/central/birch-hill-wma.pdf

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 8, 2014. Available at http://www.northquabbinwoods.org/entries/224

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 January 8, 2014. Available at http://pubs.usgs.gov/sir/2009/5227/pdf/Appendix/sir2009-5227_appendix1_fig2.pdf

USACE. 2014 [online]. *Birch Hill Dam, Royalston, MA. Flood Damage Reduction*. U. S. Army Corps of Engineers. Royalston, MA. Retrieved January 8, 2014. Available at http://www.nae.usace.army.mil/Missions/Recreation/BirchHillDam.aspx

USGS. 2015 [online]. USGS Surface-Water Monthly Statistics for Massachusetts. USGS Millers River gage at Erving, MA. (USGS station number 01166500). Monthly mean discharge values for 99 years of record in cfs (Calculation period October 1, 1915 through September 30, 2014). Retrieved December 23, 2013. Available at http://waterdata.usgs.gov/ma/nwis/monthly/?referred_module=sw&site_no=01166500&por_01166500_1=1269036,00060,1,1915-07,2014-10&format=html_table&date_format=YYYY-MM-DD&rdb_compression=file&submitted_form=parameter_selection_list

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.

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