Massachusetts Department of ENVIRONMENTAL PROTECTION

2017 DWM ENVIRONMENTAL MONITORING OVERVIEW

(CN 443.0)

A brief overview of the surface water monitoring performed in 2017 by personnel of the MassDEP's Division of Watershed Management (DWM) is presented here. Information pertaining to the individual components of DWM's Surface Water Monitoring Program is presented at http://www.mass.gov/eea/agencies/massdep/water/watersheds/water-quality-monitoring-program.html#1.

The main programmatic objectives of the DWM related to surface water quality monitoring are to:

- Collect chemical, physical and biological data to assess the degree to which designated uses, such as aquatic life, primary and secondary contact recreation, fish consumption and aesthetics, are being met in waters of the Commonwealth;
- Collect chemical, physical and biological data to support analysis and development of implementation plans to reduce pollutant loads to waters of the Commonwealth;
- Screen fish in selected waterbodies for fish tissue contaminants (metals, PCBs and organochlorine pesticides) to provide for public health risk assessment;
- To the extent feasible, locate pollution sources and promote and facilitate timely correction;
- Identify and assess new and emerging water contaminants of concern;
- Over the long term, collect water quality data to enable the determination of trends in parameter concentrations and/or loads;
- Develop new or revised standards, which may require short-term research monitoring directed towards the establishment or revision of water quality policies and standards; and to
- Measure the effectiveness of water quality management projects or programs such as the effectiveness of implementing TMDLs or watershed-based plans to control nonpoint source pollution.

Quality assurance is maintained for DWM's watershed monitoring program to ensure implementation of an effective and efficient sampling design, to meet programmatic goals and to provide data meeting specific data quality objectives. The U.S. Environmental Protection Agency (USEPA) has approved a comprehensive Quality Assurance Program Plan (QAPP) that applies to the generation and use of surface water quality data by DWM for a five-year period (2015 – 2019). This five-year *program* QAPP is annually supplemented by project-specific Sampling and Analysis Plans (SAPs), which provide detailed information regarding individual *project* organization, tasks,

background, sampling design and non-direct measurements. More information pertaining to the DWM's Quality Management Program and the 2015 – 2019 QAPP can be found on-line at http://www.mass.gov/eea/agencies/massdep/water/watersheds/environmental-monitoring-quality-management-program.html.

In accordance with the DWM's long-range monitoring strategy, the 2017 monitoring program consisted of the ongoing implementation of both probabilistic (random) and deterministic (targeted) sampling networks designed to support the multiple objectives listed above. The EPA encourages states to adopt networks of randomly selected sampling sites that will allow for statistically unbiased assessments that can be applied at larger scales (e.g., statewide). During 2011 – 2015 the DWM surface water monitoring program carried out probabilistic monitoring and assessment (MAP2) surveys of Massachusetts' shallow (i.e., "wadable") streams. In 2016 the DWM initiated a new statistically-valid (probabilistic) sampling design for Massachusetts' lakes to be carried out over three years (i.e., 2016 – 2018). With the exception of some limited targeted monitoring on specific lakes of special concern (e.g., fish toxics, TMDL development), lake monitoring and assessment had largely been absent from DWM's monitoring program for many years, so the probabilistic lake surveys are filling an existing and longstanding monitoring gap.

A number of targeted monitoring projects were also carried out to meet multiple water quality assessment and management objectives. For example, monitoring efforts continued at selected sites in DWM's reference site network (RSN) and at the five northeast climate change network sites located in Massachusetts. In addition, fish samples were collected from 31 lakes to obtain the data and information needed to inform risk assessment and management activities pertaining to fish edibility. Monitoring projects were also carried out to measure the effectiveness of TMDL implementation, to assess the impacts of chlorides on surface waters, and to support the assessment and management of harmful algae blooms (HAB). These, as well as other monitoring activities performed in 2017, are described in more detail below.

PROBABILISTIC MONITORING & ASSESSMENT PROGRAM (MAP2) – The goals of the probabilistic survey are to provide an unbiased assessment of the support status of the aquatic life, recreational, fish consumption and aesthetic uses of lakes throughout Massachusetts. The random sampling design allows for the determination, with a known statistical confidence, of the percentage of lake acres supporting and not supporting their designated uses. To implement the survey, the major river basins of Massachusetts were regionally assigned to three groups (i.e., "West", "Northeast" and "Southeast") with each group containing an approximately equal number of lakes. Each year focuses on one of the regions. The target sample size in each region and year is 25 lakes which will result in a total of 75 lakes statewide at the end of the survey. The "Northeast Group" was the focus of monitoring in 2017 (Table 1). This group includes the Blackstone, Boston Harbor (i.e., Mystic, Neponset, Weymouth & Weir), Charles, Concord, Ipswich, Merrimack, Nashua, Parker and Shawsheen watersheds and North Shore coastal drainage areas.

Selected water quality and ecological variables were measured at index (i.e. deep hole) and shoreline sites, as well as throughout the whole lake. These are listed along with their sampling frequencies in Table 2.

Table 1. Location of randomly selected lakes in the northeastern watersheds of Massachusetts that were sampled in 2017 as part of the probabilistic lakes survey.

Site	Watershed	Waterbody	Town
MAP2L-126	Blackstone	Kettle Brook Reservoir #1	Leicester, MA
MAP2L-127*	Suasco	Gleason Pond	Framingham, MA
MAP2L-128	Charles	Cambridge Reservoir	Waltham, MA
MAP2L-129	Suasco	Lake Boon	Stow, MA
MAP2L-132	Merrimack	Nabnasset Pond	Westford, MA
MAP2L-134	Blackstone	Badluck Lake	Douglas, MA
MAP2L-136	Merrimack	Crystal Lake	Haverhill, MA
MAP2L-137*	Merrimack	Upper Artichoke Reservoir	West Newbury, MA
MAP2L-138	Suasco	Sudbury Reservoir	Southborough, MA
MAP2L-139	Suasco	Heart Pond	Chelmsford, MA
MAP2L-140	Nashua	Fall Brook Reservoir	Leominster, MA
MAP2L-145	Nashua	Robbins Pond	Harvard, MA
MAP2L-146	Suasco	Little Chauncy Pond	Northborough, MA
MAP2L-147	Nashua	Wachusett Lake	Westminster, MA
MAP2L-150	Blackstone	Reservoir #6	Sutton, MA
MAP2L-151	Merrimack	Stodge Meadow Pond	Ashburnham, MA
MAP2L-154	Charles	Lake Pearl	Wrentham, MA
MAP2L-156	Nashua	Lily Ponds	West Boylston, MA
MAP2L-157	North Coastal	Walden Pond	Saugus, MA
MAP2L-159	Boston Harbor	Ponkapoag Pond	Randolph, MA

Table 1. Location of randomly selected lakes in the northeastern watersheds of Massachusetts that were sampled in 2017 as part of the probabilistic lakes survey.

Site	Watershed	Waterbody	Town
MAP2L-160	Boston Harbor	South Reservoir	Medford, MA
MAP2L-161*	Suasco	Barkers Pond	Acton, MA
MAP2L-163	Nashua	Crow Hills Pond	Princeton, MA
MAP2L-164	Ipswich	Field Pond	Andover, MA
MAP2L-167	Nashua	Fitchburg Reservoir	Ashby, MA
MAP2L-168	Nashua	Fort Pond	Lancaster, MA
MAP2L-169	Ipswich	Stiles Pond	Boxford, MA
MAP2L-172	Suasco	Bartlett Pond	Northborough, MA

* No fish tissue data

Table 2. Sampling frequency of water quality and ecological variables measured at probabilistic lakes.

Location	Variable	Sample Frequency (Minimum)
Index site	Vertical profile (dissolved oxygen, temperature, pH, conductivity)	3
	Secchi disk transparency	3
	Nutrients (total phosphorus, total nitrogen)	3
	Water chemistry (true color, alkalinity, hardness, turbidity, dissolved silica, chloride, dissolved organic carbon)	3
	Chlorophyll a	3
	Phytoplankton community (including Diatoms once in August)	3
Shoreline site	Pathogens (*E. coli*)	5
	Cyanobacteria	3
	Algal toxins (microcystins and anatoxin-a)	3
Whole lake	Littoral macroinvertebrate community	1
	Fish tissue (mercury organochlorine pesticides, metals)	1
	Macrophytes (percent cover, biovolume, exotics)	1
	Aesthetics observations	1
	Human disturbance observations	1
	Bathymetry	1

The various components of the lake surveys are briefly summarized below.

***Index Site – Water Quality (Chemical, Biological and Physical)*:** Water quality (vertical DO/temperature/pH/conductivity profile, nutrients, dissolved silica, chlorophyll a, phytoplankton, true color, alkalinity, hardness, turbidity, chloride) samples were collected approximately once a month between June and September (3 sampling events) at the index site of each lake using techniques described in DWM standard operating procedures (SOP). The index site was located at the maximum depth point in each lake. Samples were field-preserved, as appropriate, and delivered to the Senator William Wall Experiment Station in Lawrence (WES) for nutrient (total nitrogen, total phosphorus), chloride, dissolved silica, alkalinity and hardness analyses; the DWM lab in Worcester for chlorophyll a, turbidity and color analyses; PhycoTech (Saint Joseph, MI) for phytoplankton taxonomy, enumeration and biovolume (including Diatoms once); and TestAmerica Buffalo (Amherst, NY) for the analysis of dissolved organic carbon. A minimum of one duplicate and one blank sample per analyte were tested for QC for each sampling week (approx.10% of the samples).

***Shoreline Site – Water Quality (Biological and Microbiological)*:** Water quality (*E. coli*, cyanobacteria and algal toxins) samples were collected at the designated shoreline site for each lake using techniques described in the DWM SOPs. The shoreline site was located at a bathing beach if one were present or at a shoreline point where the lake is easily accessible by the public (e.g. adjacent road or culvert) for recreation. *E. coli* were sampled once a month between May and September (5 sampling events) while cyanobacteria and algal toxins were sampled once a month between July and September (3 sampling events). Samples were field-preserved, as appropriate, and delivered to the Senator William Wall Experiment Station in Lawrence (WES) for algal toxins analyses; the DWM lab in Worcester for *E. coli* analysis; and PhycoTech (Saint Joseph, MI) for cyanobacteria counts. A minimum of one duplicate and one blank sample per analyte were tested for QC for each sampling week (approx.10% of the samples).

***Whole Lake – (Bathymetry, Macrophyte and macroinvertebrate community, Fish tissue)*:**

Macrophyte Community – Bathymetry and the macrophyte community (percent cover, biovolume and species composition) were surveyed once during the summer in each lake using protocols described in DWM SOPs. The percent cover and biovolume of macrophytes were estimated using CI BioBase (Navico, Inc., Merrimack, NH). CI BioBase is cloud-based software that automates the processing of depth finder sonar log files to make aquatic vegetation and bathymetric maps. Macrophyte species composition was estimated by identifying macrophyte species from periodic, spatially diverse rake drags within each lake until no new species were identified by the survey crew with the goal of producing a dominant species list. Samples of macrophyte species that could not be identified by the survey crew were delivered to the DWM lab in Worcester for identification.

Littoral Macroinvertebrate Community - The littoral macroinvertebrate community was sampled at all lakes on one occasion during late summer or early fall, using protocols developed for the EPA's 2012 National Lake Assessments (NLA). These organisms can integrate environmental conditions (chemical – including nutrients and toxics; and physical – including shoreline alteration and water level fluctuations) over a long period of time and are an excellent measure of the waterbody's health. Specimens were placed into 2L Nalgene jars, preserved with denatured 95% ethanol and transported to the DWM lab for storage. A contractor will process (i.e. subsample) the macroinvertebrate samples and complete the necessary taxonomic identifications. In addition, habitat evaluations were completed at all lakes sampled for littoral macroinvertebrates.

Fish Tissue - Fish tissue samples were collected at all but three lakes (see Table 1) on one

occasion during late spring/early summer using a variety of techniques (electrofishing, gill nets, etc.) described in the DWM SOP. Composite samples of filets from three individuals of edible and legal size from a species were collected for 3-5 target species for the analysis by the WES of mercury, organochlorine pesticides, and metals. In addition, 10-12 individual whole fish from a single species were analyzed for mercury.

DETERMINISTIC ("TARGETED") MONITORING PROGRAM (TMP) – Several waters were selected, or "targeted", for monitoring activities designed to fulfill one or more of the monitoring program objectives listed on page 1. While the probabilistic monitoring described above was focused in the "Northeast" Group of watersheds, targeted monitoring activities were carried out in watersheds scattered throughout Massachusetts. More detail pertaining to the targeted monitoring activities of the DWM in 2017 is presented below.

Reference Site Network (RSN): The DWM has identified the need to characterize the reference condition for Massachusetts' surface waters to support multiple program objectives including, but not limited to, the interpretation of biological data obtained from the probabilistic monitoring stream network as well as the development of biocriteria and nutrient criteria. For example, the DWM is currently exploring the development of tiered aquatic life uses that will increase the accuracy of aquatic life use assessments and improve water quality goal-setting processes. An understanding of the temporal variation within the indices of biotic integrity used for assessment is a critical initial step toward the development and implementation of biocriteria and tiered aquatic life use.

Least-disturbed reference sites were selected from the two most prominent Level III ecoregions (Northeastern Highlands, Northeastern Coastal Plain) in Massachusetts through the application of a Human Disturbance Index that was derived from six individual streamflow and landscape disturbance indicators. A total of ten (10) sites were chosen for intensive study, beginning in 2011. New sites were added to the network in subsequent years until, in 2015, a total of 27 sites were sampled. In 2017, however, field and laboratory staff constraints and other monitoring priorities limited the number of RSN sites sampled to 12 (Table 3). The primary objective at each sampling site was to collect sufficient data to continue evaluating year-to-year variation in the biological communities. Monitoring activities included habitat assessment; macroinvertebrate and fish population assessments; and physicochemical sampling. All sampling and QA/QC was performed in accordance with the DWM's standard operating procedures, QAPP and SAP. A list of the water quality and ecological variables measured at each site, along with their sampling frequencies, is presented in Table 4. More detail pertaining to each component of the RSN is presented below.

Table 3. Location of selected "reference/least disturbed" sites that were sampled in 2017 as part of the reference site network.

Site	Watershed	Waterbody	Site Description
CR01	Deerfield	Cold River	[approximately 325 feet upstream of Mohawk Trail (Route 2), Florida/Savoy (upstream of Black Brook confluence)]
YB02	Housatonic	Yokun Brook	[approximately 1800 feet upstream of Edgewood Drive, Lenox]
MBW01	Westfield	Middle Branch Westfield River	[approximately 1000 feet upstream/north of Bailey Road, Chester]

Table 3. Location of selected "reference/least disturbed" sites that were sampled in 2017 as part of the reference site network.

Site	Watershed	Waterbody	Site Description
WE01	Housatonic	West Brook	[approximately 1300 feet downstream of the Beartown Road crossing nearest the intersection with Beartown Mountain Road, Great Barrington]
SB01	Westfield	Sanderson Brook	[Sanderson Brook Road bridge nearest Route 20, Chester]
WSR01	Chicopee	West Branch Swift River	[approximately 640 feet upstream from Cooleyville Road Extension, Shutesbury]
WB01	Millers	Whetstone Brook	[approximately 160 feet downstream of Kentfield Road (Kempfield Road), Wendell]
HB01	Farmington	Hubbard Brook	[west off Hartland Hollow Road, just upstream of unnamed tributary to northern bank and approximately 350 feet downstream of Pond Brook confluence, Granville]
EB01	Connecticut	Elmer Brook	[approximately 1400 feet downstream/south from Pearl Street, South Hadley]
VB01	Farmington	Valley Brook	[approximately 1/2 mile upstream of MA/CT state line, west of Clark Road, Granville]
EG01	Hoosic	East Br. Green River	[approximately 340 feet upstream of the confluence with the Green River near Roys Road, New Ashford]
SH01	Connecticut	Shattuck Brook	[approximately 3/4 mile downstream from headwaters (the confluence of Keets and Beaver Meadow brooks, Leyden), south of Keets Brook Road, Bernardston]

Table 4. Sampling frequency of water quality and ecological variables measured at RSN sites.

Variable	Sample Frequency (Minimum)
Nutrients (TN,TP, Nitrate/Nitrite, Ammonia)	4
Color	4
Turbidity	4
Chloride	4
Dissolved Oxygen/Temperature Probe Deploys (May-September)	continuous
Habitat Assessment	1
Fish Community	1
Macroinvertebrate Community	1

***Water Quality (Physico-chemical)*:** Water samples were collected from each site monthly from May through September, field preserved as appropriate, and delivered to the Senator William X. Wall Experiment Station in Lawrence (WES) for nutrient (total phosphorus, total nitrogen, nitrate/nitrite nitrogen and ammonia nitrogen) and chloride analysis and the DWM lab in Worcester for turbidity and color analysis. In addition, data loggers were deployed *in-situ* from May to September to obtain long-term continuous temperature and dissolved oxygen data.

***Biological Monitoring (Macroinvertebrates, Fish, Habitat)*:** Benthic macroinvertebrate and fish community assessments, along with associated habitat evaluations, were performed to assess the *Aquatic Life Use* status and to support multiple program objectives, as described above. These communities integrate environmental conditions (chemical – including nutrients and toxics, and physical – including flow and water temperature) over extended periods of time and are excellent measures of a waterbody's overall "health".

The benthic macroinvertebrate community at each site was sampled in July. The benthic macroinvertebrate community was assesed using Rapid Bioassessment Protocols (RBP) III or a modification thereof, depending upon available habitat. For example, typical RBP III kick-sampling protocols could not be used at low-gradient sites so a multi-habitat sampling method (i.e., multiple net sweeps) was employed. Specimens were preserved in the field and transported to the DWM lab for further processing. Sample sorting and taxonomic identifications were performed at a contract laboratory. Where applicable, benthic macroinvertebrate functional feeding group, community composition, biotic index using pollution tolerance, and abundance metrics will be calculated for analysis.

Fish community sampling for the presence/absence of resident fish species was carried out in August at all 12 sites. Fish were collected within a 100-meter reach using a backpack or tote barge-mounted electro-fishing equipment and held in plastic buckets containing stream water. Fish were identified to species and a minimum of 25 individuals of each species were measured and weighed. Fish were then redistributed throughout the sampled reach.

Field and Lab Support for the Assessment and Management of Cyanobacteria Blooms: MassDEP continued to provide technical expertise and laboratory support for the investigation of potentially toxic algae (cyanobacteria) blooms. Working from MassDEP's DWM-Worcester and Southeast Regional (SERO) offices, respectively, and in collaboration with MassDPH, staff biologists performed cyanobacteria counts and identifications on water samples to determine whether cell counts exceeded MassDPH advisory levels for recreational waters. In addition, samples were collected and/or analyzed *ad hoc* from lakes in DWM's MAP2 and Lakes Baseline networks if blooms were observed by DWM sampling crews or if water samples exhibited elevated chlorophyll levels in the lab. Cyanobacteria counts and identifications were forwarded to MassDPH for risk assessment and management. A list of waterbodies from which MassDEP processed samples in 2017 is presented in Table 5.

Table 5. Waterbodies for which MassDEP staff performed cyanobacteria cell counts (C) and/or taxonomic identifications (ID) in 2017, either at the request of the MassDPH or as part of ongoing lake monitoring activities of the DWM.

Waterbody	Municipality	Number of sampling events	Sample Processing
Stetson Pond	Pembroke	1	ID
Bartlett Pond	Northborough	2	C
Field Pond	Andover	1	C
Little Chauncy	Northborough	2	C
Lake Chauncy	Westborough	2	C/ID
Lake Boon	Hudson	3	C
Gleason Pond	Framingham	1	C
Fort Meadow Reservoir	Hudson/Marlborough	3	C

Nabnasset Pond	Westford	1	ID
Heart Pond	Chelmsford	2	C
Field Pond	Andover	2	C
Pratt Pond	Upton	2	C
Sudbury Reservoir	Southborough	1	C
Riley Pond	Northbridge	2	C
East Monponsett Pond	Halifax	28	C
West Monponsett Pond	Halifax/Hanson	28	C
Long Pond Reservoir	Falmouth	41	C
Mystic Lake	Barnstable	1	C
Wampatuck	Hanson	12	C

Phycocyanin Sampling

Phycocyanin measurements were included as part of the cyanobacteria investigations conducted in 2017. Phycocyanin is a pigment found primarily in cyanobacteria. DWM staff members are evaluating the performance of several different analytical instruments while also working to develop a predictable relationship between the cell count of cyanobacteria and phycocyanin levels so that phycocyanin can be used as a surrogate for cell counts. Cell counts and identifications require more skill and time than does obtaining phycocyanin readings. As part of the MAP2 probabilistic lake surveys, shoreline samples were collected on three different occasions and analyzed for phycocyanin using a Turner Design fluorometer Aquafluor. A subset of the samples was also analyzed using a Beagle Bioproducts fluorometer-FluorQuik, on loan from EPA.

In a separate effort, the Turner Designs (Cyclops) probe and Data Logger were used to develop depth-integrated phycocyanin profiles for a total of nine lakes. Lake Boon (Hudson/Stow), and Little Chauncy and Bartlett ponds (both in Northborough) were included for study using the EPA protocols established under the New England Cyanobacteria Collaborative. Fort Meadow Reservoir (Hudson), Lake Chauncy (Westborough), Pratt Pond (Upton), East and West Monponsett ponds (Halifax/Hanson) and Riley Pond (Northbridge) were all sampled at the request of MassDPH. Samples were collected from these six lakes for cell counts and to measure phycocyanin concentration. Samples for phycocyanin analyses were collected using both MassDPH (grab at 0.25 m depth) and EPA (depth-integrated to 1 m) sampling methods.

Fish Toxics Monitoring: In addition to the fish toxics monitoring performed at the MAP2 lakes, the DWM obtained fish samples from six water bodies at the recommendation of the Inter-agency Fish Toxics Committee (Table 6). Edible fillets from fish collected at all six water bodies were analyzed for the presence of mercury and samples from four lakes were also analyzed for additional metals, PCB arochlors and organochlorine pesticides. If necessary, fish consumption advisories will be issued by the Massachusetts Department of Public Health (MassDPH).

Table 6. 2017 fish toxics monitoring sites.

Watershed	Water Body (Municipality)	Analytes
Islands	Long Pond (Nantucket)	Hg, As, Cd, Se, PCB arochlors, organochlorine pesticides, % lipids
Islands	Washing Pond (Nantucket)	Hg
Mystic	Spot Pond (Stoneham/Medford)	Hg
Connecticut	Barney Pond (Springfield)	Hg, As, Cd, Se, PCB arochlors, organochlorine pesticides, % lipids

Connecticut	Porter Lake (Springfield)	Hg, As, Cd, Se, PCB arochlors, organochlorine pesticides, % lipids
Connecticut	Watershops Pond (Springfield)	Hg, As, Cd, Se, PCB arochlors, organochlorine pesticides, % lipids

Baseline Lake Sampling of Monponsett Pond, Halifax: The 2017 Baseline Lakes Survey focused on obtaining additional water quality information from East Monponsett Pond and West Monponsett Pond in Halifax. The specific objectives of this monitoring were to:

- Evaluate the lakes to determine if Massachusetts's water quality standards are met
- Provide data to show improvement of implementation of phosphorus TMDLs

The DWM regional monitoring coordinator, with assistance from SERO staff, sampled the epilimnetic waters over the deep holes of both East and West basins of Monponsett Pond on June 21st, July 20th, August 23rd and September 29th. Samples were analyzed for total phosphorus and total nitrogen along with chlorophyll a and Secchi disk transparency. Grab samples for bloom algae were not collected as no blooms were observed; however, DWM collected a sample for the analysis of algal toxins on Sept. 5 to assist with analytical methods development at WES. Finally, DWM conducted a bathymetric survey of East Monponsett Pond on June 28.

Monitoring the Effects on Water Quality of Road-Salt Application: DWM continued to monitor seasonal chloride levels and dynamics in selected waters that may be impaired by road salt application. Continuous conductivity loggers were deployed at five sites along Potash Brook in the Westfield River watershed from November, 2016 to July, 2017. In August, 2017 eight continuous conductivity loggers were deployed in the Neponset River watershed in order to assess the stream for possible chloride impairment. Both of these studies included the collection of chloride grab samples to check the accuracy of the specific conductance-chloride regression model.

Monitoring Water Quality in Mount Hope Bay: In 2016, MassDEP acquired two YSI marine water quality monitoring buoys to address data gaps in the Massachusetts waters of Narragansett Bay and its sub-embayment Mount Hope Bay. The deployment of these buoys is intended to expand the existing Narragansett Bay Fixed-Site Monitoring Network (NBFSMN) currently administered by the Rhode Island Department of Environmental Management (RIDEM) and the University of Rhode Island Graduate School of Oceanography (URI). Until now, there were no NBFSMN stations located in the eastern portion of Mount Hope Bay and the Taunton River in Massachusetts. The addition of the two new monitoring buoys in Massachusetts will help to define ambient water quality conditions for dissolved oxygen, nitrate-nitrogen, algal abundance, temperature and other parameters. Specifically, the data may be used to assess trends over time, identify impaired waters, assess the effectiveness of management decisions (i.e. wastewater treatment facilities (WWTF) upgrades, TMDL efforts, and stormwater management) and support refinement, calibration and validation of water quality models.

MassDEP's long-term plan for the two buoy systems is to collect continuous, real-time data seasonally from May-November for the next several years; however, the 2016 "pilot" deployment was considerably shorter (i.e., September–November) due to the timing of the procurement of the buoys. Furthermore, the "pilot" deployment was needed to become familiar with URI's protocols, establish near real-time data retrieval remotely via cellular communication

and to troubleshoot technical problems that are inherent in the installation and proper functioning of new monitoring systems.

After retrieving the buoy systems in November 2016, MassDEP redeployed the two buoys from May-November 2017 at approximately the same locations as the initial 2016 deployment. Bi-monthly grab water samples were collected for water chemistry analyses at each buoy location within one meter of the deployed sensors during both the 2016 and 2017 deployments. Instantaneous grab sample data will be compared to corresponding sensor data to validate the accuracy of sensor measurements.

Monitoring to Assess Climate Change: DWM staff continued to monitor air and water temperature and collect macroinvertebrate samples at five sites in Massachusetts as part of an ongoing collaborative effort among multiple federal and state agencies, NGOs, and academic institutions across New York and New England to assess the effects of climate change in the Northeast. Spearheaded by the EPA, this effort is aimed at coordinating temperature and biological data collection across the region. Similar "regional" collaborations have been established across the country.

In Massachusetts the five sites are Hubbard Brook in Granville, Brown's Brook in Holland, Parker's Brook in Oakham, West Branch Swift River in Shutesbury, and Cold River in Florida. UMass/Amherst and MassWildlife's Division of Ecological Restoration (DER) are the other partners on the "Massachusetts Team." DER has installed flow-gaging equipment at the two sites without USGS gages and is developing flow rating curves for them. UMass is playing a coordinating role and also plans to address the fisheries component.

Technical Support to the Blackstone River ambient monitoring program: DWM staff deployed dissolved oxygen/temperature data loggers at four sites in the Blackstone River from mid-June to early November as part of a collaborative effort with the Upper Blackstone Water Pollution Abatement District (UBWPAD) and their consultants to establish an ambient monitoring program. Throughout that time, consultants to the UBWPAD conducted periodic attended probe data collections at those deployment sites.

Continuous Stream Temperature Monitoring (Pilot Program): Water temperature is an important monitoring parameter for surface water management and for aquatic life use assessment under the federal Clean Water Act (CWA). To this end, DWM is exploring the feasibility of initiating both long-term (to measure trends) and short-term temperature monitoring networks. In 2017 DWM piloted a short-term stream temperature (and dissolved oxygen, where feasible) monitoring network to provide data for the assessment of the aquatic life use as well as other potential applications (e.g., TMDL development, NPDES permitting, cold-water fisheries protection, etc.). Metered probes were deployed from July to October at a total of 38 sites on 18 streams in the Farmington and Westfield watersheds (Table 7).

Table 7. 2017 short-term temperature monitoring network.

Watershed	Stream Name	Number of Sites
Farmington	West Branch Farmington River	3
Westfield	West Branch Westfield River	1
Westfield	Westfield River	6
Westfield	Swift River	1

Westfield	West Branch	3
Westfield	Watts Stream	1
Westfield	Wards Stream	1
Westfield	Yokum Brook	1
Westfield	Walker Brook	1
Westfield	Kinne Brook	3
Westfield	Ashley Brook	1
Westfield	Moose Meadow Brook	3
Westfield	Tower Brook	1
Westfield	Stones Brook	2
Westfield	Mill Brook	3
Westfield	Westfield Brook	3
Westfield	Shaw Brook	1
Westfield	Stage Brook	1
Westfield	Roaring Brook	2
Total sites		**38**

Monitoring Assistance to CERO: DWM staff assisted personnel of MassDEP's Central Regional Office (CERO) with two separate site investigations: 1) Water samples were collected on two separate dates from a small, unnamed stream that had received discharge from a broken sewer line leading from a condominium complex in Westborough; and 2) water samples were collected from a wetland and unnamed stream as part of an ongoing water pollution investigation in Upton.

Bacteria Source Tracking Activities of the Southeast Regional Office (SEROBST): The DWM regional monitoring coordinator, used the IDEXX quanti-tray system on site in the Southeast Region lab, to determine the concentration of "indicator bacteria" (*E.coli* and Enterococcus) in surface water, at stormdrain outfalls and within drainage infrastructure (manholes).

Additional source tracking tools used were:

- Hach test kits: to determine detergent concentrations.
- Ammonia and potassium meters: to determine ammonia/potassium ratios

These data were combined with field observations and in some cases, discussions with local watershed groups and/or municipal officials to refine sampling locations, in an attempt to track and isolate the dry-weather source(s) of *E. coli* and/or Enterococcus bacteria. A small number of opportunities for "Human Marker" analyses (fluorescent whitening agents, DNA, and caffeine) were made available by the WES State Lab. These analyses were utilized in cases where bacteria concentrations were high but no obvious source could be immediately located, in an attempt to determine if the bacteria were from a human or animal source.

Subwatersheds where bacteria source tracking was conducted are presented below in Table 8.

Highlights of the 2017 sampling season

- The successful multi-year partnership with the City of Norwood continued with:
    - SEROBST and the City consultant (CDM) conducted additional dry weather source tracking over three sample days at outfalls and up into drain lines. This

effort was focused within a few previously identified “hotspot areas” discovered by CDM, namely Westview Drive (Meadow Brook watershed), Ridgewood Drive (Neponset River watershed) and Alpine Ave (Plantingfield Brook watershed). On Westview Drive our joint source tracking efforts led to a source on Hillcrest Road. This source was investigated by the City a week later and was found to be caused by a house sewer incorrectly piped into the drain i.e. the plumbing inside the house had been connected the wrong way around!. The City is in conversations with the home owner to correct this.

- In consideration of all the years of successful source tracking and correction, including significant amounts of money spent on CIPP lining the sewer infrastructure, SEROBST collected some new baseline samples in the main-stem Neponset River. Samples were collected at three locations on the main-stem in August and October and were found to either meet or fall just above the single sample water quality standard in every case.

- The partnership with EPA Region-1 and Rhode Island DEM continued into this year, with the goal of monitoring water quality in the lower section of the Palmer River Watershed. Monitoring was focused in areas that were deemed most vulnerable to agricultural impacts and with the long-term goal of assessing trends over time in correlation to ongoing installation of agricultural BMPs. Samples were collected from May through November at 12 fixed stations on an outgoing tide (weather independent). EPA supplied YSI meters to measure temperature, specific conductance and salinity. Grab samples were tested (by EPA Region 1 lab) for *E.coli* (some analyses run by MassDEP SERO lab), enterococcus, total nitrogen, ammonia, nitrate/nitrite, total phosphorus, orthophosphate and total suspended solids (TSS). Samples were also collected for the hopeful “future analysis” of DNA, with the new PhyloChip/qPCR method for human fecal indicator. Through a potential collaboration study EPA lab may be able to send the Palmer samples to Dr. Gary Andersen, of Lawrence Berkley National Laboratory, if the funds come through at a later date.

- The successful multi-year partnership with the City of Taunton continued with:

  - A City wide outfall survey was conducted by SEROBST. This survey was “guided” by the City, in that they supplied a list of 30 “suspect” outfalls which had previously been identified as discharging during dry weather conditions. SEROBST located and mapped all 30 outfalls in advance and then collected samples from 20 flowing outfalls over the course of three days. A canoe was used for one sample day to access some outfalls from the river. None of the outfalls showed high bacteria counts except for one at the Plain Street Bridge (on the Taunton River main stem). This pipe was already a known source to SEROBST and the City and is currently under further BST investigation. Special thanks to SERO’s Martha Sullivan for field assistance throughout this survey.

  - An outfall pipe (draining Ingell Street) was discovered in 2016 to be discharging water with high concentrations of E. coli. Joint source tracking efforts (SEROBST & City) confirmed that a house a short distance away on Ingell Street had a direct sewer connection to the drain. This connection was severed in 2016. A follow up sample was collected at the outfall in July and bacteria concentrations were still significant. The City confirmed that the sewer main on Ingell Street is in dis-repair and is due to be lined in November. It is expected that this work will remove the

source.

- Additional joint source tracking was conducted for an outfall discharging to the Mill River at the Spring Street Bridge. High bacteria concentrations have been observed intermittently at this outfall for years as well as Human Marker analysis results coming back positive, however no “smoking gun” has been found up until now. This year source tracking again covered Spring Street and Summer Street but this time was taken further upstream to Union Street. The location of a probable source was narrowed down to a section of drain between Main Street and Union Street. The City is currently investigating this area with cameras and smoke.

- The successful partnership with the City of Brockton continued with:
  - SEROBST worked with City employees to follow up on a number of hotspot source areas, building on our work from the previous few years.
    1. The Grove Street outfall (Salisbury Plain River): Joint source tracking efforts identified a hot spot in the Pine/Jacob intersection area. The City arranged to have the drain in this area investigated with a camera. Two sources were identified; an offset pipe and a 3ft long fracture. The City is currently in the process of correcting these issues.
    2. Weston Street (Salisbury Brook watershed): Joint source tracking efforts identified the underdrain on Prospect Ave as contributing a significant source of bacteria to the drain/brook. The City/CDM is currently investigating this further.
    3. Pleasant/Carrlyn/Irving (Lovett Brook watershed): The City arranged to have the drain in this area investigated with a camera. One flowing “lateral” from a home was observed. The City/CDM is currently investigating this further.
    4. Main @ Brookside apartment complex (Salisbury Plain River watershed): The City requested source tracking assistance from SEROBST for this area. Joint investigations narrowed down the location of one significant source to a section of infrastructure between Greenleaf and the apartment complex. Another source was identified as the drainage stream itself day-lighting up at Clifton Ave. The City/CDM is currently investigating both of these sources further.

- A series of samples collected from Menemsha Pond (Martha’s Vineyard) were run for Human Marker Analysis. SEROBST met with Wampanoag tribe scientists in advance of the sample day to supply them with sample bottles and the necessary protocols. SEROBST later supported the tribe by transporting the samples from the Cape up to Wall Experiment station in Lawrence. Analysis results were such that none of the samples showed evidence of a human source.

Table 8. Subwatersheds where bacteria source tracking was conducted over the course of approximately 30 sample days. Note: This table includes only the names of those municipalities where sampling took place. New sub-watersheds are highlighted in **bold.**

Name	Basin	Segment	Municipalities sampled	Number of sample days
Sevenmile River	Ten Mile River	52-08_2006	Attleboro & Pawtucket	2
Palmer River project (incl. Rocky Run Brook and	Narragansett Bay	53-05_2006 53-16_2006	Seekonk & Rehoboth	7

Torrey Creek)		53-17_2010		
Coles River	Mount Hope Bay	61-04_2006	Swansea	2
Taunton River	Taunton	62-01 & 62-02_2006	Taunton	3
Salisbury Plain River	Taunton	62-05_2006	Brockton	4
Trout Brook	Taunton	62-07_2006	Brockton	2
Salisbury Brook	Taunton	62-08_2006	Brockton	2
Mill River	Taunton	62-29_2006	Taunton	1
Lovett Brook	Taunton	62-46_2010	Brockton	2
Three Mile River	**Taunton**	**62-56_2006**	**Taunton**	2
Neponset River	**Neponset**	**73-02 & 73-01_2006**	**Norwood**	**2**
East Branch Neponset	**Neponset**	**73-05_2006**	**Canton**	**2**
Germany Brook	Neponset	73-15_2006	Norwood	1
Plantingfield Brook	Neponset	73-23_2006	Norwood	2
Pecunit Brook	Neponset	73-25_2006	Canton	3
Ponkapoag Brook	Neponset	73-27_2006	Canton	3
Meadow Brook	Neponset	73-33_2006	Norwood	2
Cochato River (including tributaries Farm River & Monatiquot River)	**Weymouth/Weir**	**74-06_2006**	**Braintree & Randolph**	**2**
Third Herring Brook	South Coastal	94-27_2006	Norwell	2