Acid Rain Monitoring Project

FY17 Annual Report

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Bureau of Waste Prevention

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Introduction

This report covers the period January 1, 2017 to June 30, 2017, the sixteenth year of Phase IV of the Acid Rain Monitoring Project. Phase I began in 1983 when about one thousand citizen volunteers were recruited to collect and help analyze samples from nearly half the state's surface waters. In 1985, Phase II aimed to do the same for the rest of the streams and ponds[1] in Massachusetts. The third phase spanned the years 1986-1993 and concentrated on a subsample of streams and ponds to document the effects of acid deposition to surface waters in the state. Over 800 sites were monitored in Phase III, with 300 citizen volunteers collecting samples and doing pH and ANC analyses. In 2001, the project was resumed on a smaller scale: about 60 volunteers are now involved to collect samples from approximately 150 sites, 26 of which are long-term sites with ion and color data dating back to Phase I. In the first years of Phase IV (2001-2003), 161 ponds were monitored for 3 years. Between Fall 2003 and Spring 2010, the project monitored 151 sites twice a year, mostly streams, except for the 26 long-terms sites that are predominantly ponds. Since 2011, reduced funding eliminated our October sampling and monitoring now occurs in April only. In 2011, we also stopped monitoring some of the streams in order to add and revisit ponds that were monitored in 2001-2003. This year is the seventh year of monitoring for those added ponds.

Goals

The goals of this project are to determine the overall trend of sensitivity to acidification in Massachusetts surface waters and whether the 1990 Clean Air Act Amendment has resulted in improved water quality.

Methods

The sampling design was changed in 2011 to monitor both streams and ponds, and that design continues to date. In 2001-2003 mostly ponds were monitored. In Fall 2003 the sampling scheme switched to streams to evaluate their response to air pollution reductions. In 2011 the site list was modified to include both ponds and streams. Half of the streams monitored since 2003 were kept, and half of the ponds monitored in 2001-2003 were added back. The streams that were removed were chosen randomly within each county. Ponds that were reinstated on the sampling list were chosen at random within those counties and by ease of accessibility to replace the removed streams. Because those sites were chosen without a preconceived plan, they can be considered picked at random.

One collection took place this year, on April 2, 2017.

Methods were unchanged from previous years: Volunteer collectors were contacted six weeks before the collection to confirm participation. Clean sample bottles were sent to them in the mail, along with sampling directions, a field sheet/chain of custody form, and directions including latitude and longitude coordinates along with maps to the sampling sites. Volunteers collected a surface water sample at their sampling sites either from the bank or wading a short distance into the water body. They collected water one foot below the surface, upstream of their body, after rinsing their sample bottle three times with pond or stream water. If collecting by a bridge, they collected upstream of the bridge unless safety and access did not allow it. They filled in their field data sheet with date, time, and site code information, placed their samples on ice in a cooler and delivered the samples to their local laboratory right away. They were instructed to collect their samples as close to the lab analysis time as possible. In a few cases, samples were collected the day prior to analysis because the lab is not open on traditional "ARM Sunday." Previous studies by our research team have established that pH does not change significantly in 24 hours when the samples are refrigerated and stored in the dark.

Volunteer labs were sent any needed supplies (sulfuric acid titrating cartridge, electrode, buffers), two quality control (QC) samples, aliquot containers for long-term site samples, and a lab sheet one week to ten days before the collection. They analyzed the first QC sample (an unknown) in the week prior to the collection and called in their results to the Statewide Coordinator. If QC results were not acceptable, the volunteer analyst discussed possible reasons with the Statewide Coordinator and made modifications until the QC sample analysis gave acceptable results. On collection day or the day after, volunteer labs analyzed the second QC sample before and after the regular samples, and reported the results on their lab sheet along with the regular samples. Analyses were done on their pH-meters with KCl-filled combination pH electrodes. Acid neutralizing capacity (ANC) was measured with a double end-point

[1] Note: The term stream in this report refers to lotic waters (from creeks to rivers) and the term ponds refers to lentic waters (lakes and ponds, but not marshes)

titration to pH 4.5 and 4.2. Most labs used a Hach digital titrator for the ANC determination, but some used traditional pipette titration equipment. Aliquots were taken from 25 long-term sites to fill two 50mL bottles and one 50mL tube per site for later analysis of ions and color. These aliquots were kept refrigerated until retrieved by UMass staff. Note that one of our 26 long-term sites was not sampled (North Watuppa Lake in Fall River) this year.

Aliquots, empty bottles, and results were collected by the ARM Statewide Coordinator between one and three days after the collection. The Cape Cod National Seashore lab mailed those in, with aliquot samples refrigerated in a cooler with dry ice.

The Statewide Coordinator reviewed the QC results for all labs and flagged data for any lab results that did not pass Data Quality Objectives (within 0.3 units for pH and within 3mg/L for ANC). pH and ANC data were entered by one ARM staff and proofread by another. Data were entered in a MS excel spreadsheet and uploaded into the web-based database at http://63.135.115.71/acidrainmonitoring/. Data were also posted on the ARM web page at http://wrrc.umass.edu/research/acid-rain-monitoring-project.

Water Resources Research Center's Travis Drury, with the help of senior student Derek Smith, managed the Environmental Analysis Lab (EAL) and provided the QC samples for pH and ANC to all of the volunteer labs. EAL also provided analysis for pH and ANC for samples from Bristol County, and color analysis for the long-term site samples. The UMass Extension Soils Laboratory analyzed the samples from the long-term sites for cations, and University of New Hampshire's Water Quality Analysis Laboratory, under the direction of Jody Potter, analyzed the samples from the long-term sites for anions.

Aliquots for 25 long-term sites were analyzed for color on a spectrophotometer within one day; anions within two months on an Ion Chromatograph; and cations within one month on an ICP at the UMass Extension Soils Laboratory on the UMass Amherst campus. The available data was sent via MS Excel spreadsheet to the Statewide Coordinator who uploaded it into the web-based database.

The Project Principal Investigator plotted the data to check for data inconsistencies and gaps. She then analyzed the available April data from 1983 through 2017, using the statistical software JMP (http://www.jmp.com/software/) to run bivariate analyses of pH, ANC, and ions against date. This yielded trends analyses with a fitted X Y line, using a 95% confidence interval.

Results

1. There were 149 sites to be monitored, 77 ponds and 72 streams. Of those, 19 ponds and 7 streams are "long-term" sites that are sampled every year and analyzed for color and a suite of ions in addition to pH and ANC.

2. Sampling was completed for 143 sites (70 ponds and 69 streams) including 25 of our long-term sites.

3. There was one quality control problem this year, resulting in the failure of UMass Boston lab to pass pH. This reduced the data we could analyze for pH to include only 138 sites. Additionally, the UMass Soils labs initially sent results for cations that were mostly below detection limit. Unexpectedly, the UNH lab sent results for 4 cations in addition to the 3 anions they were contracted to analyze. This provided a comparison basis with the UMass results and showed a large discrepancy. UMass then explained that they had changed their method this year, but since they had kept the samples refrigerated since their first analysis, they re-analyzed them, with very different results, which we used for this year's dataset.

4. The network of volunteers was maintained and kept well informed on the condition of Massachusetts surface waters so that they would be able to participate effectively in the public debate. This was accomplished by e-mail and telephone communications, as well as through updates via an internet listserv. 49 volunteers participated in this year's collection. Several new volunteer collectors were recruited to replace ill or retiring volunteers via Volunteermatch.org, a press release which was picked up by at least two Massachusetts newspapers, several internet listservs, and by word of mouth. There were 11 volunteer labs across the state, in addition to the EAL at UMass Amherst, in charge of pH and ANC analyses (Table 1). As the Holden lab was not available this year, we used

instead the Upper Blackstone Water Pollution Abatement District's lab in Millbury. Unfortunately, due to an equipment issue, Bristol Community College was unable to analyze samples, but they plan to volunteer again next year. The Bristol samples were kept refrigerated. The next day (April 3rd), Travis Drury picked up and brought those samples to UMass Amherst, where he analyzed at EAL immediately.

Table 1: Volunteer Laboratories

Analyst Name	Affiliation	Town
Joseph Ciccotelli	Ipswich Water Treatment Department	Ipswich
Amy Johnston	UMass Boston	Boston
Mark Putnam	MDC Quabbin Lab	Belchertown
Dave Bennett	Cushing Academy	Ashburnham
Krista Lee	Cape Cod National Seashore	South Wellfleet
Kimberly Newton and Mary Rapien	Bristol Community College	Fall River
Bob Bentley	Analytical Balance Corp	Middleborough
Dave Christensen	Westfield State University	Westfield
Debra LaVergne	Upper Blackstone Water Pollution Abatement District	Millbury
Carmen DeFillippo	Pepperell Waste Water Treatment Plant	Pepperell
Cathy Wilkins	Greenfield High School	Greenfield
Travis Drury	UMass Amherst Environmental Analysis Lab	Amherst

5. The ARM web site and searchable database were maintained and updated. 2017 pH, ANC, color, and ion data that met data quality objectives were added to the web database via the uploading tool created in previous years. The database was evaluated for quality control and uploading errors were corrected.

6. The data collected was analyzed for trends in pH and ANC in April months (138 and 143 sites, respectively) and for color and ions (25 sites), using the JMP® Statistical Discovery Software (http://www.jmp.com/software/). Trend analyses (scatter plots, regression, and correlation) were run on pH, ANC, color, and each ion separately, predicting concentration vs. time.

Data Analysis Results

pH and ANC

Trend analysis for pH and ANC

Table 2 displays the number of sites that show a significant change over time for pH or ANC. If the difference was not statistically significant ($p>0.05$), the sites are tabulated in the 'No Change' category.

Table 2: Trend analysis results for pH and ANC, April 1983 – April 2017 (Number of sites)

	All sites		Ponds		Streams	
	pH	ANC	pH	ANC	pH	ANC
Increased	41	48	20	30	21	18
Decreased	5	2	3	1	2	1
No Change	92	93	46	43	46	50
Total	138	143	69	74	69	69

Those results are graphed as percentages of all sites in Figure 1.

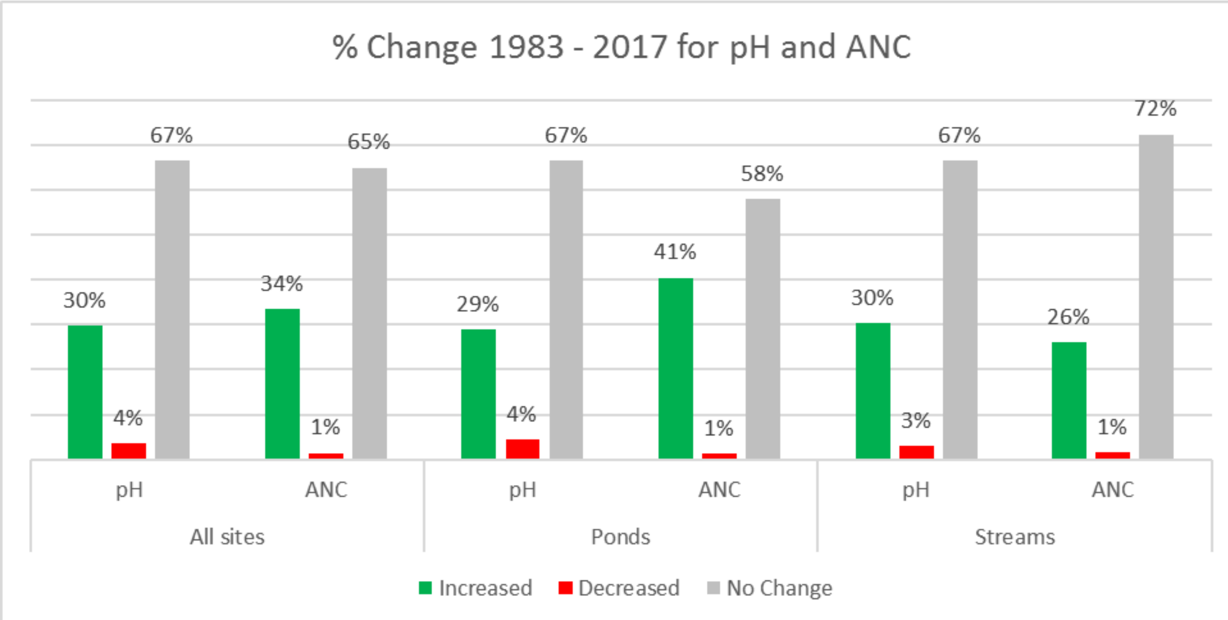

Figure 1. Percent change in number of sites for pH and ANC, from trend analysis, April 1983-2017

This trend analysis indicates that for most sites, neither pH nor ANC changed significantly over time. However, for those sites that show a significant change, many more show an increase than a decrease in value: 30% of the sites saw an increase in pH and 34% had an increase in ANC.

This year, unlike previous years, we note a slightly different picture than previous years between ponds and streams. Practically the same percentage of streams and ponds (29% and 30%) saw an increase in pH, while for ANC, the situation remains that more ponds (30%) than streams (26%) saw an increase. Overall, in 2017 we saw less improvement in pH and ANC than in previous years. There are also more sites this year that experienced a decrease in pH (5) and in ANC (2) over the 34-year study period.

There was snow on the ground in early April this year, and this might explain the small change to more acidic conditions. It will be interesting to see if this trend continues or not in 2018.

Ions

Trend analyses were run for the 25 long-term sites that were analyzed for eleven ions. Results are shown in Table 3 and Figure 2.

Table 3: Trends for number of sites with increases or decreases in ion concentration and color April 1983 – April 2017

	Increased	Decreased	No Change
Mg	9	0	16
Mn	1	4	20
Fe	0	4	21
Cu	10	0	15
Al	3	3	19
Ca	4	1	20
Na	11	0	14
K	15	0	10
Cl	14	0	11
NO3	12	1	12
SO4	0	22	3
Color	20	0	5

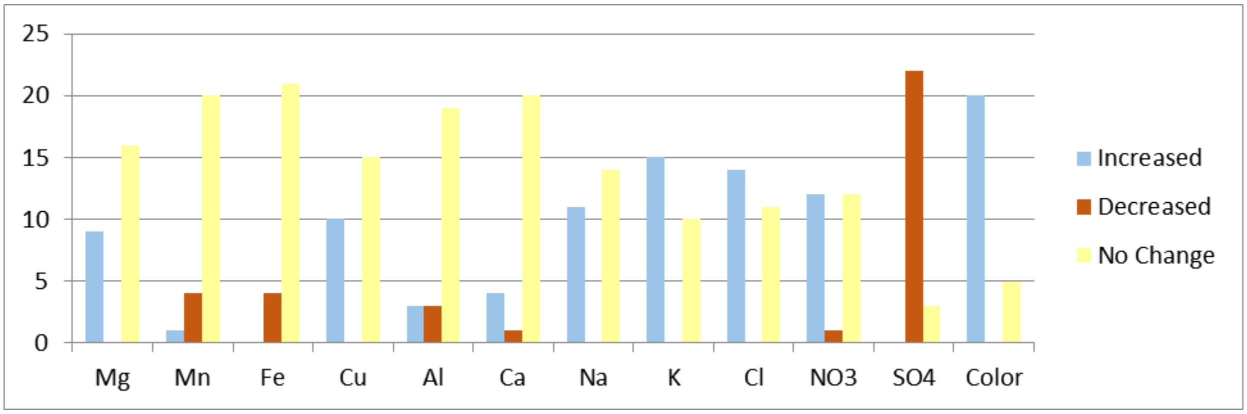

Figure 2: Results of trend analysis for ions and color at 25 long-term sites, April 1983-2017 Shown is how many sites showed an increase (blue), decrease (orange), or no significant change (yellow) over the period 1983 – 2017

Results are somewhat different from previous years. While there are still more sites that show no significant change either up or down, all cations except Iron display some significant increase over the years, with Sodium still in the higher range, though Potassium is now leading in increases. As this year we had an unexpected opportunity to compare analytical results for four cations (Mg, Ca, Na, and K), we noticed that the UMass lab results are often higher than the University of New Hampshire lab. Using the UNH analyses would have resulted in fewer statistically significant increases, particularly for Potassium. We have used the UMass Soils lab since 2013 and propose to use UNH for cations in the future.

For anions, we continue to see a very significant downward trend in Sulfate (22 sites). Nitrates, on the other hand, show more increasing than decreasing, and it is unknown at this time whether it is due to increasing vehicular emissions, or a result of climate change – smaller and less persistent snowpacks result in fine root damage and reduced microbial activity. This can result in losses of nutrient elements, most notably Nitrogen in the form of NO_3^-.

Color is still increasing in most of our sites, which is consistent with a recovery of natural alkalinity.

Discussion

The continued trend in decreasing sulfate confirms that the Clean Air Amendment of 1990 is having a positive effect in the quality of the Commonwealth's surface water quality. Road salting in the winter continues to affect the concentration of sodium and calcium in the water bodies. Continued monitoring will help tease out whether nitrate pollution is countering the beneficial effect of decreased sulfates.

Acknowledgements

Thank you to all of the project's volunteers who make this project possible by collecting samples all over the state under any weather conditions, and who spend many hours in the lab analyzing samples.

Cover photo: Volunteer Nichole Lacoy collects a water sample from Eagleville Pond in Orange, MA on April 2, 2017. Photo by MF Hatte.

Appendix

Table 4: April 2017 ARM Anion Data (All data reported as parts per million)

Name	Palsite	Cl	NO_3	SO_4
Shingle Island Brook	188	11.358	0.110	1.867
Belmont Res;Steam Sawmi	21010.0001	2.911	0.025	1.145
Cobble Mtn. Reservoir	32018.0001	9.121	0.042	2.319
Hawley Reservoir	34031.0001	7.588	0.030	1.770
Lake Wyola; Locks Pond	34103.0001	6.916	0.034	1.399
Upper Naukeag Lake	35090.0001	17.067	0.053	0.770
Crystal Lake	36043.0001	3.233	0.019	0.182
Lake Lorraine	36084.0001	37.118	0.034	1.704
Quabbin Res.Station 202	36129.0001	8.341	0.025	1.477
Nipmuck Pond	42039.0001	13.037	0.026	3.500
Ashby Reservoir	81001.0001	22.673	0.069	1.733
Wright Pd; Upper Wright	81160.0001	7.419	0.027	0.855
Whitehall Reservoir	82120.0001	40.975	0.018	3.779
Hedges Pond	94065.0001	13.785	0.018	1.461
College Pond	95030.0001	6.608	0.019	1.099
Ezekiel Pond	95051.0001	32.779	0.137	1.913
Little Sandy Pond	95092.0001	23.765	0.310	1.493
Kinnacum Pond	96163.0001	21.144	0.019	1.056
Cadwell Creek	3626575	9.961	0.018	1.699
West Br Swift River	3626800	5.320	0.018	1.444
East Br Swift River	3627200	11.675	0.046	1.570
Rattlesnake Brook	6235125	7.432	0.042	2.006
Angeline Brook	9560000	9.741	0.159	1.292
Bread And Cheese Brook	9560150	39.670	0.272	1.959
Hatches Creek	9661525	75.215	2.551	3.561

Table 5: April 2017 ARM Cation Data (All data reported as parts per million)

Name	Palsite	Mg	Mn	Fe	Cu	Al	Ca	Na	K
Shingle Island Brook	188	1.177	0.057	0.186	0.030	0.296	2.729	7.657	1.918
Belmont Res;Steam Sawmi	21010.0001	0.722	0.036	0.040	0.030	0.257	2.950	1.215	1.380
Cobble Mtn. Reservoir	32018.0001	0.961	0.014	0.040	0.037	0.120	2.954	6.385	0.473
Hawley Reservoir	34031.0001	0.829	0.021	0.040	0.034	0.131	2.626	5.897	1.393
Lake Wyola; Locks Pond	34103.0001	0.736	0.029	0.040	0.026	0.120	2.645	5.542	1.233
Upper Naukeag Lake	35090.0001	0.645	0.009	0.040	0.030	0.120	2.033	11.331	1.332
Crystal Lake	36043.0001	0.553	0.011	0.040	0.030	0.120	1.567	1.033	2.006
Lake Lorraine	36084.0001	1.175	0.002	0.040	0.027	0.120	4.142	24.104	1.970
Quabbin Res.Station 202	36129.0001	0.952	0.001	0.040	0.036	0.120	3.361	5.767	1.633
Nipmuck Pond	42039.0001	0.733	0.005	0.040	0.027	0.189	2.656	7.350	5.062
Ashby Reservoir	81001.0001	1.423	0.028	0.075	0.031	0.120	6.602	14.854	2.082
Wright Pd; Upper Wright	81160.0001	0.663	0.008	0.044	0.028	0.120	2.556	5.775	1.688
Whitehall Reservoir	82120.0001	1.659	0.020	0.060	0.031	0.120	5.322	21.040	10.282
Hedges Pond	94065.0001	1.599	0.002	0.040	0.029	0.120	2.077	8.524	1.719
College Pond	95030.0001	1.111	0.001	0.040	0.031	0.120	1.998	4.426	6.420
Ezekiel Pond	95051.0001	1.612	0.001	0.040	0.028	0.120	3.191	19.997	2.153
Little Sandy Pond	95092.0001	1.519	0.022	0.040	0.030	0.120	2.498	14.362	2.276
Kinnacum Pond	96163.0001	1.959	0.030	0.040	0.029	0.120	1.502	11.961	1.777
Cadwell Creek	3626575	0.907	0.017	0.040	0.035	0.168	2.993	7.539	1.300
West Br Swift River	3626800	0.692	0.018	0.040	0.028	0.120	2.402	3.568	1.391
East Br Swift River	3627200	0.988	0.014	0.040	0.030	0.120	3.484	7.708	1.793
Rattlesnake Brook	6235125	0.998	0.034	0.203	0.030	0.381	2.618	4.869	1.479
Angeline Brook	9560000	2.232	0.035	0.162	0.040	0.604	12.111	6.880	2.609
Bread And Cheese Brook	9560150	1.658	0.054	0.251	0.031	0.358	4.808	24.620	2.342
Hatches Creek	9661525	3.643	0.059	0.046	0.029	0.120	7.512	44.576	3.164

Table 6: April 2017 ARM pH and ANC Data

Name	Palsite	Town	pH	Alkalinity (mg $CaCO_3$/L)
Shingle Island Brook	188	Freetown	4.56	-1.3
Beagle Club Pond	371.0001	Dartmouth	5.74	2.0
Cheshire Res. North	11002.0001	Cheshire	8.17	86.2
Belmont Res;Steam Sawmi	21010.0001	Hinsdale	4.98	0.2
Lake Garfield	21040.0001	Monterey	7.52	49.0
Long Pond	21062.0001	Great Barrington	7.68	71.9
Trout Pd 2; Demming Pd	31042.0001	Tolland	5.16	0.2
Upper Spectacle Pond	31044.0001	Sandisfield	6.29	8.4
Buck Pond	32012.0001	Westfield	6.61	18.8
Cobble Mtn. Reservoir	32018.0001	Blandford	5.24	0.5
Ashfield Pd;Ashfield L;	33001.0001	Ashfield	7.31	38.1
Bog Pond; Anthony Pond	33003.0001	Savoy	5.78	1.2
Plainfield Pond	33017.0001	Plainfield	6.15	1.0
Brass Mill Pond	34011.0001	Williamsburg	7.02	9.9
Fiske Pond	34023.0001	Wendell	5.13	0.1
Hawley Reservoir	34031.0001	Pelham	5.56	0.6
Scarboro Pond	34080.0001	Belchertown	5.88	1.6
Lake Wyola; Locks Pond	34103.0001	Shutesbury	5.73	1.2
Bassett Pond	35002.0001	New Salem	5.62	0.2
Cowee Pd;Marm Johns Pd	35013.0001	Gardner	5.2	0.3
Greenwood Pond	35026.0001	Templeton	5.29	1.7
Moores Pond; Lake Moore	35048.0001	Warwick	5.77	1.0
Stump Pond	35085.0001	Gardner	6.59	9.5
Tully Pond	35089.0001	Orange	6.55	4.5
Upper Naukeag Lake	35090.0001	Ashburnham	6.03	0.9
Lake Watatic	35095.0001	Ashburnham	5.71	1.9
L Rohunta; South Basin	35107.0001	Athol	5.82	2.3
Bickford Pd;Ropers Res	36015.0001	Hubbardston	6.19	0.3
Cloverdale Street Pond	36036.0001	Rutland	6.37	6.7
Crystal Lake	36043.0001	Palmer	5.77	0.6
Lake Lorraine	36084.0001	Springfield	6.75	7.9
Quabbin Res.Station 202	36129.0001	Belchertown	6.61	4.0
Thompsons Pond	36155.0001	Spencer	5.88	0.0
East Brimfield Res	41014.0001	Brimfield	6.22	5.1
Nipmuck Pond	42039.0001	Webster	5.97	1.0
Coes Reservoir	51024.0001	Worcester	6.84	15.0
Holden Res 1;Upper Hold	51063.0001	Holden	5.75	0.5
Lynde Brook Reservoir	51090.0001	Leicester	6.62	11.0
Wallis Res/Whitin Reservoir	51179.0001	Douglas	5.58	2.0
Plain Street Pond	52032.0001	Mansfield	6.21	5.9
Deep Pond	62058.0001	Taunton	5.98	3.3
Johnson Pd; Factory Pd	62097.0001	Raynham	5.88	2.4
Winnecunnet Pd;Winnecon	62213.0001	Norton	6.26	4.2
Upper Mystic Lake	71043.0001	Winchester	7.42	42.3
Farm Pond	72039.0001	Sherborn	6.85	2.6

Name	Palsite	Town	pH	Alkalinity (mg $CaCO_3$/L)
Notch Pond	72088.0001	Medfield	5.1	-0.5
Lake Pearl; Whitings Pd	72092.0001	Wrentham	6.46	7.0
Pleasant St. Pd;Frankli	72095.0001	Franklin	6.84	17.4
Stony Brook Pond	72113.0001	Norfolk	6.59	11.4
Storrow Pond	72115.0001	Westwood	6.03	1.0
Blue Hills Reservoir	73004.0001	Quincy	7.2	11.0
Ashby Reservoir	81001.0001	Ashby	6.23	2.0
Grove Pond	81053.0001	Ayer	6.65	11.3
Heald Pond	81056.0001	Pepperell	6.9	15.5
Phoenix Pond; Double Pd	81100.0001	Shirley	6.85	18.3
Robbins Pond	81111.0001	Harvard	7.5	49.5
Sandy Pond	81117.0001	Ayer	6.73	16.3
L Wampanoag; Nashua Res	81151.0001	Ashburnham	5.21	1.1
Wright Pd; Upper Wright	81160.0001	Ashby	5.99	2.0
Whitehall Reservoir	82120.0001	Hopkinton	6.25	3.0
Mystic Pond	84043.0001	Methuen	6.42	13.0
Upper Attitash Pond	84072.0001	Amesbury	7.31	17.8
Duck Pond	84083.0001	Groton	6.15	3.0
Hedges Pond	94065.0001	Plymouth	6.1	1.3
Indian Pond	94072.0001	Kingston	6.1	3.1
College Pond	95030.0001	Plymouth	6.5	2.6
Ezekiel Pond	95051.0001	Plymouth	6.39	3.6
Little Sandy Pond	95092.0001	Plymouth	5.75	1.0
New Long Pond	95112.0001	Plymouth	6.08	0.9
Spectacle Pond	95142.0001	Wareham	6.69	3.8
Turner Pd;Turners Mill	95151.0001	New Bedford	4.68	-0.8
Noquockoke L;South Basi	95170.0001	Dartmouth	6.04	2.9
Great Pond	96117.0001	Wellfleet	5.83	0.4
Kinnacum Pond	96163.0001	Wellfleet	5.1	-0.4
Round Pond	96264.0001	Brewster	5.21	-0.4
Soda Creek	2103725	Sheffield	6.87	15.7
Williams River	2104100	West Stockbridge	7.83	106.6
Sleepy Hollow Brook	2104200	Richmond	7.91	156.9
Barton Brook	2105350	Dalton	7.29	23.0
Anthony Brook	2105425	Dalton	6.7	7.0
Kilburn Brook	2105700	Peru	6.79	7.8
Bilodeau Brook	2105750	Hinsdale	7.02	22.1
Fox Brook	3106825	Granville	6.01	1.2
Benton Brook	3107375	Otis	5.98	4.8
Babcock Brook	3107625	Tolland	5.4	0.5
Valley Brook	3107700	Granville	5.7	1.0
Little River	3208725	Westfield	6.66	7.9
Walker Brook	3210300	Becket	6.84	10.8
Hinsdale Brook	3313175	Shelburne	7.72	44.8
Shingle Brook	3313850	Shelburne	7.5	44.7
North River	3314100	Colrain	7.32	17.0

Name	Palsite	Town	pH	Alkalinity (mg $CaCO_3$/L)
Kinsman Brook	3314450	Heath	7.01	10.5
Vincent Brook	3314550	Colrain	7.19	13.3
Underwood Brook	3314650	Heath	6.76	4.3
East Oxbow Brook	3314925	Charlemont	6.51	3.7
Hartwell Brook	3315075	Charlemont	7.24	19.1
Bozrah Brook	3315325	Hawley	6.98	13.4
Todd Brook	3316050	Charlemont	6.56	3.1
Lord Brook	3316550	Rowe	6.61	3.2
Bagg Brook	3417750	West Springfield	7.41	49.3
Mill River	3419825	Conway	7.41	25.1
Black Brook	3522675	Warwick	6.23	2.3
Kenny Brook	3523750	Royalston	6.08	1.0
Beaman Brook	3523825	Winchendon	5.55	1.6
Wilder Brook	3523950	Gardner	5.21	0.5
Baker Brook	3524050	Gardner	5.43	0.8
Robbins Brook	3524250	Winchendon	5.44	0.4
Sucker Brook	3625975	New Braintree	6.12	2.4
Maynard Brook	3626475	Oakham	5.41	0.3
Cadwell Creek	3626575	Pelham	5.44	0.2
West Br Swift River	3626800	Shutesbury	5.5	0.3
Hop Brook	3627000	New Salem	6.58	3.8
East Br Swift River	3627200	Barre	6.2	2.1
Flat Brook	3627500	Ware	6.28	5.4
West Br Ware River	3628175	Hubbardston	6.15	1.5
French River	4230075	Oxford	6.44	7.0
Wellington Brook	4230325	Oxford	6.47	16.0
Round Meadow Brook	5131275	Mendon	5.68	2.0
Aldrich Brook	5131425	Millville	6.04	2.0
Sewall Brook	5132600	Boylston	6.73	12.0
Cronin Brook	5132625	Grafton	6.32	3.0
Dorothy Brook	5132700	Worcester	6.28	8.0
Bungay River	5233750	North Attleborough	6.48	15.1
Torrey Creek	5334075	Seekonk	6.2	10.5
Rocky Run	5334100	Rehoboth	5.97	3.0
Clear Run Brook	5334150	Seekonk	6.63	18.7
Kickamuit River	6134500	Swansea	6.02	2.7
Rattlesnake Brook	6235125	Freetown	4.65	-0.9
Mulberry Meadow	6235775	Easton	6.37	9.0
Beaver Brook	6235800	Easton	5.78	3.8
Bassett Brook	6236100	Raynham	5.08	0.1
Godfrey Brook	7240375	Milford	6.71	16.0
Gulf Brook	8143675	Pepperell	6.9	11.3
Robinson Brook	8143825	Pepperell	7	6.9
Mcgovern Brook	8144725	Lancaster	6.99	10.6
Bartlett Pond Brook	8146000	Leominster	5.17	0.3
Millham Brook	8247475	Marlborough	6.7	20.0

Name	Palsite	Town	pH	Alkalinity (mg $CaCO_3$/L)
Ipswich River	9253500	Ipswich	6.77	14.0
Black Brook	9253700	Hamilton	6.48	9.3
Boston Brook	9253925	Middleton	6.67	9.8
Angeline Brook	9560000	Westport	4.51	-1.3
Bread And Cheese Brook	9560150	Westport	5.26	1.4
Hatches Creek	9661525	Eastham	6.18	7.6

Note: Values in red did not pass quality control