2022 Water Quality Report, Canton, Massachusetts

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Background

The Neponset River Watershed Association (NepRWA) has been collecting water quality data in Canton and throughout the Neponset River watershed since 1996. As part of the Community Water Monitoring Network (CWMN), volunteers collect monthly water samples annually from May to October. Data gathered by the CWMN volunteers are used to track the health of the Neponset River and its tributaries, inform the public about threats to human health and wildlife, and to locate pollution sources (hot spots) for follow-up sampling. There are eight permanent CWMN stations within and bordering the town of Canton; two on Pequit Brook, one on Pecunit Brook, one on Ponkapoag brook, one on Beaver Meadow Brook, one on Massapoag Brook, one on the East Branch of the Neponset River, and one on the Neponset River (Figure 1). Waterbodies in Canton are tested for *Escherichia coli* (*E.coli*), total phosphorus, pH, dissolved oxygen, and temperature once per month between May and October. Sites EAB010, MPB088, NER125, POB040, and PQB036 are also tested for ortho-phosphate and ammonia. The parameters discussed in this report are limited to those that are tested at

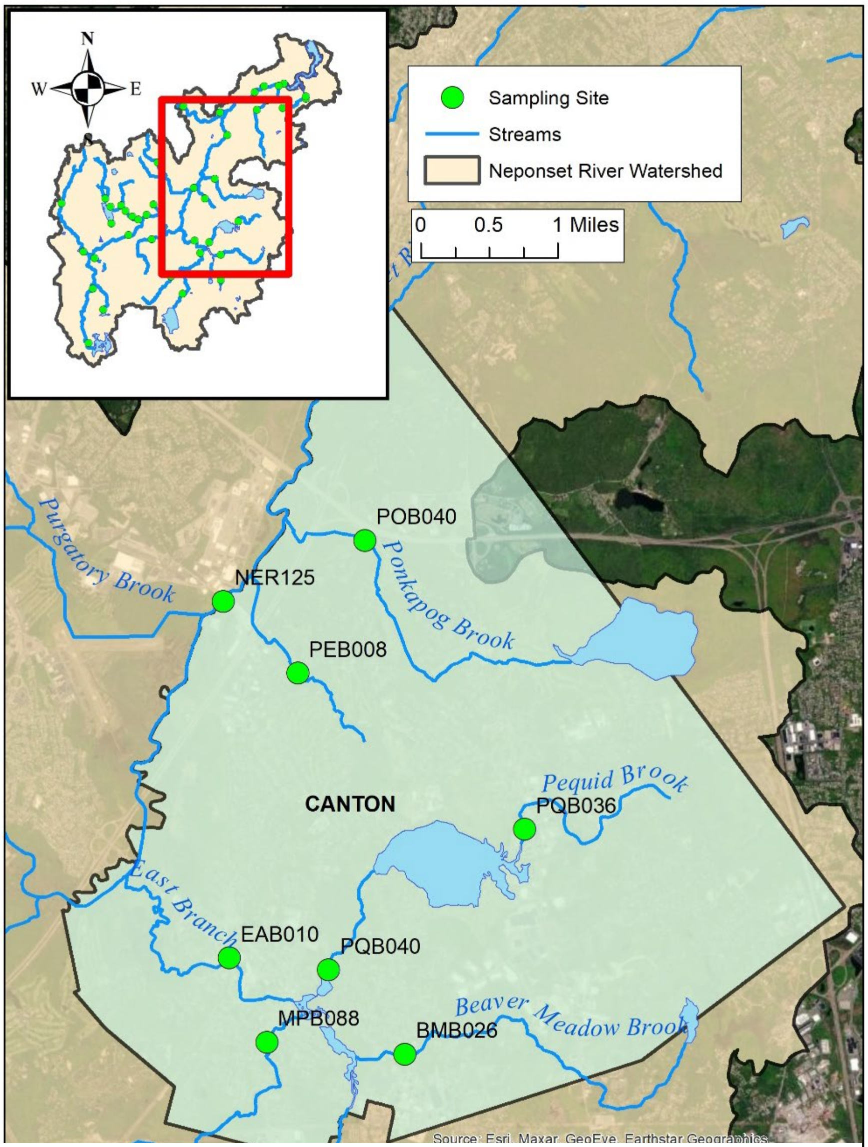

Figure 1: Map of the CWMN sites in Canton, Massachusetts.

every site, namely *E. coli*, total Phosphorus, pH, and dissolved oxygen. The raw water quality data are available upon request.

E. coli bacteria concentration is used by NepRWA and the Commonwealth to assess a waterbody's safety for "contact recreation" through activities such as swimming (primary contact) and boating (secondary contact). The presence of *E. coli* is not necessarily hazardous itself, but it provides evidence of fecal contamination and is an indicator that other, more dangerous, pathogens associated with human and animal waste might be present. The most common source of excess *E. coli* in our watershed is the improper disposal of pet waste in streets, lawns, and catch basins. Additional common sources include sewer or septic system malfunctions and discharges of organic wastes from household or commercial garbage. Wildlife waste also contains *E. coli,* so some amount of *E. coli* in waterbodies is normal. However, elevated concentrations from wildlife are typically due to human activities, such as feeding ducks or large populations of geese. Management interventions to reduce *E. coli* loads can include education on pet waste disposal, proper management of solid waste, frequent cleaning of catch basins, filtration or infiltration stormwater best management practices (BMPs) to reduce the runoff that reaches a waterbody, and rapid identification and repair of sewage leaks and spills.

Phosphorus is a required plant nutrient that is often the "limiting nutrient" in freshwater ecosystems. This means that plants and algae will grow until the lack of phosphorus limits them. Therefore, the concentration of available phosphorus in a freshwater waterbody will often control the rate of aquatic plant growth (the other required nutrients are typically present at proportionately higher levels). *Excess* phosphorus creates *excess* biomass, especially algae, leading to a process called eutrophication. When these excess plants and algae die, the process of decomposition by bacteria and other decomposers consumes dissolved oxygen from the water. In extreme cases, dissolved oxygen levels get too low to support aquatic animals such as fish. Other impacts of eutrophication include unattractive and smelly algal blooms and loss of underwater plant communities due to reduced light penetration in turbid and algae-rich waters. Elevated phosphorus concentrations can also cause *harmful* algal blooms (HABs), where toxins are produced by the algae. A notable culprit is cyanobacteria, which produce toxins harmful to people and pets as well as wildlife.

Phosphorus sources can include wet (from rain) or dry (from sprinklers) weather runoff from parking lots, streets/gutters, and lawns. These surfaces contain phosphorus from fertilizers, organic matter (leaves, grass clippings), soil, garbage, and pet waste. Interestingly, phosphorus can also accumulate on these surfaces from atmospheric deposition, from fine dust particles and aerosols. Illegal dumping of organic matter, such as leaves in or near waterways or catch basins is a common problem. Poorly maintained septic systems, illicit discharges of sewage, and naturally occurring dead aquatic plant materials are additional sources.

The pH of a waterbody is a measure of how acidic the water is, with low pH meaning the water is more acidic than neutral, and high pH meaning it is more basic or alkaline. Water that is too acidic or too basic can be toxic to aquatic life. The pH is influenced by soil and bedrock characteristics, groundwater seepage, acid rain, carbon dioxide in the atmosphere, or heavy loading of tannin rich leaves/needles.

Adequate concentrations of dissolved oxygen (DO) are necessary to support fish, amphibians, mollusks, aquatic insects, and other invertebrate species. Many environmental drivers impact the DO levels in a water body. For example, cooler water temperatures can sustain higher concentrations of DO, which is why there is often a seasonal trend in DO concentration: low levels in the warm months and higher levels in the colder months. Rapid mixing and turbulence (such as riffles or step pools) also increase levels of DO due to atmospheric mixing. Aquatic plants also generate oxygen via photosynthesis during daytime hours. Alternatively, large amounts of decaying organic matter consume dissolved oxygen as microorganisms degrade the organic matter and lower levels of DO result, particularly in overnight hours when decomposition is not offset by active photosynthesis. Excessive phosphorous that causes eutrophic conditions is also closely associated with low dissolved oxygen levels, because it drives plant growth and subsequent decomposition. In thermally stratified lakes, oxygen deficient conditions can occur in the deeper portions of the water where there is no atmospheric mixing and no photosynthesis (the two sources of DO in aquatic systems). In the summer, ponds and lakes typically have warmer surface waters and thus lower surface DO concentrations. Management interventions that can increase DO levels include increasing riparian shading to maintain lower water temperatures, removing obsolete dams, reducing excessive water withdrawals / diversions, and reducing decaying organic matter though the reduction of phosphorous runoff and other drivers of eutrophication.

Results and Discussion

Monthly sampling events occur rain or shine on the second Thursday of the month during the sampling season. This means that weather is not a criterion in determining when to collect water quality data. This allows our sampling program to address the different conditions that occur in our waterbodies in wet vs. dry weather. Rain events result in significant increases in street runoff via stormwater and overland flow into our rivers, which can significantly alter the concentrations of bacteria, nutrients, and other chemicals. In 2022, despite the seasonal drought, four sampling days occurred during wet periods and only two sampling days occurred during a dry period. A wet period is defined as greater than 0.1 inches of precipitation within the 48-hour period preceding a sampling event. As shown in Table 1, both 2021 and 2020 had more sampling events occur during dry weather than any year since 2016, when all six sampling events occurred during dry weather. The lack of additional data during wet weather for the past 2 years suggests we should be cautious about any relative improvements or declines in parameters, especially for *E. coli*, as changes year to year may reflect wet vs. dry dynamics rather than real improvements to water quality or changes in the frequency of sewage spills.

Table 1: The number of water quality sampling days that occurred during dry or wet weather since year 2012.

Year	Dry (days)	Wet (days)
2012	2	4
2013	5	1
2014	4	2
2015	4	2
2016	6	0
2017	4	2
2018	3	3
2019	3	3
2020	5	1
2021	5	1
2022	2	4

Escherichia coli (E. coli)

In Massachusetts, the criteria that defines acceptable levels of *E.coli* in Class B waterbodies (waterbodies that support wildlife, swimming, and boating, but not drinking) was formerly set by a single sample maximum (235 Colony Forming Units (CFU) per 100 mL) and geometric mean calculation (not to exceed 126 CFU/100mL). Changes in the 2022 sample year now have criteria set by both a statistical value threshold (<10% of samples should exceed 410 CFU/100mL) and a rolling geometric mean calculation (not to exceed 126 CFU/100mL in 20% of windows). Because NepRWA's sampling is performed monthly, and the purpose of these reports is to provide meaningful historic comparison, the new criteria will not be applied in this report. For Canton sites, this means no single sample should exceed 235 CFU/100 mL (the single sample standard), nor should the geometric mean of at least 5 samples taken within the same season exceed 126 CFU/100mL (the seasonal standard). For ease of interpretation, NepRWA calculates the geometric mean on the whole sampling season (6 sampling events).

In 2022 maximum *E. coli* levels at all eight sampling sites exceeded the 235 CFU/100mL single sample limit and the 126 CFU/100mL seasonal average (Table 2). The highest levels were observed at Pecunit Brook, which had more than ten times the threshold values for both maximum and seasonal average. Minimum *E. coli* levels were acceptable at all eight sites. The seasonal standard was lowest at two sites: NER125 and EAB010, both on the "mainstem" of the river (Table 2). This suggests an issue with the tributaries in Canton. Additionally, two tributary sites still exceeded the state criteria in our May and October samples. These were both dry weather sampling days, with less runoff influence, and also outside the optimal bacteria growth conditions (i.e. summer). Combined with data from 2021, which showed all tributary sites above state guidelines in summer dry weather as well, Canton tributaries are experiencing both runoff and potential sewage related issues.

Table 2: The maximum, average, minimum, and geometric mean levels of *E. coli* at the eight sampling sites in Canton, MA, year 2022. N=6 for each site. Units are in cfu/100ml. Bold rows and values were sites with *E. coli* levels that failed the single sample limit at least once. An * means the seasonal sample limit was surpassed.

CWMN Site	Maximum	Average	Minimum	Geometric Mean
BMB026*	**1400**	**566**	20	**239**
EAB010*	**933**	**325**	41	**169**
MPB088*	**1610**	**596**	109	**403**
NER125*	**862**	**273**	20	**128**
PEB008*	**12000**	**6944**	52	**3062**
POB040*	**2010**	**550**	41	**256**
PQB036*	**1870**	**792**	31	**363**
PQB040*	**5170**	**2086**	10	**635**

Table 3: The maximum *E. coli* levels from samples in 2022 in wet and dry weather. N = 4 for wet weather and N = 2 for dry weather. Bolded values indicate *E. coli* levels above state criteria, and bolded sites names reflect sites above the criteria even in dry conditions.

Site	Dry	Wet
BMB026	31	**1400**
EAB010	97	**933**
MPB088	**448**	**1610**
NER125	74	**862**
PEB008	**7700**	**12000**
POB040	74	**2010**
PQB036	145	**1870**
PQB040	97	**5170**

Wet weather events were generally associated with higher *E. coli* levels in past years at all the sampling sites in Canton, with the exception of 2020 (Figure 2). While this is unusual, because of the low sample size of wet weather that year (N=1), it may represent outlier data. For the 2022 data, the wet/dry patterns follow the typical trends for most sites.

Pecunit Brook appears to have the greatest problem with *E. coli* for the streams in Canton in 2022. In both wet and dry weather, Pecunit Brook was well above the state criteria, with wet weather samples higher than in the last ten years and dry weather values were the worst recorded since 2016 (Figure 2). However, all Canton tributaries had three or more sampling events above the state criteria for single station maximums, suggesting a systemic problem at these sites with *E. coli*. Because dry weather sampling only occurred outside the summer months, we cannot say if there is a systemic problem due to rain events or if other factors may be contributing. While E. coli is a concern at all Canton sites, the number of high *E. coli* counts in the smaller brooks raises particular concerns about the health of these tributaries.

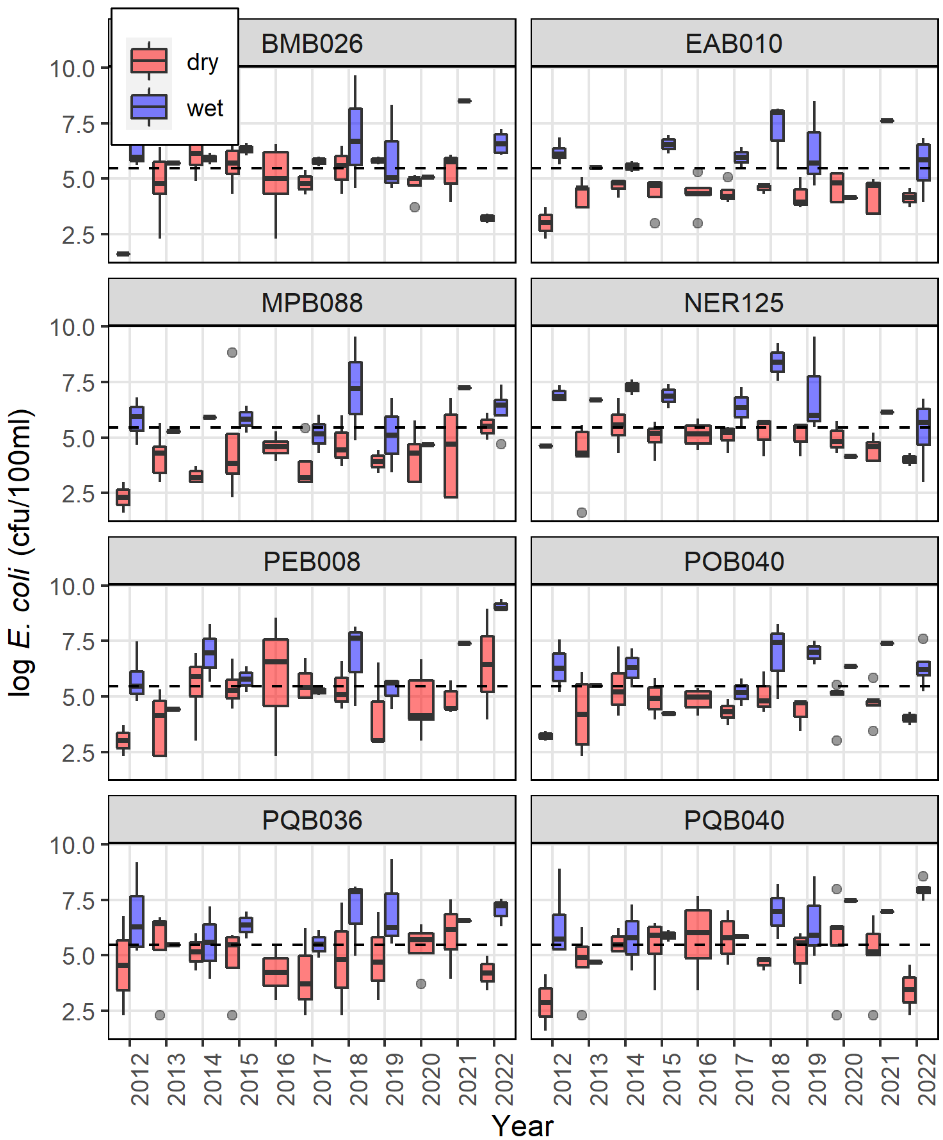

Figure 2: *E. coli* levels at the eight sampling sites in Canton from years 2012 to 2022 – note the log scale, which allows exponential data to be viewed more easily. The plot shows levels grouped by weather (blue = wet, red = dry). The black dashed line shows the single sample maximum acceptable threshold (235 CFU/100mL). The lower and upper bounds of each box correspond to the first and third quartiles (the 25th and 75th percentiles). The upper whisker extends to the largest value or no further than 1.5 * the range between these two quartiles. Similarly, the lower whisker extends from the hinge to the smallest value or 1.5 * this interquartile range. Data beyond the end of the whiskers are “outlying" points and are plotted individually.

Phosphorus

The Commonwealth of Massachusetts does not currently provide numerical standards for classification of water quality impairments by phosphorus alone. Instead, the Massachusetts Department of Environmental Protection (MassDEP) uses a narrative standard that considers the EPA gold book standard for phosphorus alongside dissolved oxygen levels and excessive primary producer growth. The EPA gold book standard identifies an average of at least three samples exceeding 0.1mg/L as the upper threshold for flowing waters and 0.05mg/L for streams entering a lake/reservoir. We considered four sites in Canton to be flowing waters and four sites to be entering a lake or reservoir (Table 4). Dissolved oxygen and excess primary producer growth, like algal blooms, are used as evidence that phosphorus levels are causing an impact to the stream ecology.

In 2022, no Canton sites had seasonal phosphorus averages that were above the EPA standards. However, BMB026, MPB088, and PQB036 all had maximums above the phosphorus threshold and all had averages that equaled the standard - notably these three sites are where the stream is entering a lake or reservoir with a more stringent criteria (Table 4). The other four sampling sites, all flowing waters, were below the threshold.

Table 4: The maximum, average, and minimum values of total phosphorus recorded during 2022 at the 8 sampling sites in Canton. Sites broken out into flowing waters or those entering a lake or reservoir. Bolded rows have a seasonal average that exceed the EPA gold book standard for total phosphorus. N=6 for each site.

Site	Maximum (mg/l)	Average (mg/l)	Minimum (mg/l)	Standard (mg/l)
Flowing				
EAB010	0.06	0.04	0.02	0.1
NER125	0.08	0.06	0.03	0.1
PEB008	0.1	0.07	0.04	0.1
POB040	0.1	0.07	0.03	0.1
Entering Reservoir				
BMB026	0.07	0.05	0.03	0.05
MPB088	0.1	0.05	0.02	0.05
PQB036	0.07	0.05	0.02	0.05
PQB040	0.05	0.03	0.02	0.05

The levels of total phosphorus in 2022 at the flowing water sites do not appear to be concerning (Figure 3). However, in the past few years, site POB040 has had total phosphorus levels above the threshold multiple times. While they remained below concern this year, they did increase relative to 2021. Similarly, Pecunit Brook had elevated phosphorus levels this year relative to the last decade, which combined with the bacteria data discussed above makes more investigation at Pecunit Brook merited.

In contrast, the levels of total phosphorus at the sites with the more stringent standard did not comply with the standard at three of the four sites. Pequit Brook appears to have the largest problem with total phosphorus levels, particularly at PQB036. However, three of the four sites showed a decline or no change relative to previous years (Figure 4). Site PQB036 water samples have had concerning phosphorus levels during a majority of sampling events since 2012. At site PQB040 total phosphorus levels appeared to be increasing annually since 2017, yet the last 2 years showed a reduction. Finally, total phosphorus levels for Massapoag Brook has shown an increase in phosphorus over the last 3 years, which should be investigated.

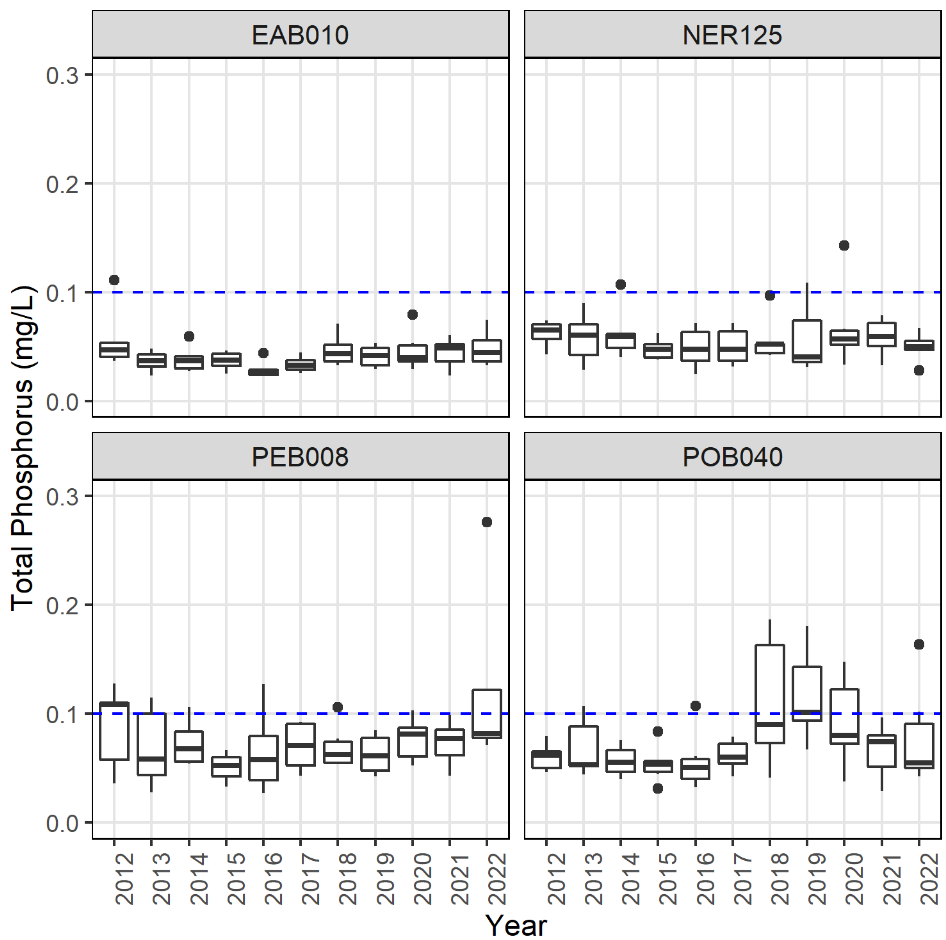

Figure 3: Total phosphorus levels at the four flowing water sites in Canton from year 2012 to 2022. The blue dashed line is at 0.1mg/l. Boxplot statistics are the same as Figure 2.

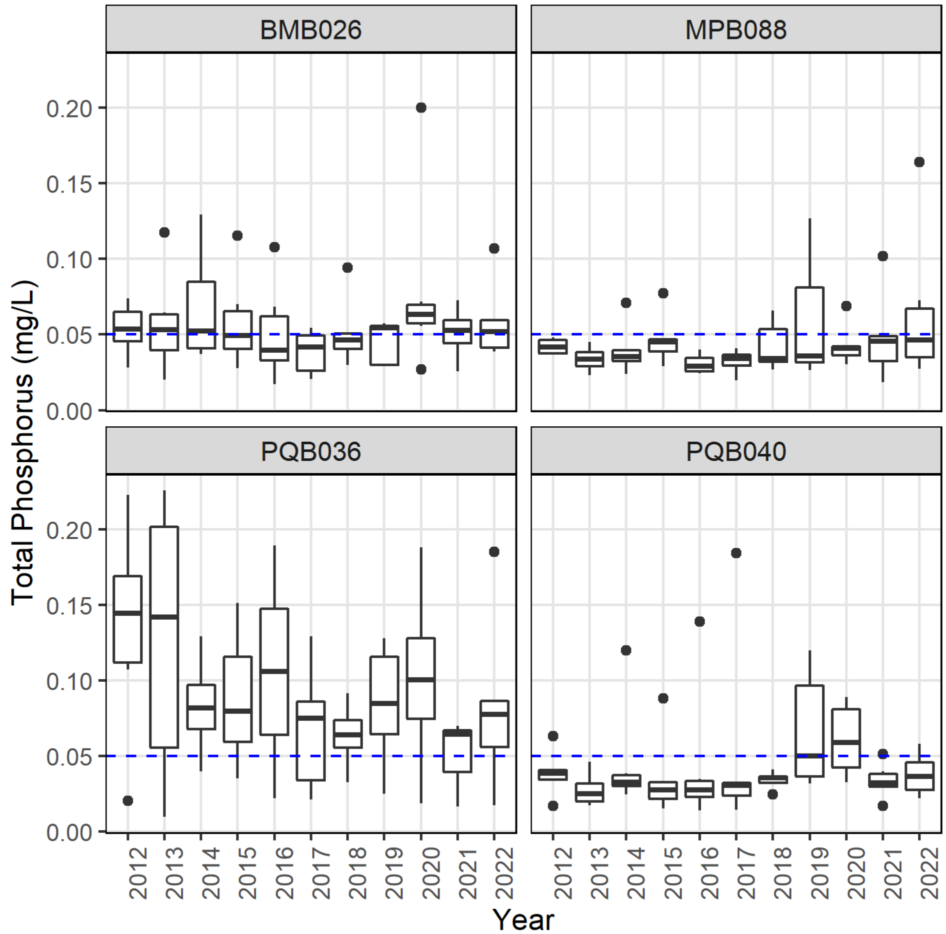

Figure 4: Total phosphorus levels at the four stream sites that are entering a lake or reservoir in Canton from year 2012 to 2022. The blue dashed line is at 0.05mg/l. Boxplot statistics are the same as Figure 2. Note that the y-axis range is different than Figure 3.

Massachusetts DEP asks for additional information to help identify a problem with total phosphorus, such as primary producer data. While we do not have primary producer data at these sites, many sites in Canton have a strong negative correlation between total phosphorus levels and dissolved oxygen levels (Table 5), which can be a symptom of eutrophication. The strongest correlations are observed at PQB036, followed by POB040, and BMB026.

Table 5: Correlation coefficient (r) between total Phosphorus levels and dissolved oxygen levels at the eight sites in Canton, MA using data from 2012 - 2022.

Site	r
PQB036	-0.43
POB040	-0.40
BMB026	-0.36
NER125	-0.31
PEB008	-0.25
PQB040	-0.21
MPB088	-0.15
EAB010	0.06

pH

The Commonwealth of Massachusetts considers a pH range between 6.5 and 8.3 SU (standard units) to be healthy for waterbodies in the state. All sites in Canton failed to meet the pH standard in 2022 for at least one sampling events, possibly due to low flow conditions in the drought (Figure 5). Of particular concern is NER125, PEB008, POB040, PQB036, and PQB040, all of which had more than half of their samples below the 6.5 SU threshold. Such largescale change at multiple sites in Canton, and seen across the watershed, is likely drought related, but these values should be closely monitored over the next few years.

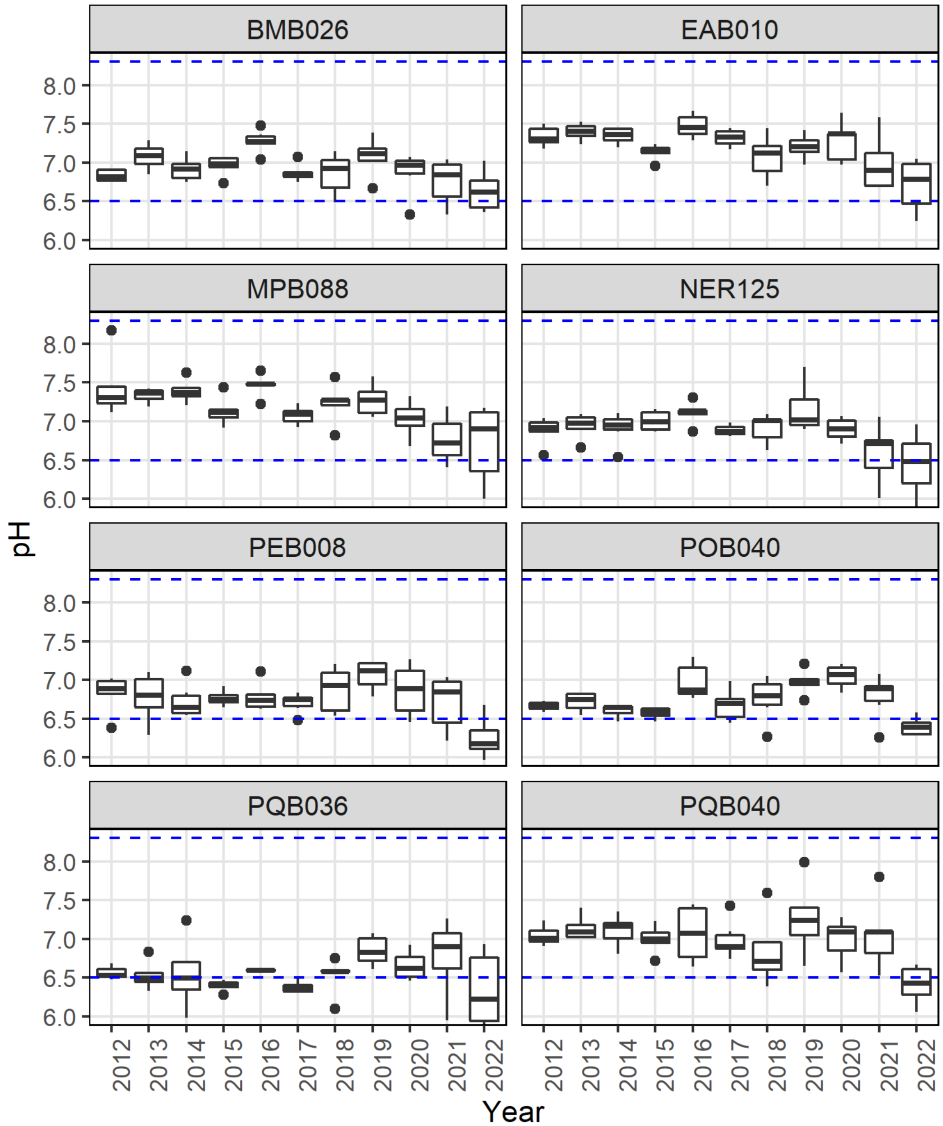

Figure 5: The pH levels at the eight sites in Canton for years 2012 through 2022. Boxplots statistics are the same as Figure 2. The blue dashed lines are at pH = 6.5 and pH=8.3, the criteria range for pH level in Massachusetts.

Dissolved Oxygen:

The Commonwealth of Massachusetts considers DO levels below 5 mg/L to be stressful to all aquatic organisms and 6 mg/L to be stressful to certain species of fishes that require colder water. Ponkapoag Brook is listed as a Coldwater Fish Resource by the Massachusetts Division of Fisheries and Wildlife, so we apply the 6 mg/l threshold for this site and the 5mg/l threshold elsewhere. However, it is important to note that the Massachusetts DEP does not recognize Ponkapoag Brook as a cold-water fishery stream and they are therefore not regulated as such under the Surface Water Quality Standards.

Levels of DO at five sites were lower than the thresholds at some point during the sampling season, with only EAB010, MPB088, and PQB040 consistently meeting standards (Figure 6). NER125, PEB008, and POB040, all dipped below their respective criteria during the sampling year, but only slightly. PQB036 experienced the worst dissolved oxygen values, with 3 sampling events with hypoxic conditions (<3mg/l), which cannot support many aquatic species. It is not surprising that these this site also had the strongest negative correlation between phosphorus levels and dissolved oxygen, suggesting eutrophication may be playing a role here. Finally, BMB026 showed highly variable dissolved oxygen values, dipping into borderline hypoxic conditions several times over the year. Some dissolved oxygen dropping can be attributed to low flow and stagnation during the drought, however, PQB036 has consistently had issues that deserve more detailed investigation.

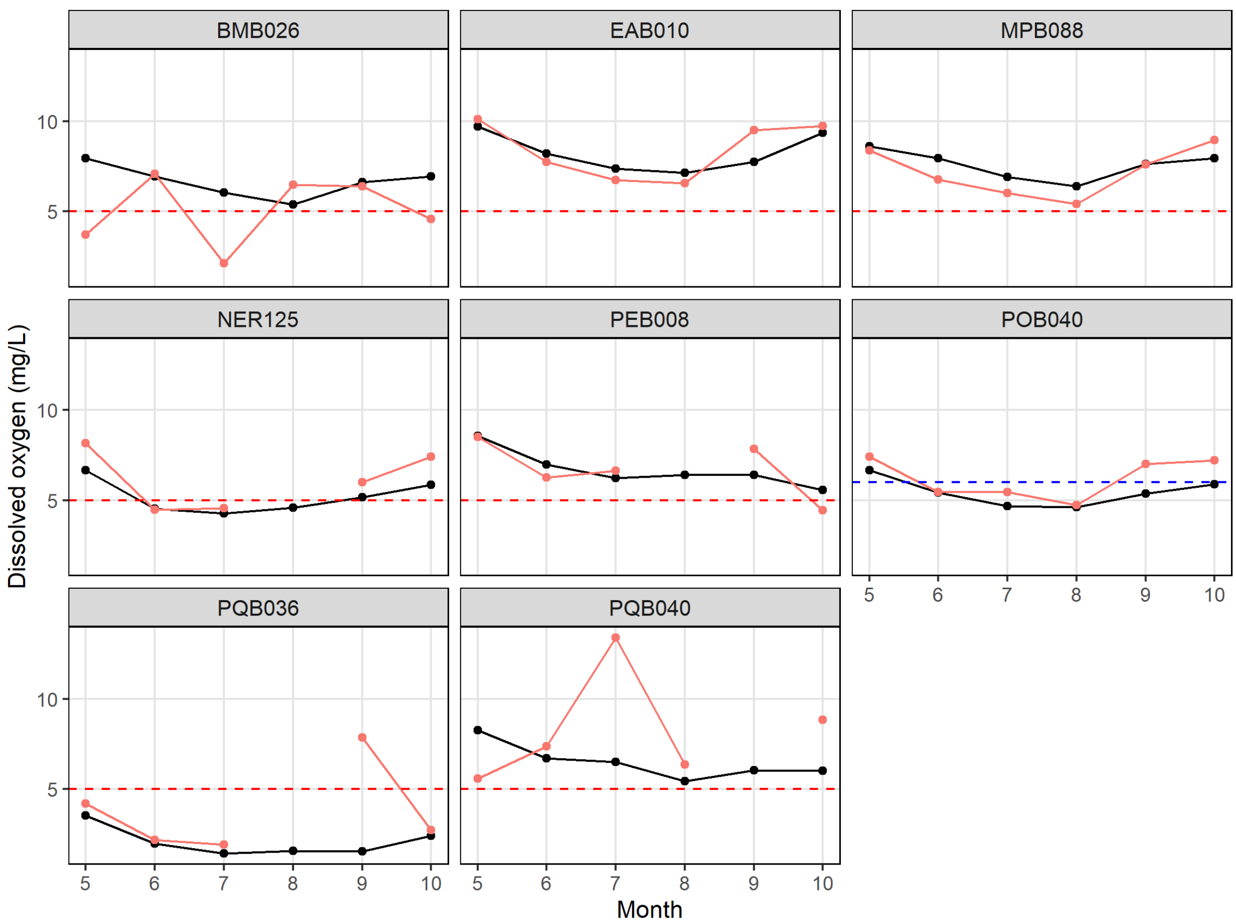

Figure 6: Monthly dissolved oxygen levels at each of the eight sites in Canton. The black line shows the mean monthly value from 2012 to 2021 and the red line shows the 2022 values. The red dashed line is at dissolved oxygen = 5mg/l and the blue dashed line is at dissolved oxygen = 6mg/l (Ponkapoag Brook only).

Conclusion

The water quality data that we collect through the CWMN program is used to inform our messaging to the public and follow up site visits to sites to investigate problems (hot spot sampling). Table 6 details our recommendations and items to discuss with the Town.

Table 6: Major parameters of concern by site with recommendations on first steps to address the problem. * signifies a critical problem. DO = Dissolved oxygen.

Site	Parameter	Recommendation
PQB036 **Pequit Brook @ Del Pond Dr.**	DO*	• Reduce nutrient loads and organic content • Evaluate ways to increase flow rates and shading throughout the summer and fall • Consider continuous monitoring of DO with loggers to identify key changes over time
	TP*	• Sample for primary producers (algae, Chlorophyll-a) and survey for overgrowth of aquatic plants in stream and at Reservoir Pond • Identify sources of TP (runoff or inflows)
	E. coli	• Identify source of persistent issues with bacteria, including during dry weather (possible sewage contamination) • Conduct bacterial source identification survey
NER125 **Neponset River @ Dedham St Bridge**	DO*	• Evaluate flow rates and shading in summer • Evaluate loads of organic matter, consider
POB040 **Ponkapoag Brook @ Elm St**	DO	• Reduce nutrient loads • Assess shading and flow rates during the summer months
	TP	• Identify sources and any changes that may have resulted in lower TP this year • Assess aquatic plant growth via survey

PQB040 **Pequit Brook @ Sherman St.**	TP	• Identify sources and cause for increase • Sample for primary producers in Forge Pond
	E. coli	• Identify source of peak levels consistent high levels during the other dry weather sampling events. • Identify sources of wet weather elevated levels. Sample during more rain events to increase the sample size of wet weather and determine if the elevated levels in 2020 are a continuing issue or a one-time event.
BMB026 **Beaver Meadow Brook @ Pine St.**	*E. coli*	• Identify wet weather sources of bacteria, develop BMPs to intercept high runoff flows
PEB008 **Pecunit Brook @ Elm St.**	TP	• Identify sources and cause for increases
	E. coli	• Identify highly elevated 2022 bacteria source, potentially follow up with source identification tracking for both dry and wet weather sources. • Develop wet weather runoff interception (BMPs)
MPB088 **Massapoag Brook @ Walnut St.**	*E. coli*	• Determine cause of consistently high bacteria loads in both wet and dry weather 2022.
EAB010 **East Branch @ Neponset St.**	*E. coli*	• Determine best interventions to divert wet weather runoff to limit high bacteria loads.