# Water Quality Summary: pH

## 2017 Barr Lake & Milton Reservoir

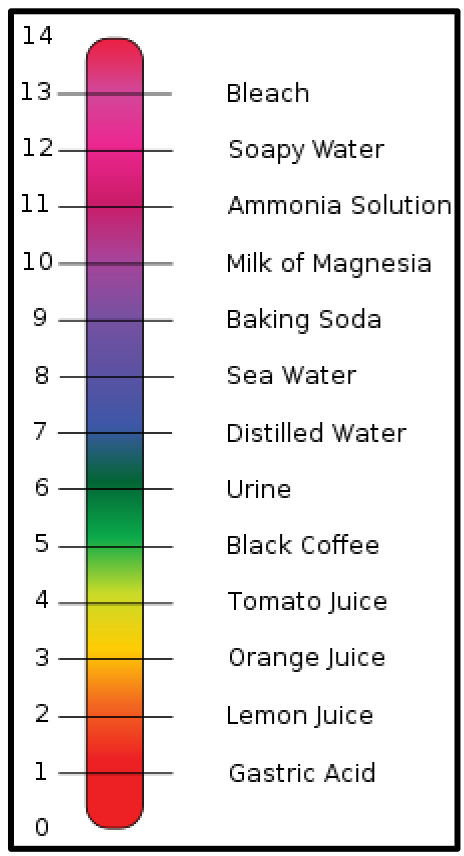
Twenty times a year since 2003, **Barr Lake** and **Milton Reservoir** have been sampled for water quality. These 300 trips to both reservoirs have produced an abundance of data and information. This is Part 1 of 8 of a water quality summary series for 2017 calendar year for both reservoirs. This first summary focuses on pH.

**The Big Picture** – Eutrophication is the addition of nutrients to water bodies resulting in nuisance algae growth and sedimentation. This natural process usually occurs over a long geological period of time. Many lakes, reservoirs, and even estuaries and bays throughout the world experience "*cultural eutrophication*". This term means that water bodies tend to become more productive and shallower over relatively short periods of time due to increased inputs of nutrients and sediments from human activities. Accelerated aging of lakes causes a quick biological response – severe algae growth. This response then leads to other chemical and physical changes within the water – pH, oxygen, water clarity and color, fish, plants, and aesthetics can all change.

**pH –** This is the measurement of how many hydrogen ions ($H^+$) are in the water (scale is 1 through 14). The higher the concentration of $H^+$, the more acidic or lower the number (scale of 1-6). The lower the $H^+$ concentration, the more basic or higher the number (scale of 8-14). Pure water has a neutral pH around 7.0. Normal rainfall is about 5.6 because of exposure to the air.

Colorado's water quality standard is a pH between 6.5 and 9.0. To determine if a lake is satisfying this standard, pH data are collected from the surface (epilimnion) and bottom of the lake (hypolimnion). pH is important when it comes to aquatic organisms such as fish.

**2017 pH Data –** For Barr Lake and Milton Reservoir, pH data are collected throughout the entire water column in half meter increments during each visit. pH measurements from 0.5 meter to 2.0 meters are then averaged for each visit for the top water. For 2017, there were 20 pH averages recorded for each reservoir (Table 1). The data are then ranked from highest to lowest. The 85$^{th}$ percentile pH value is the one that has 15% of the values higher and 85% of the values lower. For **Barr Lake**, the 2017 85$^{th}$ percentile pH value was 9.15 and for **Milton Reservoir** it was 9.25. Both reservoirs have met the pH standard for three out of the five past years using in-reservoir water quality data.




pH Scale 1 to 14

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Table 1. 2017 Barr Lake and Milton Reservoir average pH for the top water (0.5 – 2.0 m) for each sampling event and the 85th percentile. Bold values exceed the water quality standard.

| Barr Lake | | | | Milton Reservoir | | | |
|---|---|---|---|---|---|---|---|
| **Month** | **pH** | **Rank** | **%tile** | **Month** | **pH** | **Rank** | **%tile** |
| **Jan** | **9.00** | **9.36** | ***100*** | **Jan** | 8.38 | **9.67** | ***100*** |
| **Feb** | 8.43 | **9.31** | | **Feb** | 8.70 | **9.33** | |
| **Mar** | 8.96 | **9.23** | ***90*** | **Mar** | **9.19** | **9.26** | ***90*** |
| **Mar** | 8.78 | **9.15** | ***85*** | **Mar** | **9.33** | **9.25** | ***85*** |
| **Apr** | **9.14** | **9.14** | ***80*** | **Apr** | **9.67** | **9.19** | ***80*** |
| **Apr** | 8.62 | **9.12** | | **Apr** | **9.08** | **9.10** | |
| **May** | **9.06** | **9.06** | ***70*** | **May** | **9.01** | **9.08** | ***70*** |
| **May** | 8.72 | **9.00** | | **May** | 8.55 | **9.04** | |
| **Jun** | 8.94 | 8.96 | ***60*** | **Jun** | 8.65 | **9.03** | ***60*** |
| **Jun** | **9.12** | 8.95 | | **Jun** | **9.04** | **9.01** | |
| **Jul** | **9.31** | 8.94 | ***50*** | **Jul** | **9.25** | 8.96 | ***50*** |
| **Jul** | **9.23** | 8.87 | | **Jul** | **9.10** | 8.93 | |
| **Aug** | 8.86 | 8.86 | ***40*** | **Aug** | 8.93 | 8.90 | ***40*** |
| **Aug** | **9.36** | 8.86 | | **Aug** | **9.26** | 8.80 | |
| **Sep** | 8.95 | 8.78 | ***30*** | **Sep** | **9.03** | 8.76 | ***30*** |
| **Sep** | 8.71 | 8.72 | | **Sep** | 8.80 | 8.70 | |
| **Oct** | 8.55 | 8.71 | ***20*** | **Oct** | 8.96 | 8.65 | ***20*** |
| **Oct** | 8.87 | 8.62 | | **Oct** | 8.90 | 8.55 | |
| **Nov** | **9.15** | 8.55 | ***10*** | **Nov** | 8.76 | 8.46 | ***10*** |
| **Dec** | 8.86 | 8.43 | | **Dec** | 8.46 | 8.38 | |

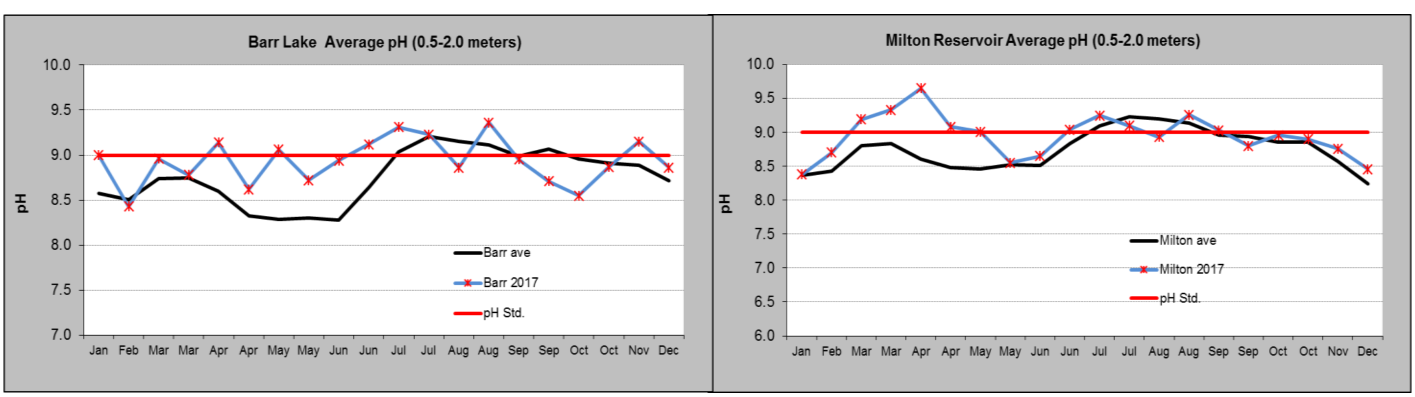
*There is no seasonality for the pH standard, all data collected in a year are included in the calculations.*

*With 20 sampling events, only three can be higher than 9.0. The fourth highest pH value is the 85th percentile number.*

The median (50th percentile) pH for **Barr Lake** in 2017 was 8.94 and for **Milton Reservoir** it was 8.96. Both reservoirs experienced a typical spring time diatom bloom and followed by algal blooms during the summer. The lowest pH for Barr Lake occurred in February when the reservoir had little algal growth. For Milton, the lowest pH occurred during January and February when the water was coolest.

Figures 1 shows the annual pH patterns, upper pH standard, and 2017 pH values. The annual algae growth cycle determines the annual pH pattern. It important to notice that the background pH is over 8.0 so there is not much room for higher pH values.

Figure 1. 2017 pH data compared to WQ target and 2003-2017 annual average



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**Algae and pH –** How does the growth of algae change the pH of a lake? When algae grow, they photosynthesize. This is the process of taking in $CO_2$ and water in the presence of sunlight and producing oxygen and sugar (food) for growth. Taking $CO_2$ out of the water results in less carbonic acid ($H_2CO_3$). Less carbonic acid means less $H^+$ in the water, and therefore a higher pH. If the algae grow fast, the reservoir does not have enough time to get back into equilibrium with the atmosphere to dissolve more $CO_2$.

The opposite can also occur; decomposition of the algae at the lake bottom consumes oxygen and produces $CO_2$. Bottom water can get below pH of 6.0 (acidic) because of the carbonic acid formation. Due to water movement and alkalinity (ability of the water to neutralize acids), this does not happen in **Barr Lake** or **Milton Reservoir**.