



Portland Water District

Sebago Lake Watershed Monitoring Programs Crooked River Monitoring (2023)

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Introduction

Sebago Lake is the primary drinking water supply for the greater Portland area. The Portland Water District (PWD) treats and delivers drinking water to over 200,000 people in 11 communities. PWD has a waiver from the filtration requirements of the federal Safe Drinking Water Act. There are many criteria for obtaining and keeping the waiver, but one of the largest factors is the continued excellent water quality of Sebago Lake and PWD's watershed protection efforts. This waiver agreement requires ongoing monitoring of lake water quality.

PWD monitors Sebago Lake and the rivers and streams that drain to it through more than 10 monitoring and surveillance programs. In general, more samples are collected and tested for more parameters the closer one moves to the intake pipes, located in Lower Bay.

The water quality of Sebago Lake is influenced by many factors, one of which is the condition of the watershed. A watershed is the land area that drains to a water body. In the case of Sebago Lake, the watershed includes part or all of 24 towns from Standish to Bethel. The majority of the watershed is forested, and because forests act as a natural filter, the water quality of the lake is excellent.

The Crooked River run was created to be an indicator of conditions in the watershed. If problems arise on the land that drains to the lake, one would expect to see it in the tributaries first.

This report covers the Crooked River Monitoring Program. The Crooked River originates at the southern end of Songo Pond in Bethel and meanders southward for approximately 38 miles to its junction with the Songo River near the State Park in Naples, Maine. The two rivers then wind two more miles to their outlet in the northernmost part of Sebago Lake. The District has monitored the Crooked River for over 40 years. Since the Crooked contributes nearly 40% of the surface inflow to the lake, it is the most important tributary we monitor.

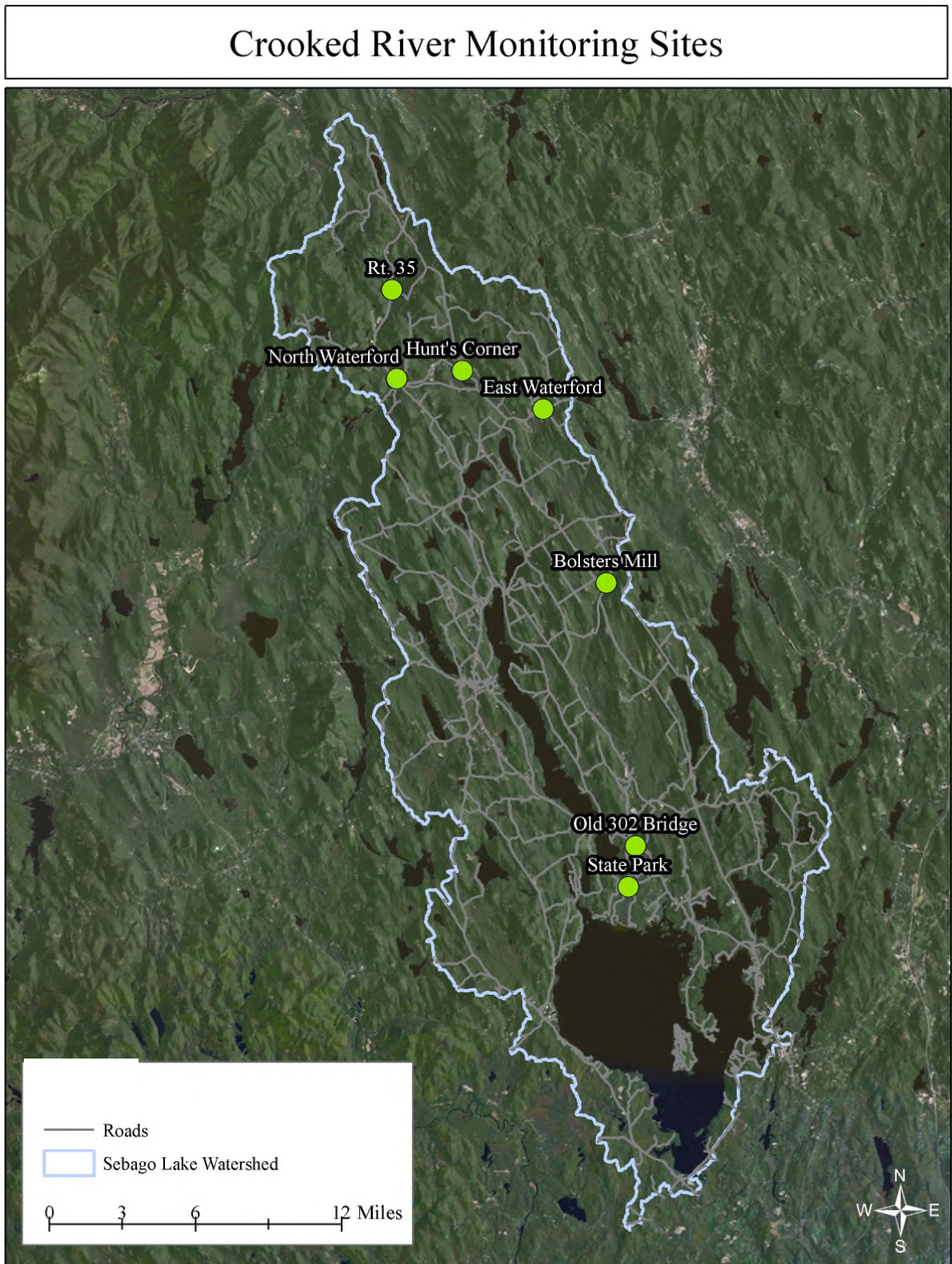
Methods

The Crooked River is monitored four times a year from the Sebago Lake State Park in Naples to a bridge on Rt. 35 in Albany Township for the following analytes: turbidity, total phosphorus, and *E. coli* bacteria. A total of seven sites are monitored as part of the program. These sites listed from North to South are as follows: Route 35, North Waterford, Hunt's Corner, East Waterford, Bolster's Mills, Old 302 Bridge, and State Park (see Figure 1). Of these sites, the southern-most sampling point (State Park) has been monitored for the longest period of time, and at the highest frequency. This is due in part to the fact that this site is also included in the Tributary Monitoring Program (see the 2023 Tributary Monitoring Report).

For the purposes of this report, data from the State Park site will be used to characterize the Crooked River's overall contribution to Sebago Lake. All data collected from this site are presented.

Sampling is performed using a "dipper" to lower acid-washed total phosphorus collection flasks and sterilized bacteria collection bottles into the water, usually from a bridge over the river. Total phosphorous samples are analyzed using the ascorbic acid method and a spectrophotometer in the District's water quality laboratory. *E. coli* samples are analyzed using the IDEXX Colilert method and are incubated at 35 degrees Celsius for 24 hours. Turbidity is analyzed using a laboratory benchtop turbidimeter. In 2019, the Hach 2100N Turbidimeter was replaced with a Hach TU5200 Turbidimeter. Data presented in this report pertain to data collected at the State Park sample site as a measure of the overall contribution of total phosphorus, *E. coli* bacteria, and turbidity from the Crooked River to Sebago Lake. Data from all seven sample sites for 2023 are included in the appendix of this report.

Figure 1.



Results and Discussion

Total Phosphorus

Phosphorus is one of the major nutrients needed for plant growth. It is generally present in relatively small amounts in temperate lakes. Phosphorous is often the limiting nutrient for algal growth in the system, meaning that as phosphorus increases, the amount of algae also increases. Phosphorus levels are generally higher in flowing tributaries than in a lake. When tributary water enters a lake, phosphorus becomes diluted and sediments with phosphorus attached settle out on the lake bottom. Total phosphorus includes phosphates attached to sediment as well as dissolved forms of phosphorus and is measured in parts per billion (ppb). A reading of 35 ppb is the action level established by the District. Sampling events that result in total phosphorus levels above 35 ppb are reviewed and appropriate corrective measures are taken if possible.

Total phosphorus has been monitored at the State Park sampling site since 1977, at Bolster's Mills, East Waterford, Hunt's Corner, North Waterford, and Route 35 since 1993, and at the Old 302 Bridge site since 1995.

No total phosphorus concentrations exceeded the action level at the State Park or any other site on the Crooked River in 2023. To determine if 2023 data are normal results, the mean (M) and standard deviation (SD) are calculated for the State Park data set. A value that is within two standard deviations of the mean is considered normal, and those outside are outside of the normal range. In 2023 State Park total phosphorus levels ranged from 13 ppb to 21 ppb (Table 1) and all levels were within the normal range (M=16.2, SD=12.4) for data collected from 1977 to 2022. A lab error caused all of the total phosphorus analysis in April and some of the results in June 2023 to be invalid.

Table 1. 2023 Total phosphorus (ppb) results for the State Park site on the Crooked River, Naples, ME. No total phosphorus samples exceeded the action level in 2023.

6/12/2023	13.3
8/7/2023	16.4
8/28/2023	15.7
10/16/2023	15.6
10/23/2023	21.4

Escherichia coli Bacteria

E. coli bacteria is a type of fecal coliform bacteria found in the gastrointestinal tracts of warm-blooded animals. The presence of *E. coli* in water is a strong indication of recent sewage or animal waste contamination. Sewage may also contain many other types of disease-causing organisms such as Giardia, Cryptosporidium, typhoid, viral and bacterial gastroenteritis, and hepatitis A. Natural occurrences can also cause elevated *E. coli* levels. Examples include significant precipitation events that wash pollution from impervious surfaces and areas of development (animal feces, etc.) into the river, and the erosion of soil into the river since a small percentage of fecal bacteria is associated with soil. *E. coli* levels tend to be higher in the tributaries but become diluted when the tributary water enters the lake. The District's action level for *E. coli* is 235 MPN/100 mL in accordance with the Maine Healthy Beaches Program. Sampling events that result in *E. coli* levels above 235 MPN/100mL are reviewed or re-sampled if the cause is unknown.

On June 5th *E. coli* results exceeded the action level at the State Park with a reading of 248 MPN/100 mL and at the Old 302 Bridge with a reading of 238 MPN/100 mL. Both sites were re-sampled on June 7th and results had fallen below the action level to 42 MPN/100 mL at the State Park and 41 MPN/100mL at Old 302 Bridge. To determine if 2023 data are normal results, the mean (M) and standard deviation (SD) are calculated for the State Park data set. A value that is within two standard deviations of the mean is considered normal, and those outside are outside of the normal range. In 2023 *E. coli* levels ranged from 2 MPN/100 mL to 248 MPN/100 mL at the State Park (Table 2). The high result in June was outside of the normal range (M=56, SD=72.6) for data collected from 2009 to 2022 at the State Park. The likely cause of the June elevated readings was a rain event in which 1.25 inches of rain fell within 48 hours prior to sampling.

Table 2. 2023 *E. coli* (MPN/100 mL) results for the State Park site on the Crooked River, Naples, ME. One *E. coli* sample exceeded the action level in 2023.

1/24/2023	Frozen
2/14/2023	6
3/29/2023	2
4/11/2023	7
4/18/2023	30
5/9/2023	9
6/5/2023	248
6/12/2023	63
7/25/2023	51
8/7/2023	46
8/28/2023	75
9/26/2023	35
10/16/2023	64
10/23/2023	62
11/20/2023	8
12/19/2023	173

Turbidity

Turbidity refers to the amount of suspended particulate matter in the water. Turbidity measurements are performed through the use of a turbidimeter, in which a beam of light is passed through a water sample and the light output is measured on the other side. The greater the amount of suspended particulate matter in the water, the more the light beam is refracted and blocked, and the higher the turbidity. In streams, the three major types of suspended particulates that contribute to turbidity are algae, detritus (dead organic material), and silt (inorganic or mineral suspended sediment). High turbidity decreases light penetration and facilitates eutrophication of rivers and lakes. Particulates also provide attachment sites for heavy metals such as cadmium, mercury and lead, and many toxic organic contaminants such as PCBs and many pesticides. Turbidity is measured in NTU (nephelometric units). Generally, readings below 1 NTU indicate water that appears “clear” to the naked eye. Readings greater than 4 NTU indicate water that would appear cloudy or murky. A reading of 4.0 NTU or greater is the action level determined by the District’s Environmental Services Department. Values of 4.0 NTU or higher are reviewed, the site is resampled, and appropriate corrective measures are taken if possible.

One turbidity reading exceeded the action level at the State Park on December 19th with a result of 9.4 NTU. To determine if 2023 data are normal results, the mean (M) and standard deviation (SD) are calculated for the State Park data set. A value that is within two standard deviations of the mean is considered normal, and those outside are outside of the normal range. In 2023 turbidity values ranged from 0.5 NTU to 9.4 NTU at the State Park (Table 3). The high result in December was outside of the normal range (M=1.5, SD=1.3) for data collected from 2019 to 2022 at the State Park. The likely cause of this high turbidity result was a very large rain event in which >5 inches of rain fell in the 48 hours prior to sampling. In this storm the river over flowed its banks and the extreme flooding even necessitated the evacuation of people from their houses along the Crooked River by air boat in Naples.

Table 3. 2023 Turbidity (NTU) results for the State Park site on the Crooked River, Naples, ME. One turbidity sample exceeded the action level in 2023.

1/24/2023	Frozen
2/14/2023	0.7
3/29/2023	0.5
4/11/2023	0.5
4/18/2023	1.3
5/9/2023	1.1
6/5/2023	1.9
6/12/2023	0.8
7/25/2023	1.6
8/7/2023	1.7
8/28/2023	1.3
9/26/2023	0.8
10/16/2023	0.8
10/23/2023	1.8
11/20/2023	0.9
12/19/2023	9.4

Conclusion:

This sampling program provides a “snapshot” determination of the health of the Crooked River. Samples that exceed established action levels are re-sampled and investigated if necessary. Because sampling occurs four times a year under various weather conditions, it is difficult to determine a continuous water quality trend from the data. Rather, this program reflects the variability of water quality in response to both environmental and human factors.

Overall, water quality remained high during the sampling events in 2023 and weather was the most likely cause of exceedances of action levels. Continued monitoring of the river is necessary as the Crooked River contributes more surface inflow to Sebago Lake than any other tributary and a reduction in water quality in the Crooked River could reduce water quality in the lake.

Appendix: Crooked River Data 2023

Sample Date	Site	<i>E. coli</i> (MPN/100mL)	Turbidity (NTU)	Total Phosphours (ppb)
1/24/2023	State Park	Frozen	Frozen	
2/14/2022	State Park	6	0.65	
3/23/2022	State Park	2	0.52	
4/11/2022	State Park	7	0.53	
4/11/2023	Old 302 Bridge	5	0.61	
4/11/2022	Bolster's Mill	11	0.63	
4/11/2022	E. Waterford	4	0.60	
4/11/2022	Hunt's Corner	10	0.60	
4/11/2022	N. Waterford	23	0.70	
4/11/2022	Rte. 35	3	0.42	
4/18/2022	State Park	30	1.26	
5/9/2023	State Park	9	1.10	
6/5/2023	State Park	248	1.88	
6/5/2023	Old 302 Bridge	238	1.42	22.2
6/5/2023	Bolster's Mill	122	1.02	17.4
6/5/2023	E. Waterford	152	1.38	
6/5/2023	Hunt's Corner	91	1.01	
6/5/2023	N. Waterford	91	0.88	
6/5/2023	Rte. 35	82	0.66	
6/7/2023	State Park	42		
6/7/2023	Old 302 Bridge	41		
6/12/2023	State Park	63	0.83	13.3
7/25/2023	State Park	51	1.64	
8/7/2023	State Park	46	1.73	16.4
8/7/2023	Old 302 Bridge	40	1.02	16.0
8/7/2023	Bolster's Mill	43	1.00	14.6
8/7/2023	E. Waterford	57	1.25	18.9
8/7/2023	Hunt's Corner	48	1.02	13.5
8/7/2023	N. Waterford	96	0.78	15.6
8/7/2023	Rte. 35	105	0.85	15.9
8/28/2023	State Park	75	1.27	15.7
9/26/2023	State Park	35	0.82	
10/16/2023	State Park	64	0.81	15.6
10/16/2023	Old 302 Bridge	24	0.64	14.0
10/16/2023	Bolster's Mill	11	0.67	12.3
10/16/2023	E. Waterford	10	0.80	11.3
10/16/2023	Hunt's Corner	48	0.77	11.2
10/16/2023	N. Waterford	18	0.59	10.5
10/16/2023	Rte. 35	17	0.72	12.2
10/23/2023	State Park	62	1.83	21.4
11/20/2023	State Park	8	0.94	
12/19/2023	State Park	173	9.37	

