



Portland Water District

Sebago Lake Watershed Monitoring Programs Crooked River Monitoring (2021)

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Introduction

Sebago Lake is the primary drinking water supply for 200,000 people in 11 Greater Portland communities. Lake water was first pumped to Portland in 1869, from an intake located in the southernmost part of the lake, referred to as Lower Bay. In 1908, the Portland Water District was chartered by the Maine Legislature to provide water and wastewater services to the region. Since its inception, the District has been actively monitoring and working to protect Sebago Lake.

In 1993, the District was granted a waiver to the filtration requirements of the federal Safe Drinking Water Act based in part on the purity of the water and the effectiveness of watershed protection efforts. This waiver agreement requires ongoing monitoring of lake water quality. The District maintains more than 10 monitoring and surveillance programs throughout the watershed and lake. In general, as one moves closer to the intakes, more samples are collected and tested for more parameters.

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

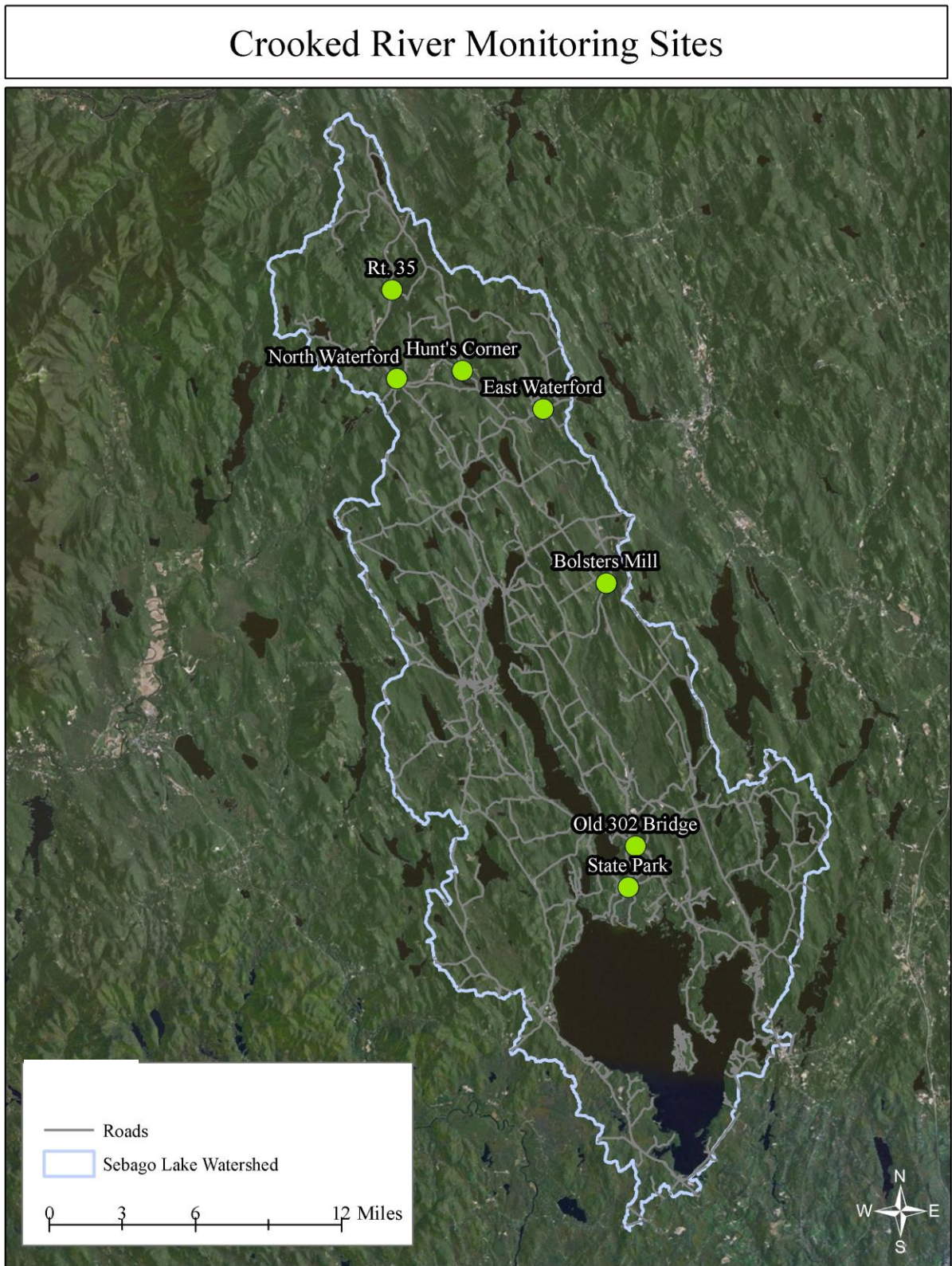
The Crooked River is monitored four times a year from the Sebago Lake State Park in Naples to a bridge on Rt. 35 in Albany for the following analytes: turbidity, total phosphorus, and *E. coli* bacteria. A total of seven sites are monitored as part of the program. These sites listed from North to South 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 2021 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 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 2021 are included in the appendix of this report.

In 2021, the Crooked River was sampled for an expanded set of water quality parameters to compare to historical baseline data. The sampling occurred in June, 2021, and is referred to as the “expanded” Crooked River run in this report. The parameters included: temperature, dissolved oxygen, pH, conductivity, alkalinity, total dissolved solids, total suspended solids, color, nitrate, hardness, iron, and chloride. Temperature, dissolved oxygen, pH, conductivity, and total dissolved solids were measured using field meters. Alkalinity, total suspended solids, color, hardness, iron, and nitrate were analyzed in the PWD laboratory. Chloride was analyzed by Maine Environmental Laboratory, using the ion chromatography method for the first time in 2021.

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.

Total phosphorus concentrations exceeded the action level at the State Park one time in 2021, with a reading of 53 ppb on June 14th. The site was sampled again on June 22nd as part of the Tributary Monitoring Program, and had dropped below the action level with a reading of 14.2 ppb. The cause of the high total phosphorus value is unknown. Often results above the action level are due to rain events but there was not a significant storm prior to the June sampling event.

Elsewhere on the river, no samples exceeded the action level in 2021. During the time period of 1977 to 2020, total phosphorus levels at the State Park ranged from 5 ppb to 126 ppb. In 2021 State Park total phosphorus levels ranged from 6 ppb to 53 ppb (Table 1), and remained within the historical range.

Table 1. 2021 Total phosphorus (ppb) results for the State Park site on the Crooked River, Naples, ME. One total phosphorus sample exceeded the action level in 2021.

4/26/2021	8.9
4/28/2021	9.7
6/14/2021	53.0
6/22/2021	14.2
8/18/2021	6.3
8/23/2021	11.0
10/19/2021	15.0
10/26/2021	12.8

***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.

E. coli levels did not exceed the action level at the State Park in 2021. The only reading above the action level was 308 MPN/100mL at Hunt’s Corner on August 23rd, 2021. Hunt’s Corner was re-sampled on August 25th with a reading of 192 MPN/100 mL. The cause of the high *E. coli* value is unknown. Often results above the action level are due to rain events but there was not a significant storm prior to the August sampling event. During the time period of 2009-2020 *E. coli* levels ranged from 2 MPN/100 mL to 613 MPN/100 mL at the State Park. In 2021, *E. coli* levels ranged from 4 MPN/100 mL to 145 MPN/100 mL at the State Park (Table 2).

Table 2. 2021 *E. coli* (MPN/100 mL) results for the State Park site on the Crooked River, Naples, ME. No *E. coli* samples from the State Park exceeded the action level in 2021.

1/21/2021	4
2/8/2021	Frozen
3/18/2021	Frozen
4/26/2021	25
4/28/2021	14
5/10/2021	20
6/14/2021	101
6/22/2021	110
7/7/2021	53
8/18/2021	41
8/23/2021	71
9/27/2021	145
10/19/2021	33
10/26/2021	29
11/8/2021	37
12/14/2021	19

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.

In 2021 turbidity values ranged from 0.6 to 1.1 NTU at the State Park site (Table 3). No turbidity readings were above the action level at the State Park or any other site on the river.

Table 3. 2021 Turbidity (NTU) results for the State Park site on the Crooked River, Naples, ME. No turbidity samples from the State Park exceeded the action level in 2021.

1/21/2021	1.1
2/8/2021	Frozen
3/18/2021	Frozen
4/26/2021	0.8
4/28/2021	1.0
5/10/2021	0.6
6/14/2021	1.1
6/22/2021	1.1
7/7/2021	1.1
8/18/2021	0.7
8/23/2021	1.1
9/27/2021	1.1
10/19/2021	1.0
10/26/2021	0.9
11/8/2021	0.9
12/14/2021	0.7

Expanded Crooked River Run

Historically, the expanded set of parameters (listed in the Methods section of this report) was sampled on every run. PWD determined, however, that these parameters were not needed as indicators of stream health four times a year because they did not vary much over time. The expanded set of parameters has been consistently monitored every 5 years since 2011 to determine whether the water quality has changed in comparison to historical data. The results of the expanded sampling can be found below in Table 4. Results from the 2021 expanded sampling fell within the historical range for all parameters. In 2021 the method used to analyze chloride was changed when samples were run by an outside lab for the first time. Because of the method change, we cannot compare 2021 chloride data to historical data. The highest chloride results in 2021 of 12 mg/L found at both the State Park and Old 302 Bridge sites are well below the EPA and State of Maine recommended limit for drinking water of 250 mg/L.

Table 4. Results of expanded Crooked River run sampling on 6/22/21							
	State Park	Old Rte. 302 Bridge	Bolsters Mills	East Waterford	Hunt's corner	North Waterford	Rte. 35
Temperature (°C)	22.1	21.4	21.7	20.1	21	20.4	20
Dissolved Oxygen (% saturation)	87	94	86	87	86	80	84
pH	7.5	7.5	7.5	7.6	7.6	7.4	7.6
Alkalinity (mg/L)	16	15	13	13	13	11	12
Conductivity (µohms)	70.0	69.6	58.0	57.0	54.6	54.5	41.6
Total Suspended Solids (mg/L)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Total Dissolved Solids (mg/L)	35.0	34.8	29.0	28.0	27.3	27.3	20.8
Color (SPU)	77	74	80	89	83	88	129
Nitrate (mg/L)	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Chloride (mg/L)	12.0	12.0	9.1	9.3	8.8	8.3	5.4
Hardness (mg/L)	15.3	15.9	13.2	12.0	10.2	12.0	10.7
Iron (mg/L)	0.25	0.17	0.30	0.36	0.22	0.38	0.51

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, 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.

The total phosphorus levels in 2021 remained consistent with historical data, with one reading at the State Park above the 35 ppb action level. No other sites on the river had levels above 35 ppb in 2021.

E. coli bacteria levels obtained at the State Park in 2021 remained consistent with historical fecal coliform bacteria and *E. coli* data, with no readings above the 235 MPN/100 mL action level. Only one sample at Hunt’s Corner was above the action level.

Turbidity levels in the Crooked River in 2021 also remained within the historical range. No turbidity readings exceeded the action level.

Overall, the Crooked River appears to have generally stable water quality. 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 2021

Sample Date	Site	<i>E. coli</i> (MPN/100mL)	Turbidity (NTU)	Total Phosphours (ppb)
1/21/2021	State Park	4	1.1	
2/8/2021	State Park	Frozen	Frozen	Frozen
3/18/2021	State Park	Frozen	Frozen	
4/26/2021	State Park	25	0.8	8.9
4/26/2021	Old 302 Bridge	12	0.6	9.4
4/26/2021	Bolster's Mill	21	0.6	8.6
4/26/2021	E. Waterford	34	1.0	9.5
4/26/2021	Hunt's Corner	40	0.6	8.1
4/26/2021	N. Waterford	28	0.4	7.9
4/26/2021	Rte. 35	13	0.4	7.3
4/28/2021	State Park	14	1.0	9.7
5/10/2021	State Park	20	0.6	
6/14/2021	State Park	101	1.1	53.0
6/22/2021	State Park	110	1.1	14.2
6/22/2021	Old 302 Bridge	108	0.8	13.9
6/22/2021	Bolster's Mill	26	1.1	14.7
6/22/2021	E. Waterford	111	1.4	16.1
6/22/2021	Hunt's Corner	186	1.0	13.6
6/22/2021	N. Waterford	167	1.4	15.4
6/22/2021	Rte. 35	66	1.3	19.8
7/7/2021	State Park	53	1.1	
8/18/2021	State Park	41	0.7	6.3
8/23/2021	State Park	71	1.1	11.0
8/23/2021	Old 302 Bridge	172	0.9	11.0
8/23/2021	Bolster's Mill	86	1.1	10.0
8/23/2021	E. Waterford	105	1.2	10.0
8/23/2021	Hunt's Corner	308	0.9	11.0
8/23/2021	N. Waterford	122	1.2	11.0
8/23/2021	Rte. 35	126	1.0	20.0
8/25/2021	Hunt's Corner	192		
9/27/2021	State Park	145	1.1	
10/19/2021	State Park	33	1.0	15.0
10/26/2021	State Park	29	0.9	12.8
10/26/2021	Old 302 Bridge	28	0.7	12.5

10/26/2021	Bolster's Mill	13	1.0	13.3
10/26/2021	E. Waterford	52	0.9	11.0
10/26/2021	Hunt's Corner	79	0.9	13.3
10/26/2021	N. Waterford	39	0.9	10.9
10/26/2021	Rte. 35	19	0.9	14.5
11/8/2021	State Park	37	0.9	
12/14/2021	State Park	19	0.7	