Portland Water District
Sebago Lake Watershed Monitoring Programs
Tributary Monitoring (1977 – 2017)

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Introduction

Sebago Lake is the primary drinking water supply for nearly 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 (PWD) was chartered by the Maine Legislature to provide water and wastewater services to the region. Since its inception, PWD has been actively monitoring and working to protect Sebago Lake.

In 1993, PWD 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. PWD 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.

This report outlines results of the Sebago Lake Tributary Monitoring Program since it began in 1977.

Methods

Eleven tributaries to Sebago Lake are sampled at one location each for three parameters: total phosphorus, turbidity, and *Escherichi. coli (E. coli)* bacteria (Figure 1). The tributaries include: 1952 Brook, Panther Run, Crooked River, Songo River, Muddy River, Northwest River, Rich Mill Outlet, Smith Mill, Sticky River, Standish Brook, and an un-named stream near St. Joseph's College (added to the program in March 2017). The Crooked River monitoring site is also included in the Crooked River Monitoring Program, and results are discussed in the Crooked River report. The other ten tributaries will be discussed here.

Tributary sampling occurred monthly through 2002. In 2003, sampling occurred quarterly in order to target the spring high and fall low flows. Since 2004, total phosphorus has been sampled four times per year, while turbidity and *E. coli* sampling have occurred monthly. A "dipper" is used to lower sterile collection bottles into the water, usually from a bridge over the tributary.

Total phosphorous samples are analyzed using the ascorbic acid method and a spectrophotometer in the Portland Water District's Water Quality Lab. Total phosphorus has been monitored in 1952 Brook since 1995, at Smith Mill since 1997, and at Rich Mill since 1999. Total phosphorus has been monitored in the other six tributaries since 1977.

Turbidity is measured using a turbidimeter. Prior to 1999, turbidity was measured using a benchtop turbidimeter. In 1999, a switch was made to using a Hach Pocket Turbidimeter. In July 2008, a switch was made from using the Hach Pocket Turbidimeter to a benchtop Hach 2100N Turbidimeter, because the Hach Pocket Turbidimeter was not calibrating accurately.

Fecal coliform bacteria samples were analyzed using the membrane filtration technique and incubated on mFC agar at 44.5 degrees Celsius for 24 hours. Fecal coliform was monitored in Smith Mill from 1997-2008 and in 1952 Brook from 1995-2008. Fecal coliform was monitored in the other seven tributaries from 1991-2008. In December 2008, microbiological monitoring changed from fecal coliform to *E.coli*. *E. coli* samples are analyzed using the Colilert method and are incubated at 35 degrees Celsius for 24 hours.

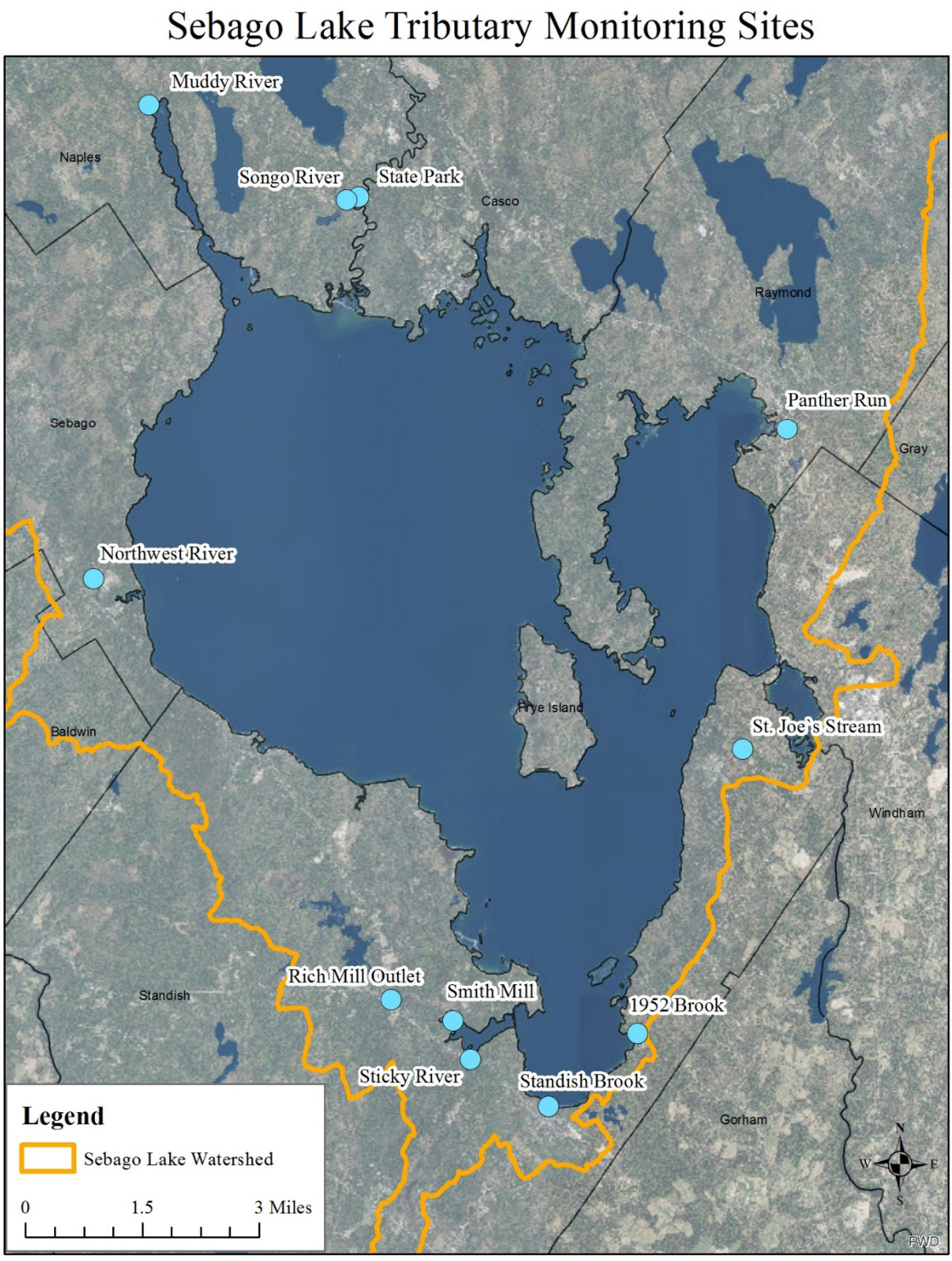

Figure 1: Tributary sampling sites location map for 2018.

Results and Discussion

Total Phosphorus

Phosphorus is one of the major nutrients needed for plant growth. It is generally present in small amounts in temperate lakes and is often the limiting factor for algae growth. As phosphorus increases, the amount of algae also increases. Phosphorus levels are higher in the tributaries, but become diluted once tributary waters enter Sebago Lake. Total phosphorus includes both phosphates attached to sediment and dissolved forms of phosphorus and is measured in parts per billion (ppb) or micrograms per liter (ug/L). A reading of 35 ppb is the action level established by PWD. Sampling events that result in total phosphorus levels above 35 ppb are reviewed and appropriate corrective measures are taken if possible.

In 2018, total phosphorus levels exceeded the 35 ppb action level in St. Joe's stream on 6/26/18 and 8/13/18 (Table 1).

Table 1: Total phosphorus (ppb) results for 2018. Results above the action level are indicated by bolded text.

	1952 Brook	St. Joe's Stream	Panther Run	Songo River	Muddy River	Northwest River	Rich Mill	Smith Mill	Sticky River	Standish Brook
4/24/18	Laboratory error – no data									
6/26/18	Dry	**64.8**	20.6	11.9	34.2	14.2	20.9	28.5	Flowing backwards	Dry
8/13/18	34.5	**70.4**	10.0	4.8	13.9	16.2	19.0	17.9	Flowing backwards	10.4
10/26/18	25.9	33.5	9.7	6.8	12.3	11.8	13.3	16.8	20.8	17.8

The causes of the high total phosphorus values in the St. Joe's stream on 6/26/18 and 8/13/18 might be due to small rain events in the days preceding both of those sampling events, however, none of the other tributaries had high total phosphorus values on those dates. Because total phosphorus sampling has only been conducted on St. Joe's stream since 2017, there are not enough data to determine the typical range of values one might expect in the stream. The stream may have higher values of total phosphorus as compared to the other tributaries.

Turbidity

Turbidity refers to the amount of suspended particulate matter in the water. Turbidity measurements are performed with 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 reading. 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 lakes. Particulates also provide attachment sites for heavy metals such as cadmium, mercury and lead, 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 NTU or greater is the action level established by the District. Values that exceed 4 NTU are reviewed and appropriate corrective measures taken if possible.

In 2018, 1952 Brook exceeded the action level for turbidity on 5/23/18 and 8/13/18, and Standish Brook exceeded the action level on 2/12/18 (Table 2).

Table 2: Turbidity (ntu) results for 2018. Results above the action level are indicated by bolded text, and resampling results are indicated by italicized text.

	1952 Brook	**St. Joe's Stream**	**Panther Run**	**Songo River**	**Muddy River**	**Northwest River**	**Rich Mill**	**Smith Mill**	**Sticky River**	**Standish Brook**
1/29/18	Frozen	0.5	0.8	0.7	Frozen	0.5	1.3	1.1	0.4	0.8
2/12/18	3.0	0.8	2.8	0.6	Unsafe to sample	0.8	1.3	1.5	0.7	**5.2**
2/13/18										*1.5*
3/27/18	0.9	0.4	0.8	0.5	0.5	0.4	0.7	0.6	0.4	0.7
4/24/18	1.2	0.9	1.0	0.5	0.5	0.6	1.0	0.9	1.0	1.5
5/23/18	**7.9**	0.7	0.8	0.7	1.0	0.6	1.2	0.9	0.9	2.0
5/24/18	*7.7*									
6/26/18	Dry	1.1	2.3	0.6	0.6	0.6	0.8	1.3	Flowing backwards	Dry
7/10/18	Dry	0.6	1.7	0.8	1.4	0.5	0.9	1.5	2.0	Dry
8/13/18	**26.0**	0.4	1.3	0.8	0.8	0.5	1.0	1.4	Flowing backwards	1.7
9/25/18	Dry	0.5	1.9	0.6	0.5	0.4	0.8	1.1	Flowing backwards	Dry
10/16/18	2.1	0.8	1.4	0.5	0.9	0.6	0.6	1.1	1.2	1.5
11/19/18	0.7	0.7	1.1	1.0	0.6	0.6	0.6	1.2	Unsafe to sample	0.7
12/12/18	1.2	1.0	1.0	0.9	Frozen	0.7	1.5	0.8	Frozen	0.7

High turbidity levels in 1952 Brook can most likely be attributed to large amounts of iron bacteria observed in the stream during the May and August sampling events. High turbidity results due to iron bacteria are typically not resampled because the presence of iron bacteria is a known cause of elevated turbidity levels in 1952 Brook. The high turbidity on 5/23/18 was resampled because the presence of iron bacteria was not noticed during that sampling event. Upon closer inspection of the brook during resampling on 5/24/18, the presence of iron bacteria was determined to be the cause of the high turbidity level on 5/23/18.

The high turbidity level in Standish Brook is most likely due to a 0.35 inch rain event on 2/11/18. The turbidity fell below the action level upon resampling on 2/13/18.

***Escherichia coli* Bacteria**

In 2008, microbiological monitoring changed from fecal coliform to *E. coli*. *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 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 CFU/100mL in accordance with the recommended level for beach closure under the Maine Healthy Beaches Program. Sampling events that result in *E. coli* levels above 235 CFU/100mL are reviewed or re-sampled if the cause is unknown.

Panther run exceeded the *E. coli* action level on 6/26/18, and two tributaries exceeded the action level on 7/10/18 (Table 3).

Table 3: *E. coli* (MPN/100mL) data for 2018. Results above the action level are indicated by bolded text, and resampling results are indicated by italicized text.

	1952 Brook	**St. Joe's Stream**	**Panther Run**	**Songo River**	**Muddy River**	**Northwest River**	**Rich Mill**	**Smith Mill**	**Sticky River**	**Standish Brook**
1/29/18	Frozen	3	4	2	Frozen	2	6	8	45	79
2/12/18	23	3	9	2	Unsafe to sample	19	10	10	4	13
3/27/18	0	1	1	0	11	3	4	2	4	18
4/24/18	0	0	0	0	3	6	2	6	5	1
5/23/18	8	3	48	8	18	35	88	86	10	26
6/26/18	Dry	38	**326**	88	12	16	22	125	Flowing backwards	Dry
6/28/18			***517***							
6/29/18			***548***							
7/3/18			***308***							
7/10/18	Dry	12	**270**	114	20	15	45	**261**	3	Dry
7/16/18			*76*					*166*		
8/13/18	100	172	47	64	67	37	20	127	Flowing backwards	130
9/25/18	Dry	20	50	16	5	12	54	50	Flowing backwards	Dry
10/16/18	29	6	44	19	15	8	6	15	14	84
11/19/18	43	1	9	1	17	11	5	6	Unsafe to sample	50
12/12/18	12	0	0	0	Frozen	2	8	9	Frozen	15

The *E. coli* level was high at Panther Run during the 6/26/18 sampling event and remained high during multiple resampling events into early July. On 7/3/2018, PWD staff surveyed the tributary upstream of the Panther Run sampling point via kayak to investigate possible sources of *E. coli* contamination. Samples were taken at five locations along the river. The normal Panther Run sampling location and the next northern sample were above the action level. The three samples taken at more northern points were below the action level. Water fowl were observed feeding and swimming in the southern section of the river, just upstream of the normal Panther Run sampling point. Anecdotal information from the staff at the kayak rental company indicated that the water fowl are regular inhabitants of the area. The presence of numerous water fowl feeding, swimming, and stirring up sediment were determined to be the likely cause of the high *E. coli* levels at Panther Run.

The cause of the high levels of *E. coli* at Panther Run and Smith Mill on 7/10/18 are unknown. The *E. coli* level in both tributaries fell below the action level during resampling on 7/16/18.

Conclusion

This sampling program provides a "snapshot" determination of the health of the major tributaries to Sebago Lake. Samples that exceed established action limits are investigated and re-sampled if necessary. Because sampling occurs on a monthly basis, 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.

In 2018, weather and other events were the most likely causes of exceedances of action levels in some tributaries. The number of exceedances in 2018 were within the normal range and the overall water quality in the tributaries remained high during the sampling events in 2018. However, continued monitoring of the tributaries is necessary. The tributaries empty directly into Sebago Lake, and reductions in water quality in these streams could affect the health of the lake.