CRYSTAL LAKE IN-LAKE NUTRIENT MANAGEMENT PROGRAM

INITIAL 2020 SEASON REPORT

City of Newton
1000 Commonwealth Avenue
Newton Centre, MA 02459

INTRODUCTION

Crystal Lake, located in Newton, Massachusetts has experienced summer blooms of cyanobacteria. The lake is surrounded by private residential properties and is a popular recreation area with two small parks, a town beach, and a bath house. In 2019, a comprehensive lake management plan, titled The Crystal Lake Management Plan dated January 2020, was developed by Woodard & Curran, Inc. (W&C) and Water Resources Services, LLC (WRS). The Crystal Lake Management Plan included both internal and external management evaluations. The Crystal lake Management Plan concluded that both internal and external management of nutrients were necessary to reduce potential for algae blooms and for long-term lake health and sustainability. The management plan provided a recommended nutrient management strategy to address both external nutrient loading (watershed) and internal nutrient recycling for Crystal Lake. Phosphorus inactivation was identified as the most viable and cost-effective approach to management of internal nutrient recycling in Crystal Lake.

The City of Newton, through W&C and WRS, has proceeded with a three-year internal lake nutrient management program, including phosphorus inactivation in two applications and in-lake monitoring over a three-year timeframe. The nutrient inactivation treatment with aluminum was planned to occur over two treatments anticipated to be two years apart. This approach was recommended to control internal loading while stripping phosphorus from the water column multiple times. The target treatment area, as determined in the Crystal Lake Management Plan, was an area of approximately 9 acres or the lake, representing the area deeper than 16 feet. The aluminum compound treatment utilizing aluminum sulfate and sodium aluminate was planned to be applied to the target area at a specific dose to strip phosphorus from the water column and inactivate phosphorus in surficial sediment. A total treatment dose of 60 g/m^2 was planned to be spread over two treatments, with the first application treatment of 35 g/m^2 in spring of 2020 and the second treatment dose of 25 g/m^2 planned for spring of 2022. However, timing of the second treatment may be adjusted based on conditions observed in conjunction with lake monitoring. As such, a comprehensive monitoring program is also being conducted as part of the Crystal Lake internal lake management program by W&C and WRS.

The Crystal Lake in-lake nutrient management monitoring and sampling program includes monitoring and/or sampling prior to treatment, during treatment, and after treatment. On-going monitoring throughout the growing seasons (generally June-August) is also planned for the season following the first treatment, the season between treatments as well as the season following the second treatment. This monitoring is planned for the 2020, 2021, and 2022 seasons. Three reports will be prepared documenting the treatment, monitoring, and sampling results as well observations of the in-lake nutrient inactivation program.

The following report documents the initial phosphorus inactivation treatment performed on May 8, 2020, the pre and post treatment monitoring and the follow up monitoring performed during the 2020 season. This report is the first of three reports which will be prepared at the end of each monitoring season. The report is intended to be expanded upon at the end of each seasonal monitoring, with each subsequent report building off the prior report, such that the final report provides comprehensive documentation of the Crystal Lake internal lake management program.

In-Lake Nutrient Management Program
Crystal Lake
Newton, Massachusetts

Initial Phosphorus Inactivation Report
2020 Season

Prepared by
Water Resource Services, Inc.

Fall 2020

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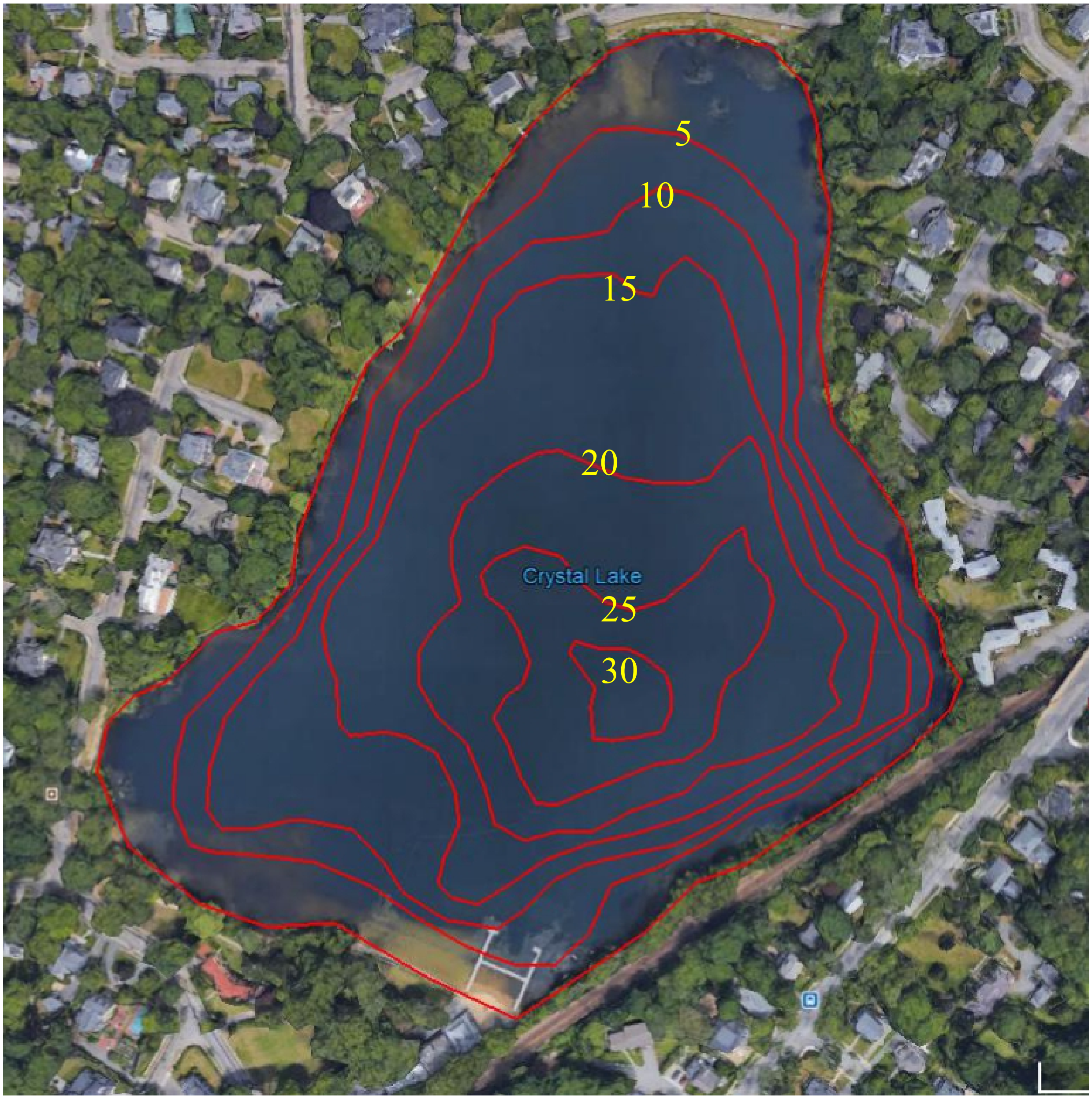
Introduction and Background

Crystal Lake, located in the City of Newton, Massachusetts, is a popular recreation area with two small parks, a town beach, a bath house and surrounding residential properties. Crystal Lake is a natural kettlehole pond, formed by stranded glacial ice over 10,000 years ago. The lake covers approximately 27.5 acres of area to a maximum depth slightly more than 30 feet, by recent measurement, and an average depth of 13.6 feet (Figure 1). The lake has a bowl-like morphometry, leading to a fairly uniform change in area or volume as depth changes. Volume is about 373 acre-feet at full pool elevation. Residence time for water in the pond averages about two years with overflow via a pipe with the discharge eventually reaching the Charles River.

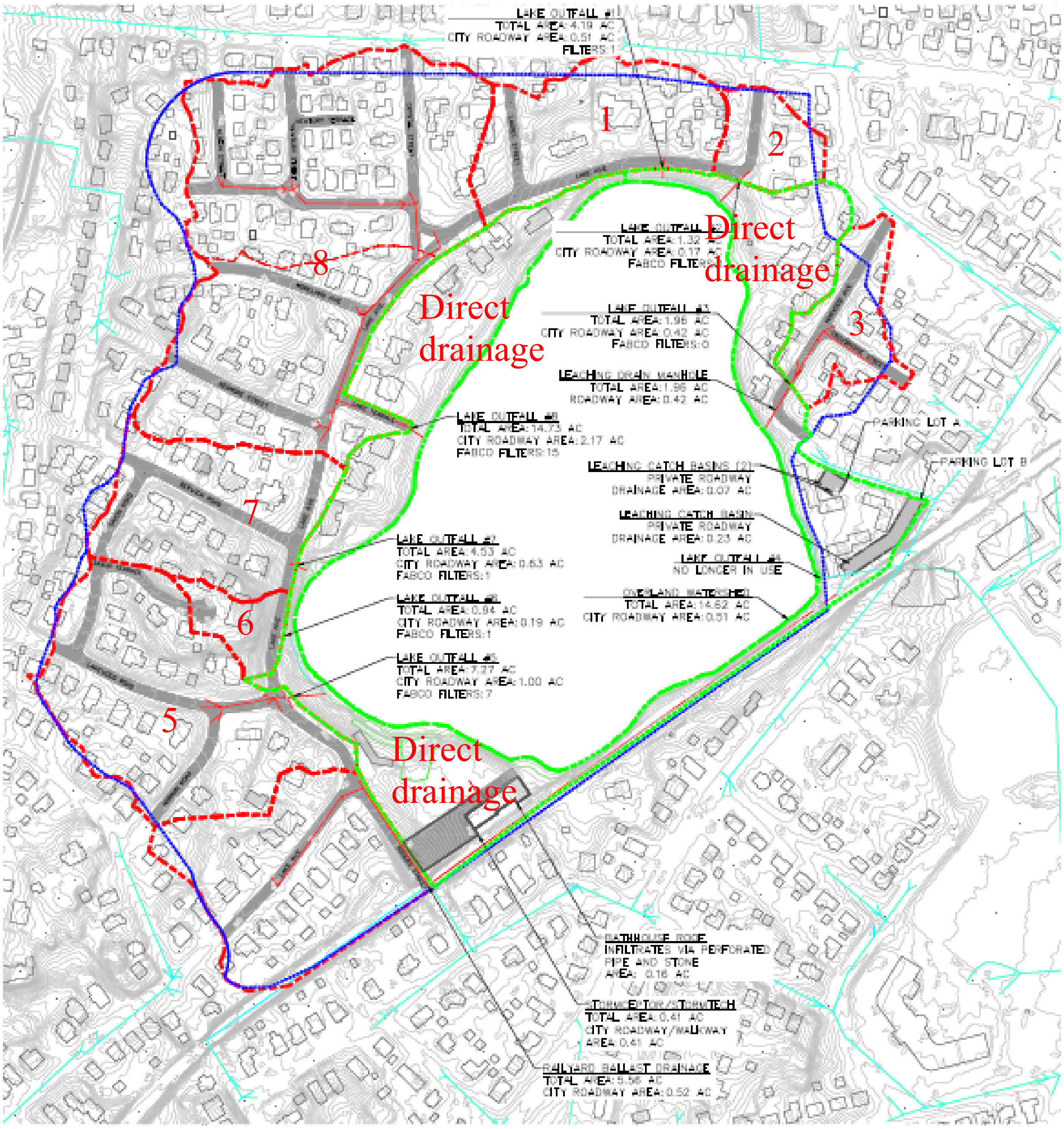
The watershed covers approximately 55 acres of largely residential land and has a low watershed to lake area ratio of 2 to 1. There are seven active stormwater discharges (and one inactive discharge) that drain watershed areas ranging from <1 to almost 15 acres plus a direct overland drainage area of approximately 20 acres (Figure 2). Historically, the watershed was wetland and forest, with most development occurring in the last half of the nineteenth century. Consequently, the chemistry of Crystal Lake has been influenced by stormwater runoff for more than a century. With a long detention time for water in the lake, most contaminants are likely to settle to the sediment and some, like the important nutrient phosphorus, can be recycled during periods of low dissolved oxygen conditions. Excessive phosphorus is known to cause algae blooms and related water quality problems, including toxicity by cyanobacteria. The build-up of organic matter creates an oxygen demand that results in low oxygen near the bottom when the lake is thermally stratified in summer, fostering the recycling of phosphorus. This fertilization of the lake is a natural process but has been accelerated by human influence over the last 150 years.

Figure 1: Crystal Lake, Newton, Massachusetts Aerial View with Bathymetry



(Contours in feet, adapted from Beals and Thomas survey as augmented by 2019 measurements by WRS Inc.)

Figure 2: Crystal Lake, Watershed and Stormwater Drainage Areas



Concern over deteriorating conditions in Crystal Lake prompted a study by Woodard & Curran, Inc. (W&C) with support from Water Resource Services (WRS) in 2019. Cyanobacteria blooms have appeared intermittently during summer, including August of 2019. Monitoring by the City of Newton and community volunteers as well as assessments conducted by W&C and WRS facilitated an evaluation of conditions and causative agents in the lake and its watershed. Phosphorus (P) loading was found to be excessive. Natural and human-derived inputs from the watershed during storms and internal recycling of past watershed loading were both determined to be important to elevated summer P concentrations and cyanobacteria blooms. A program of both watershed management, focusing on stormwater improvements, and in-lake P control, involving inactivation of surficial sediment P reserves with aluminum compounds, was recommended. This management approach has been adopted by the City of Newton.

In-lake P control by inactivation of P was recommended to occur in two phases. The first P inactivation effort was accomplished in May of 2020. The second phase is planned for spring of 2022, or as monitoring otherwise dictates. The phase 1 dose was expected to be adequate to meet use goals for the lake but is not expected to last more than a few years without implementation of planned watershed management actions. Since it takes time to implement watershed management improvements, and because the in-lake P inactivation also strips substantial P from the water column, the decision was made to wait to apply the second part of the total recommended dose to provide the potential to address additional loading over a period of one to three years.

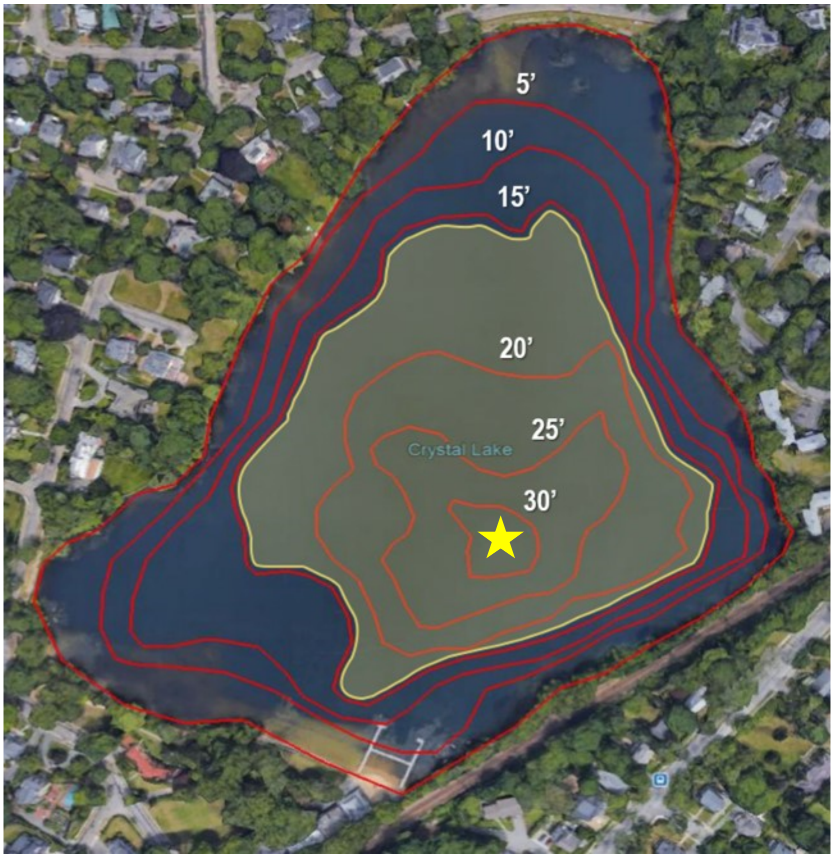
This report covers the 2020 treatment and follow up monitoring through September 2020. Additional monitoring is planned for 2021 and 2022. This on-going monitoring will support a decision of when to apply the second part of the total recommended inactivation dose, currently planned for spring of 2022.

Treatment Planning and Conduct

A practical goal based on experience in MA was to reduce the internal load by 90%. With a goal of 90% reduction, models predict that the phosphorus concentration would decline to 13 µg/L, average clarity would be 3.3 m (10 feet) and there would only be about a 2% chance of an algae bloom. The sediment data obtained in 2019 were used to calculate an aluminum dose that would provide the desired load reduction and related improvement in water quality and clarity. That calculated dose is between 43 and 67 g/m^2 as aluminum. This dose is firmly in the middle of the range of treatment doses used in Massachusetts to date. Refining the calculations, a recommendation to apply a total of 60 g/m^2 was offered with the intent of splitting the application into an initial dose of 35 g/m^2 and a follow up dose of 25 g/m^2 within three years.

Sampling results showed that the distribution of soft, organic sediment that harbors the greatest available phosphorus reserves was found to start at depths as shallow as 13 feet, but coverage was complete at >16 feet (just under 5 m). Low oxygen, a critical condition for much internal P loading, was found to occur at depths no shallower than 18 feet, but the temperature gradient suggested that low oxygen could occur at depths between 16 and 17 feet under some conditions. This supported a recommendation for treatment of all areas deeper than 16.5 feet (5 m). For Crystal Lake, this is an area of 9.1 ac or 36,700 m^2 (Figure 3).

Figure 3: Crystal Lake Treatment Area



Yellow star indicates standard monitoring location.

The first application of 35 g/m^2, completed in early May 2020, was estimated to require 2,523 gallons of aluminum sulfate (alum) and 1,262 gallons of sodium aluminate (aluminate) at standard industry concentrations of aluminum in each product and an expected application ratio of 2:1 (alum to aluminate by volume) to minimize pH change. Monitoring the day before the treatment suggested that the pH was near the upper end of the desired range during treatment, so the ratio was increased slightly (more alum, which is acidic) to lower pH to enhance reactions and minimize any risk of aluminum toxicity. The actual product volumes applied were 2,733 gallons of aluminum sulfate and 1,093 gallons of sodium aluminate, achieving the targeted dose of 35 g/m^2 over the treatment area at a ratio of 2.5:1.

The application was completed in one day (May 8, 2020) by SOLitude Lake Management of Shrewsbury, MA. The beach facility parking area, the access driveway west of the building, and the water by the beach were used for access, staging and filling the tanks in the boat. As further described later in this report additional pre-treatment monitoring was conducted the day before treatment, continuous monitoring occurred during the treatment and follow up monitoring was performed the day after treatment and monthly thereafter into September 2020. A boat with two tanks, one for each aluminum product, and a pump and manifold system for delivering those products to the same area separately, followed a GPS-guided path to apply the products at the designated ratio evenly over the target area. Floc formation was observed and settling was tracked, along with frequent measurements of pH, conductivity and several other field parameters assessed with a multi-probe sonde from a second boat by WRS personnel. In addition to field water quality assessment, the pond was visually surveyed by eye and with the aid of an underwater video system for any distressed organisms, most notably fish, during treatment and on the day after treatment.

Monitoring Results

Approach

Pre- and post-treatment monitoring was conducted at a single, central station at the deepest point in the lake (Figure 3). A Hach DS5 multi-probe sonde with probes for depth, temperature, oxygen, pH, conductivity, turbidity and chlorophyll-a was used to assess water quality in the field at 1 m increments from the surface to the bottom. Water samples were collected from the top and bottom and, when thermal stratification existed, from the depth of the boundary between the upper and lower water layers. Those samples were preserved with sulfuric acid and delivered to Microbac Laboratories in Lee, MA for testing of total phosphorus, nitrate-nitrogen, and Total Kjeldahl nitrogen by standard methods. Aluminum was also assessed from samples preserved with nitric acid, collected just before treatment and after treatment on each sampling visit until aluminum returned to background levels. Phytoplankton were assessed by microscopic examination of a composite sample from multiple depths that was preserved with glutaraldehyde. Zooplankton were assessed from samples collected by towing a net with 53 um mesh through 30 m of water, yielding a concentrated sample representing 380 L of water that was preserved with glutaraldehyde until examined microscopically. Secchi transparency was assessed with the standard disc from the surface of the lake from a boat using a view tube to avoid undermeasurement from glare or wave action. Alkalinity was measured from collected water samples with a field titrator.

Monitoring During Treatment

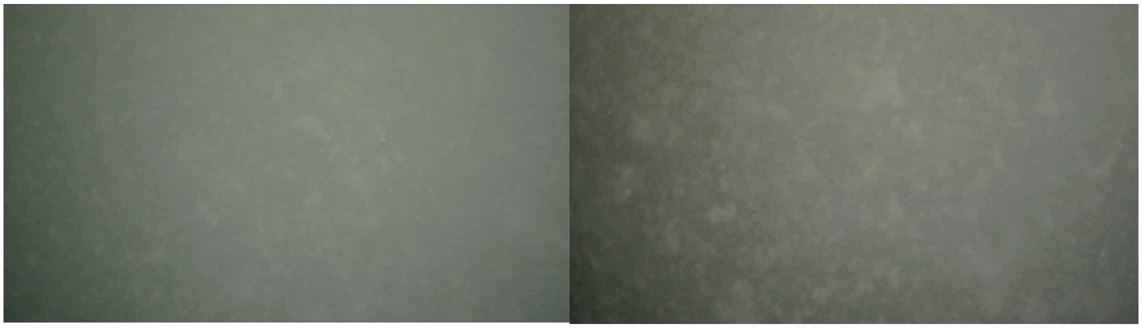
During the actual treatment the DS5 multi-probe sonde was used to track pH over the vertical and spatial range of the lake, and the other field water quality parameters available from the DS5, including temperature, oxygen, conductivity, turbidity and chlorophyll-a, were also recorded. Visual observation from the surface and at various depths, aided by a Marcum underwater video viewing system, was nearly continuous and allowed assessment of floc formation, floc settling, and any distressed organisms in the lake potentially related to treatment.

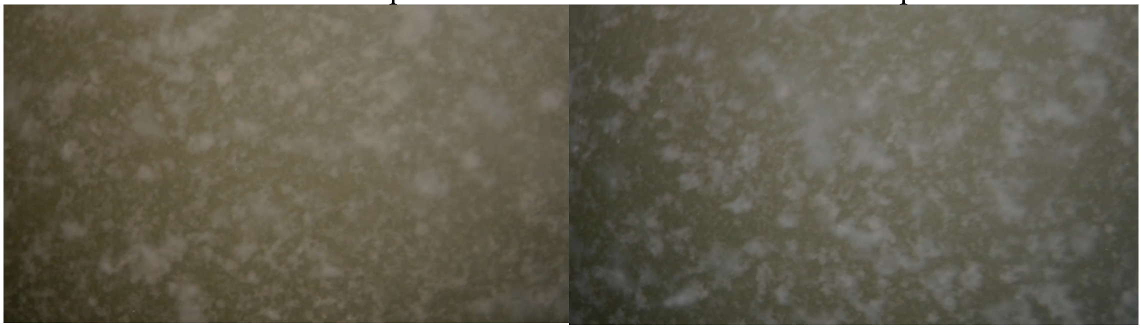
Of the 84 pH measurements recorded during treatment (Appendix), 4 were <6.0, the lower target level and none were >8.0, the upper target level. Two of the low values occurred at the start of the first treatment run as pumping rates and boat speed were being adjusted. The other two low values occurred randomly later in the day and were 5.9 and 5.8 SU, close to the preferred lower limit. Other field water quality parameters showed only small variation. Conductivity averaged 224 uS just prior to treatment and 230 uS during treatment. As the treatment adds sodium and sulfate that do remain in solution until flushed from the system, an increase is expected, yet the average conductivity in the central monitoring station profile was only 233 uS at the conclusion of treatment, a minor increase.

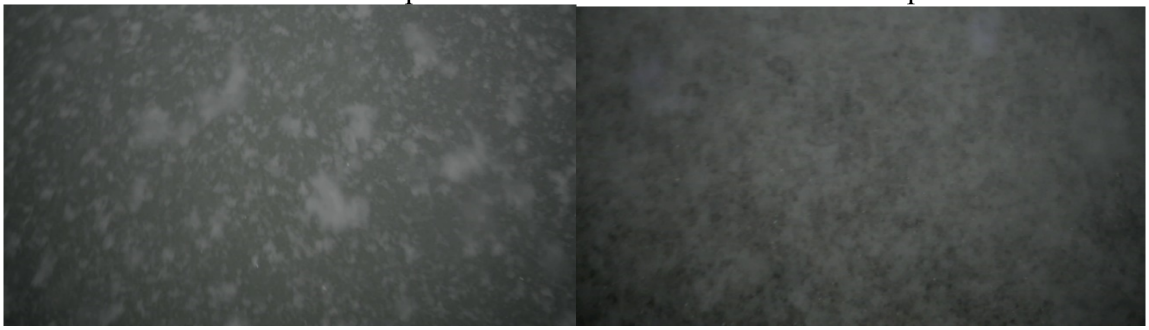
Aluminum treatments can consume alkalinity, especially where the pH declines, and the average alkalinity declined from 8 mg/L before treatment to 6 mg/L at its conclusion. Alkalinity is typically low in Crystal Lake, necessitating careful monitoring of pH and adjustment of the aluminum product ratio to avoid large fluctuations in pH, but the minor decrease occurring from treatment is of no particular concern. Aluminum treatments also tend to decrease chlorophyll-a levels as algae are coagulated with floc formation and settled from the water column. Turbidity tends to decline proportionally, although there may actually be increases in turbidity until the floc settles completely. In Crystal Lake the changes in chlorophyll-a (4.9 ug/L before, 4.1 ug/L at conclusion) and turbidity (3.1 NTU before, 4.7 NTU at conclusion) were minor. The thermal profile of the lake was not altered. Oxygen level rose slightly, likely a function of photosynthesis over the day, but all values were high enough to support all desirable aquatic life from the start, so the changes observed are not considered important.

Floc formation (Figure 4) was excellent and settling occurred over <24 hours; no evidence of floc in the water column was evident the day after treatment. There is always some drift outside the treatment target zone, but that drift was minimal in Crystal Lake, rarely more than 50 lateral feet beyond the 5 m depth contour. The floc blanket on the bottom was fairly loose for over a month after treatment, a little longer than typically observed, but by the end of summer the sediment appeared as it did before treatment. The floc had infiltrated the sediment and become an inseparable part of the upper 10 cm.

Figure 4: Floc Formation and Settling in the Crystal Lake Treatment Area


3 feet water depth 8 feet water depth


13 feet water depth 18 feet water depth


23 feet water depth 29 feet depth, on bottom

No dead or distressed aquatic organisms were detected as a result of treatment. One can find empty mussel shells in shallow water, usually a result of predation, but the treatment was in deeper water and no dead mussels were observed there. However, low oxygen prevents mussels from living permanently in most of the treatment zone, so few mussels were observed in that area. A few dead fish were found prior to treatment, with 1 largemouth bass, 2 rainbow trout and 1 sunfish found in shallow water. No dead or stressed fish were observed during treatment or the following day, and live fish were observed swimming in the treated area (Figure 5).

Figure 5: Yellow Perch Swimming in the Crystal Lake Treatment Area

Pre- and Post-Treatment Monitoring Comparison

Conditions in Crystal Lake after treatment in May 2020 suggest improvement. However, Crystal Lake historically only experienced an unacceptable condition during part of some summers, therefore a major change is not expected. The key to success is to eliminate peak algae biomass and related loss of clarity and increased threat from cyanobacterial toxins. Aluminum treatments often improve oxygen levels in water at the thermocline and below, as the oxygen demand from decaying phytoplankton is limited, but low oxygen is still expected near the bottom. High pH from intense algal photosynthesis may be reduced where surface scums of cyanobacteria had formed in the past, but these were not common in Crystal Lake. Phosphorus in surface water should be reduced but is not usually very high in Crystal Lake. Most critically, phosphorus near the bottom should be reduced, as this is the phosphorus that supports cyanobacteria that grow at greater depth before rising to form blooms.

The time to look for any change in oxygen status due to treatment is in August, when stratification is usually strongest and oxygen depression is most evident in deeper water. Oxygen concentrations were slightly increased in water 5-6 m deep, right around the thermocline, in August of 2020 vs August of 2019, but the increase was minor and the overall temperature and oxygen profiles are similar for 2019 and 2020 (Figure 6). Likewise, pH declined substantially right after treatment but increased over the summer to more typical levels (Figure 7).

Figure 6: August Temperature/Oxygen Profiles in Crystal Lake

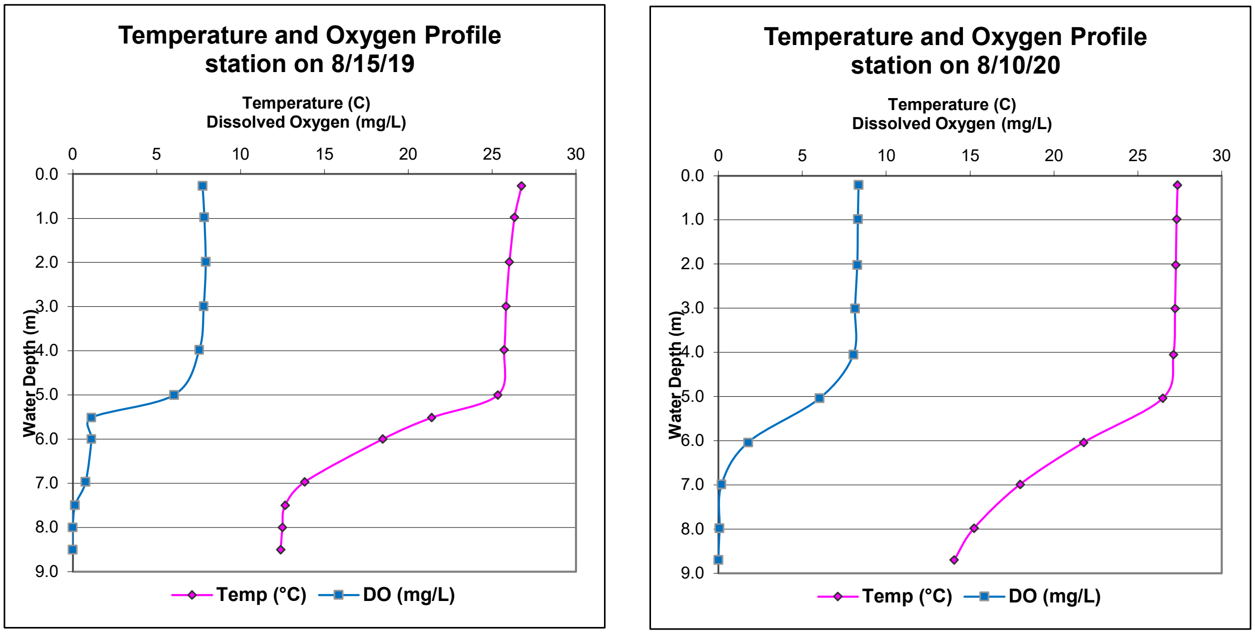
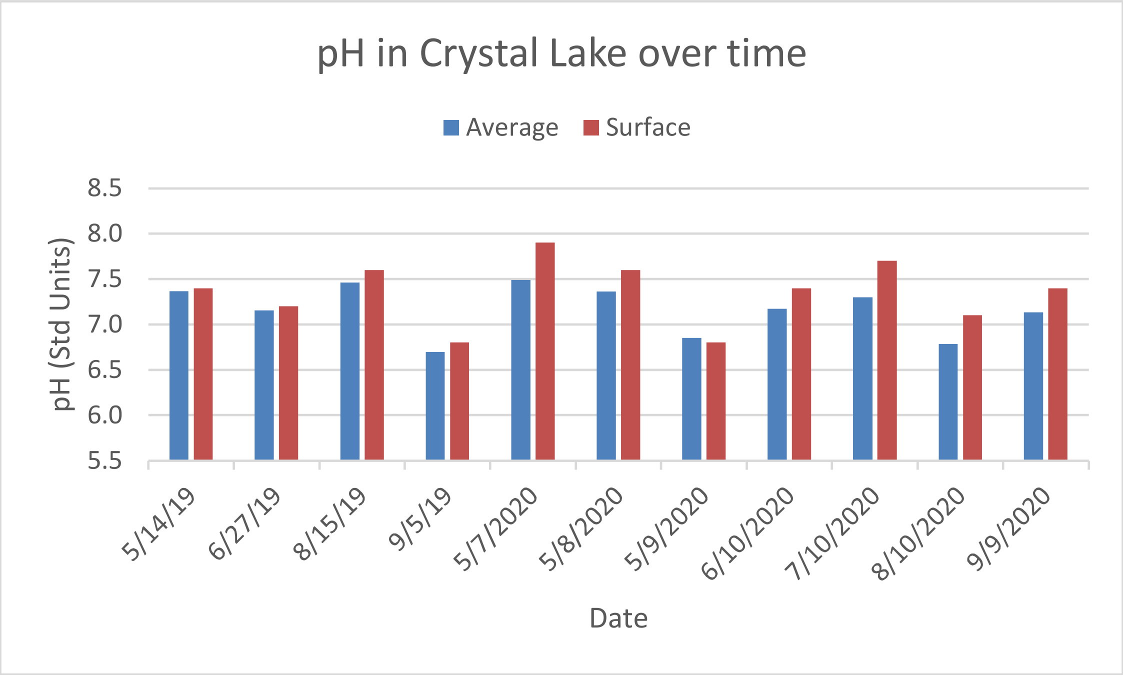


Figure 7: Average pH in Crystal Lake



Chlorophyll-a and turbidity decreased in surface water and at mid-depth after treatment (Figures 8 and 9) but not appreciably near the bottom. Measurement near the bottom, is complicated by fine organic matter remaining in suspension slightly above the bottom. That matter increases the turbidity and tends to fluoresce like chlorophyll-a, giving a false impression of accumulated live algae. The lower surface and mid-depth values in summer are more reliable indicators. Water clarity, as assessed by Secchi disk transparency, increased with treatment and remained higher in summer of 2020 than in summer of 2019 (Figure 10). Clarity was improved by treatment overall, but variation is expected; watershed inputs will continue to provide nutrients that will support some algae growth.

Figure 8: Chlorophyll-a over Depth and Time in Crystal Lake

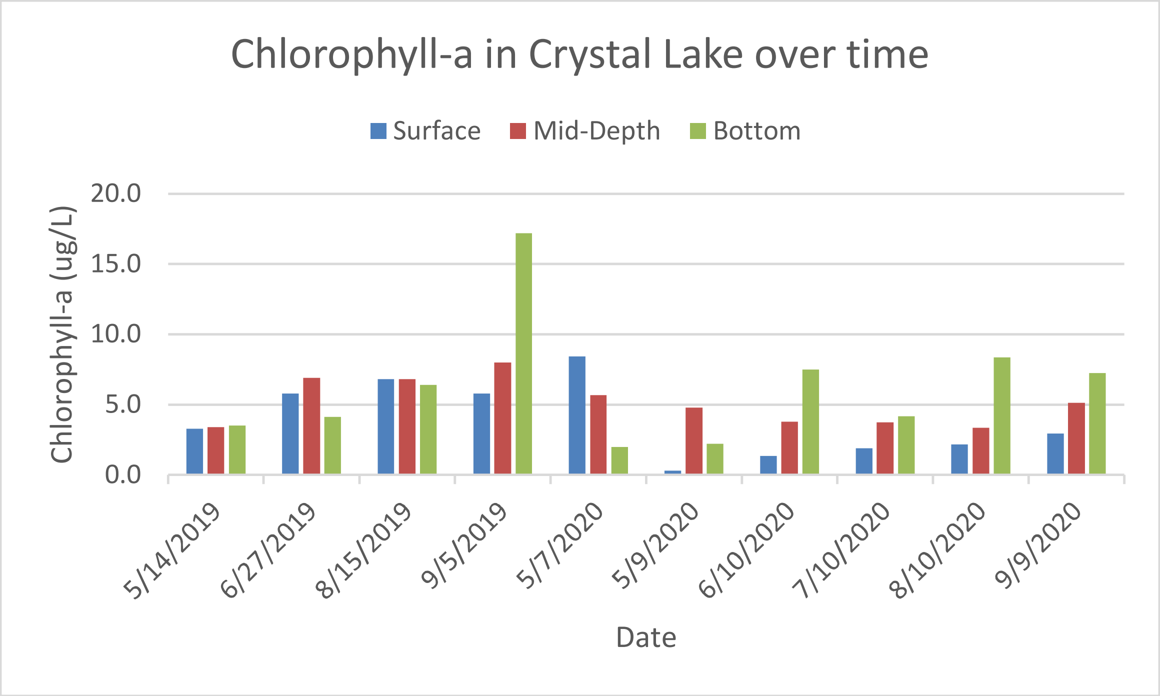


Figure 9: Turbidity over Depth and Time in Crystal Lake

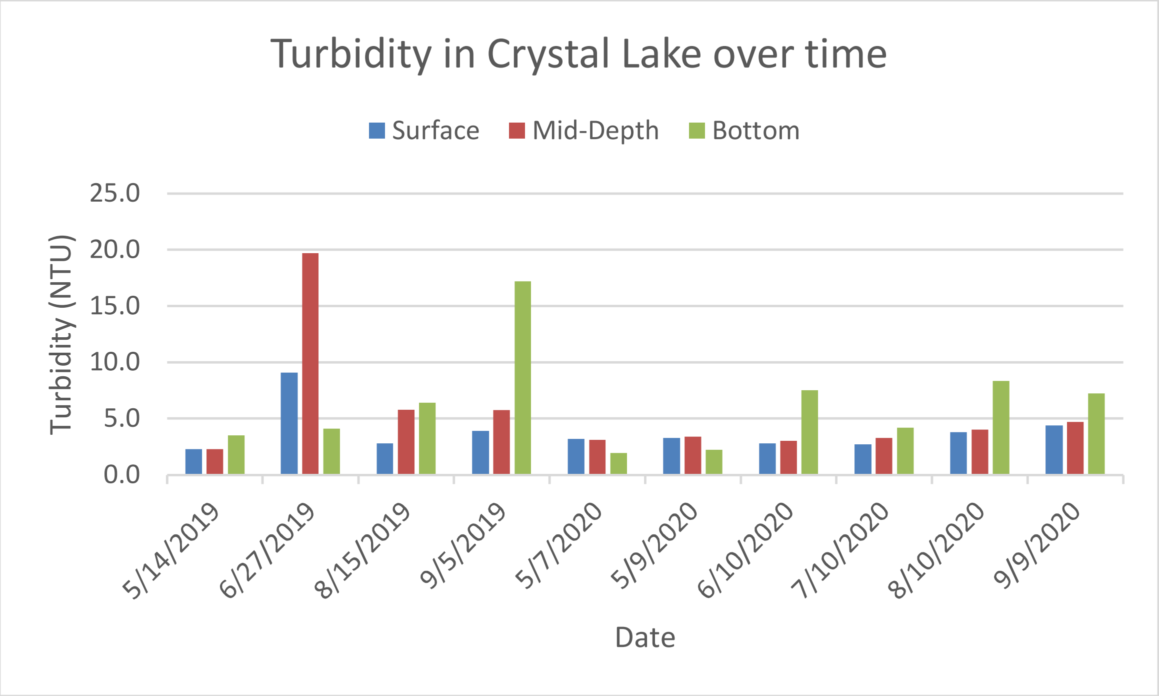
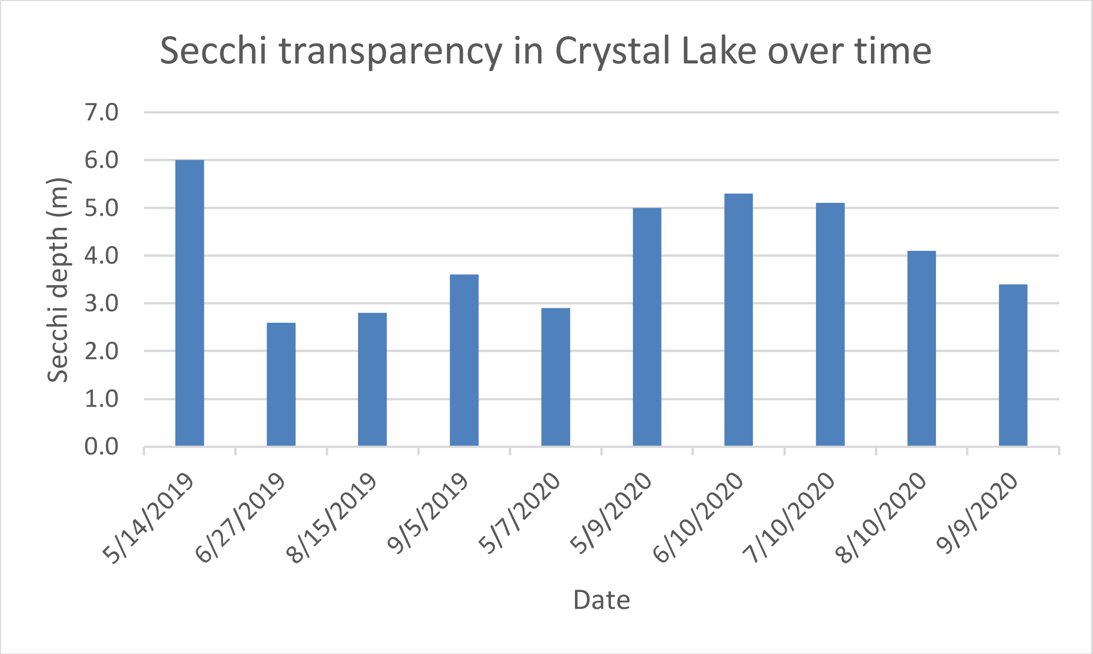


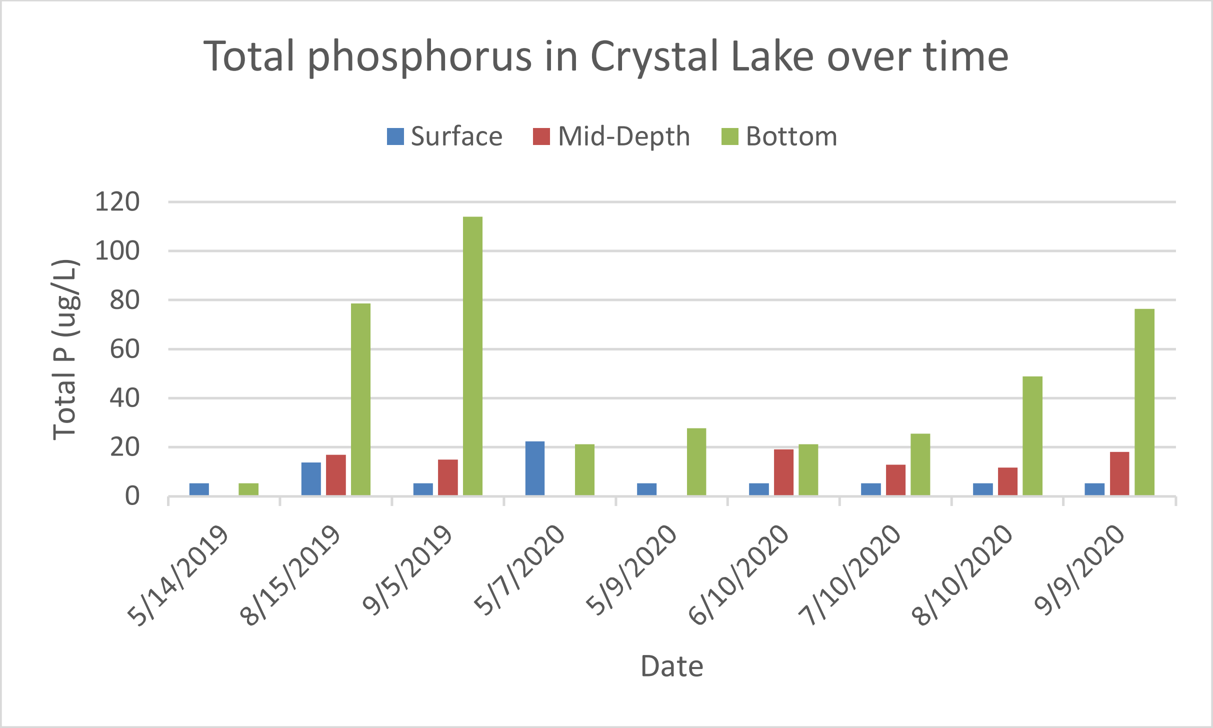
Figure 10: Secchi Transparency over Time in Crystal Lake



Total phosphorus concentrations were reduced by aluminum treatment at all measured depths (Figure 11). Surface values are not usually high, but concentrations >20 ug/L can support blooms and concentrations <10 ug/L are preferred. The detection limit for laboratory testing in this case is 10 ug/L and by convention we graph values below the detection limit as one half that detection limit, or 5 ug/L. Half the pre-treatment surface P concentrations were <10 ug/L while all the post-treatment values were <10 ug/L. Mid-depth concentrations tended to be slightly higher than the detection limit but still <20 ug/L. Mid-depth concentrations in 2020 were slightly lower than those of 2019.

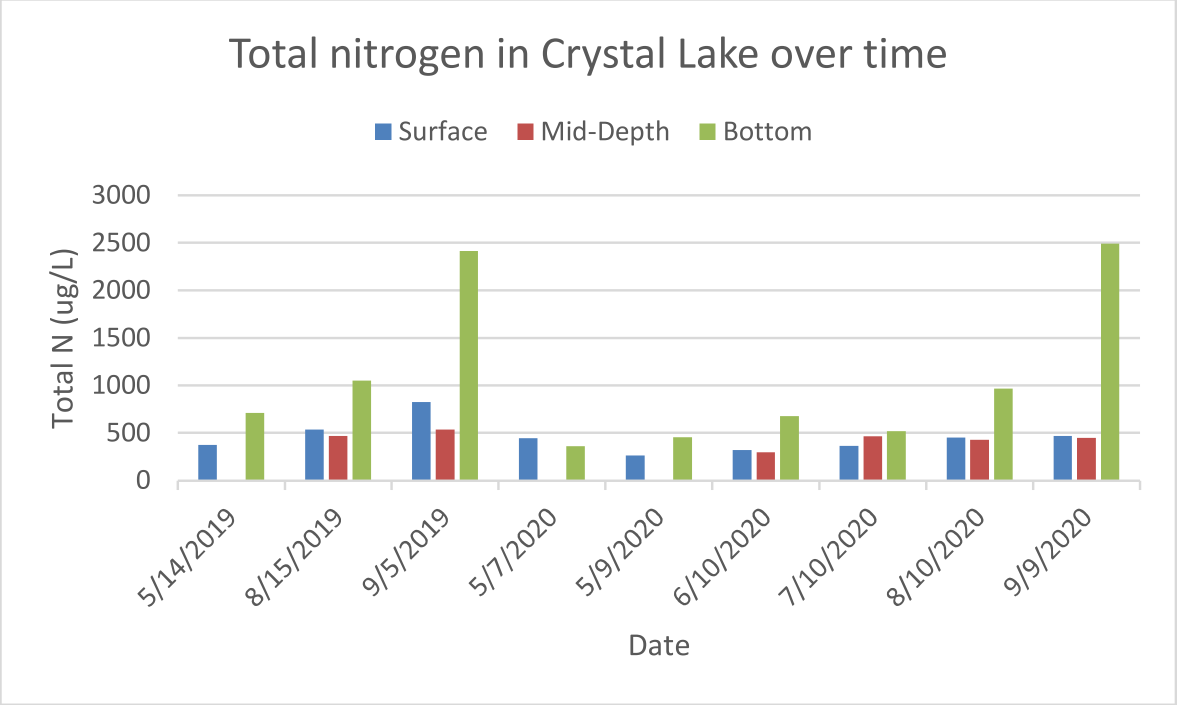
The greatest concern is the P concentration in the bottom layer of the lake, as light penetrates far enough to allow this P to be used by algae, particularly cyanobacteria. The cyanobacteria can grow, absorb extra P, then create gas pockets in cells and rise synchronously to form a bloom in the upper waters. The P content of the upper waters does not need to be high for such blooms to occur. Prior to treatment the near-bottom P concentration started at <10 ug/L in May of 2019 but increased through release from surficial sediment exposed to anoxia as summer progressed, reaching a peak of 114 ug/L in September 2019 (Figure 11). The near-bottom P concentration was already >20 ug/L when treatment occurred in May 2020 and remained at that level into August. The increases in August and September were about one third to one half the 2019 increases, culminating in a near-bottom P concentration of 76 ug/L in September 2020. The lower value and shift in releases to later in the summer is advantageous for avoiding algae blooms during the primary lake use season.

Figure 11: Total Phosphorus over Depth and Time in Crystal Lake



No major change in nitrogen (N) is expected as the result of an aluminum treatment. Aluminum does not bind with N, although particles containing N may be coagulated and settled out during treatment, so there could be an initial decrease in N concentration as a result of treatment. Total N (sum of nitrate-N and TKN) was not greatly altered by treatment (Figure 12) but continued to exhibit a seasonal pattern of increase in deep water over the summer. This is the result of a build-up of ammonium-N, which is measured as part of TKN, as decaying N compounds cannot proceed past the ammonium state without oxygen, which is scarce in the bottom of the lake during summer. The ratio of N to P is high, suggesting that P will be the limiting nutrient for algae in this system. Further, many cyanobacteria are capable of utilizing dissolved N gas and are not limited by inorganic N like nitrate or ammonium in the water anyway.

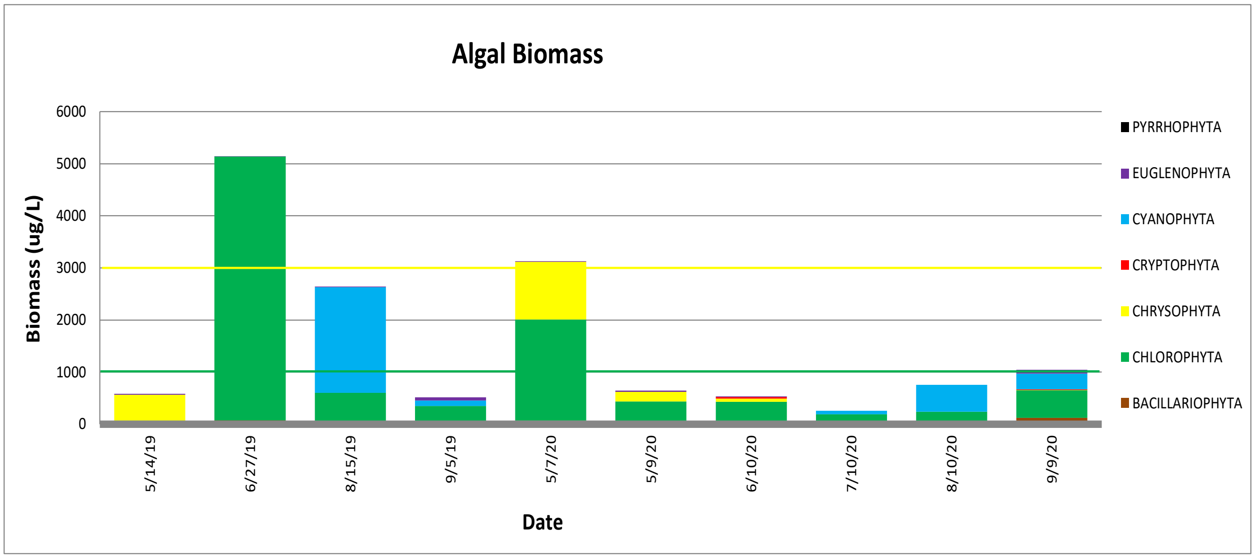
Figure 12: Total Nitrogen over Depth and Time in Crystal Lake



In addition to water clarity, which many lake users noted was the best in 2020 that it had been in many years, the other major proof of improvement comes from direct algae data. Algae floating in the water column, or phytoplankton, can belong to about 7 major groups that include the cyanobacteria, green algae, and golden algae, the groups most often dominant in New England lakes. The water may appear greenish if any of these becomes abundant, usually taken as a biomass >3000 ug/L, but cyanobacteria may produce toxins that pose additional threats to human and non-human lake users. Serious issues are usually associated with biomass >10,000 ug/L. At concentrations <1000 ug/L, problems with water appearance, odor or toxicity should not occur, regardless of the phytoplankton composition.

Detailed algal data are provided in the Appendix, but Figure 13 provides a useful summary of phytoplankton abundance and composition for 2019 and 2020. Algae were not abundant on the first field visit in May 2019 but increased markedly in June 2019 with green algae dominant. Clarity was low and the water was distinctly greenish, but no health hazard from exposure or consumption was indicated. A cyanobacteria bloom occurred in August 2019. The sample collected from the standard monitoring station in the middle of the lake indicated a moderately high biomass, but much higher values would have been expected in areas where windblown cyanobacteria accumulate, like the town beach. Indeed, the swimming area was closed for about a week until the bloom dissipated. Biomass in May 2020 was much higher than that observed at roughly the same time in 2019, demonstrating the year to year variation that is common within lakes, and was comprised of mainly green and golden algae. Aluminum treatment substantially reduced algal biomass by coagulating and settling it from the water column without appreciably altering the composition of remaining algae. Later in the summer of 2020 low concentrations of cyanobacteria did appear, which was coincident with warmer water and higher deep-water P concentrations, but the abundance never exceeded the low threshold of 1000 ug/L. These low concentrations posed no threat to lake ecology or human health.

Figure 13: Phytoplankton Composition and Biomass over Time in Crystal Lake



Zooplankton are small invertebrates that live in the water column. They eat mostly algae and are in turn eaten by small fish, making them an important link in the food chain and a potentially important control on algae abundance. The zooplankton community of Crystal Lake is generally healthy and has a desirable biomass (Figure 14) and average body length (Figure 15). Sometimes the community is depressed for a year after aluminum treatment, since the floc can pull zooplankton out of the water column when thick. Biomass exhibited a minor decrease for the month after treatment but rebounded to higher levels than before treatment by July. Copepods and cladocerans were dominant and average length of those crustaceans did not change appreciably after treatment.

There is therefore adequate grazing pressure if the algae are edible (some cyanobacteria are not) and zooplankton in Crystal Lake can be a potent force in maintaining water clarity if nutrient concentrations are not excessive. The zooplankton of Crystal Lake also represent a valuable food resource for small fish but the lack of a major decline in biomass or average length through summer suggest that predation pressure on those zooplankton is not severe. The aquatic biology of Crystal Lake appears reasonably balanced.

Figure 14: Zooplankton Composition and Biomass over Time in Crystal Lake

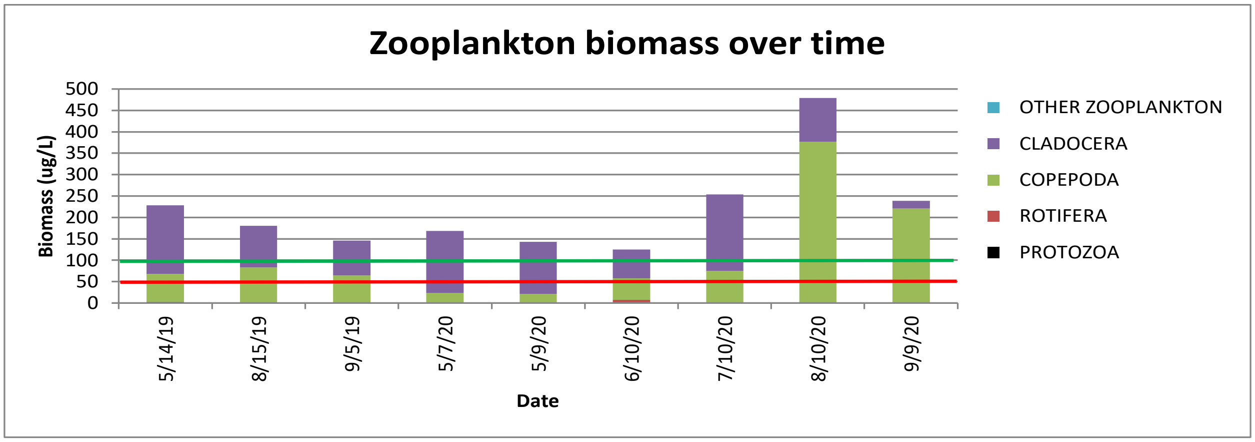
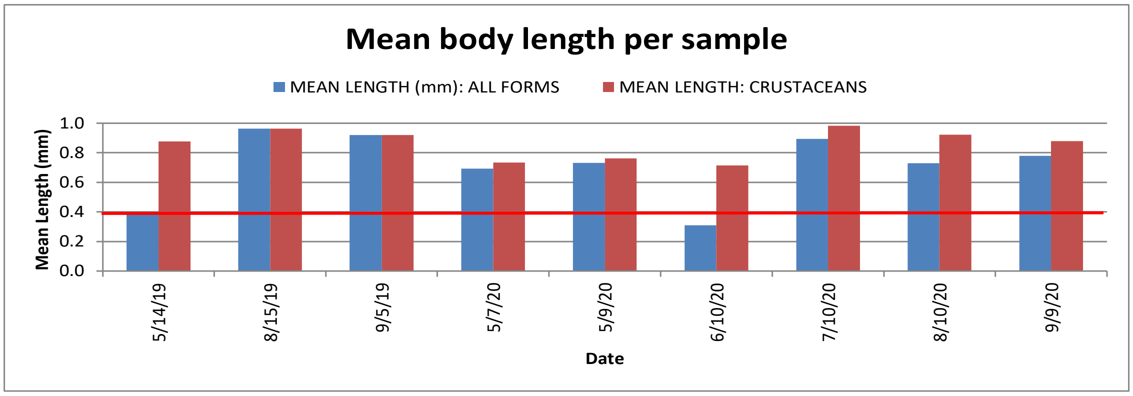


Figure 15: Average Zooplankton Length over Time in Crystal Lake



Interim Conclusions

The first phase of the phosphorus inactivation program for Crystal Lake proceeded smoothly in early May 2020. The pH remained within the desired range for nearly the entire treatment process, which took only one day, and no distressed organisms were encountered during surveys during or following treatment. The floc formed well and settled into the target area as expected. The floc merged with the surficial sediment over the course of about two months.

Follow up monitoring throughout the summer of 2020 detected reduced phosphorus concentrations, reduced algae, and increased water clarity with no major negative consequences. There are seasonal influences that impose certain limits on aluminum-induced changes and no significant reductions in watershed inputs have been achieved in 2020. Yet conditions in the lake have improved noticeably, especially given that this season marked the first of the two planned treatment doses and only 35 g/m^2 of a total recommended dose of 60 g/m^2, was applied.

Since the treatment strips phosphorus from the water as well as decreasing the release of phosphorus from treated sediment, and given that the detention time for water in Crystal Lake is on the order of two years, it would be expected that conditions would be improved in the summer following treatment. Evidence of ongoing improvement is typically determined in the second summer after treatment, as external nutrient inputs to the lake are anticipated to continue and internal loading may not have been suitably inhibited by the initial treatment. For these reasons, nutrient inputs after treatment may be enough to negate the initial treatment effects, potentially warranting adjustment of the timing of the second treatment. Monitoring will therefore continue in 2021 to document ongoing water quality and support a recommendation of when to perform the second phase of the phosphorus inactivation program.

Appendix: Raw Data

Table A.1 – Water quality data

	Date	Time	Depth	Temp	DO	DO	Sp. Cond	pH	Alk	CHL	Turbidity	Secchi	Total P	Total Al	TKN	Nitrate N	Total N
Timing of Assessment	MM.DD.YY	HH:MM:SS	meters	°C	mg/l	% Sat	µS/cm	Units	mg/L	µg/l	NTU	meters	mg/L	mg/L	mg/L	mg/L	mg/L
1 yr pre-T	5/14/19	11:48:54	0.1	14.0	10.0	98.8	254	7.4		3.3	2.2	6.0	<0.0106		0.3500	<0.050	0.3550
	5/14/19	11:48:44	1.0	14.0	10.0	98.5	254	7.4		3.3	2.3						
	5/14/19	11:48:33	2.0	14.0	10.0	98.3	254	7.3		3.4	2.4						
	5/14/19	11:48:16	3.0	14.0	10.0	98.6	254	7.3		3.4	2.4						
	5/14/19	11:47:56	4.0	14.0	9.9	97.9	254	7.3		3.4	2.3						
	5/14/19	11:47:29	5.0	14.0	8.9	87.8	255	7.3		3.3	2.4						
	5/14/19	11:47:03	6.0	10.9	5.0	45.7	261	7.4		3.5	3.1						
	5/14/19	11:46:31	7.0	9.6	2.7	24.1	262	7.4		3.4	1.7						
	5/14/19	11:46:06	8.0	9.0	1.5	13.4	264	7.5		3.5	1.5		<0.0106		0.6870	<0.050	0.7370
11 mo pre-T	6/27/19	8:23:47	0.1	23.9	9.6	115.2	245	7.2		5.7	8.2	2.6					
	6/27/19	8:23:29	0.6	23.9	9.6	115.1	245	7.2		5.8	9.1						
	6/27/19	8:23:08	1.5	23.9	9.5	113.7	245	7.1		6.0	10.6						
	6/27/19	8:22:47	2.5	23.9	9.3	112.2	245	7.1		6.2	12.7						
	6/27/19	8:22:24	3.5	23.4	8.8	105.3	245	7.0		6.5	12.8						
	6/27/19	8:22:00	4.5	20.9	7.1	80.7	243	7.0		6.9	19.7						
	6/27/19	8:21:35	5.5	16.4	3.0	31.4	243	7.0		7.4	13.5						
	6/27/19	8:21:06	6.5	13.4	0.6	5.6	246	7.1		8.3	5.4						
	6/27/19	8:19:04	7.5	11.0	0.3	2.9	250	7.5		4.1	4.8						
	6/27/19	8:20:02	8.5	10.2	0.3	3.1	256	7.3		8.4	5.5						
10 mo pre-T	8/15/19	14:53:48	0.3	26.8	7.7	98.2	247	7.6		6.6	2.3	2.8	0.0138		0.5090	<0.050	0.5590
	8/15/19	14:54:07	1.0	26.3	7.9	98.7	247	7.6		6.8	2.8						
	8/15/19	14:55:00	2.0	26.0	7.9	99.2	247	7.6		6.9	3.8						
	8/15/19	14:55:37	3.0	25.8	7.8	97.3	247	7.6		7.0	4.5						
	8/15/19	14:56:28	4.0	25.7	7.6	93.9	248	7.6		6.9	5.5						
	8/15/19	14:57:40	5.0	25.3	6.1	74.7	247	7.5		6.8	5.8		0.0170		0.4450	<0.050	0.4950
	8/15/19	14:58:23	5.5	21.4	1.1	12.8	251	7.4		6.5	6.7						
	8/15/19	14:59:04	6.0	18.5	1.1	12.1	251	7.4		6.4	6.7						
	8/15/19	14:59:53	7.0	13.8	0.8	7.5	254	7.3		7.2	27.7						
	8/15/19	15:00:38	7.5	12.7	0.1	1.3	267	7.1		10.0	12.8		0.0786		0.9960	0.0543	1.0460
9 mo pre-T+C40:N50	9/5/19	10:13:39	0.1	24.1	8.1	97.8	247	6.8		5.8	3.9	3.6	0.0106		0.8040	<0.050	0.8540
	9/5/19	10:13:11	1.0	24.1	8.1	97.4	247	6.7		6.0	5.0						
	9/5/19	10:12:41	2.0	24.1	8.1	97.4	247	6.8		6.2	5.4						
	9/5/19	10:12:24	3.0	24.1	8.1	97.5	247	6.7		6.3	5.5						
	9/5/19	10:11:44	4.0	24.0	7.7	93.2	247	6.7		6.8	5.5						
	9/5/19	10:10:26	5.0	23.9	6.7	80.0	247	6.7		8.0	5.8		0.0149		0.5110	<0.050	0.5610
	9/5/19	10:09:53	5.6	22.4	1.2	13.7	250	6.7		8.9	6.1						
	9/5/19	10:08:52	6.0	20.2	0.4	4.4	251	6.7		11.9	6.2						
	9/5/19	10:08:06	7.0	15.0	0.5	4.7	251	6.7		17.2	6.5						
	9/5/19	10:07:19	8.1	11.3	0.3	2.5	319	6.6		18.3	7.0		0.1140		2.3900	<0.050	2.4300

Table A.1 - continued.

	Date	Time	Depth	Temp	DO	DO	Sp. Cond	pH	Alk	CHL	Turbidity	Secchi	Total P	Total Al	TKN	Nitrate N	Total N
Timing of Assessment	MM.DD.YY	HH:MM:SS	meters	°C	mg/l	% Sat	µS/cm	Units	mg/L	µg/l	NTU	meters	mg/L	mg/L	mg/L	mg/L	mg/L
Pre-T profile	5/7/2020	14:52:10	0.1	15.5	11.5	116.6	226	7.9	7	6.7	3.3	2.9	0.0223	<0.050	0.4180	<0.050	0.4680
	5/7/2020	14:51:32	1.0	15.4	11.4	115.5	226	7.7		8.4	3.2						
	5/7/2020	14:51:14	2.0	15.3	11.3	114.1	226	7.6		9.7	3.1						
	5/7/2020	14:50:49	3.0	11.6	11.7	109.4	223	7.4		2.7	3.0						
	5/7/2020	14:50:10	4.0	10.8	11.2	102.1	224	7.3		4.7	3.0						
	5/7/2020	14:49:33	5.0	10.3	10.6	96.0	223	7.3		5.7	3.1						
	5/7/2020	14:49:04	6.0	10.0	10.1	90.7	223	7.4		4.1	3.2						
	5/7/2020	14:48:22	7.0	9.7	8.6	76.5	223	7.4		3.8	3.3						
	5/7/2020	14:47:56	8.0	9.6	6.8	60.6	223	7.5		3.9	3.6						
	5/7/2020	14:47:02	9.0	9.5	4.2	37.0	225	7.5	9	2.0	4.2		0.0213	<0.050	0.3080	0.0518	0.3598
Immediate pre-T profile	5/8/2020	9:07:42	0.2	14.5	11.2	111.0	225	7.6		4.2	3.2						
	5/8/2020	9:07:23	1.0	14.5	11.1	110.7	227	7.5		4.3	3.1						
	5/8/2020	9:06:57	2.0	14.4	11.1	110.4	225	7.4		5.8	3.1						
	5/8/2020	9:06:17	3.0	12.2	10.5	99.2	222	7.3		9.3	2.8						
	5/8/2020	9:05:59	4.1	10.8	10.5	95.8	223	7.3		4.7	2.7						
	5/8/2020	9:05:32	5.0	10.4	9.8	88.5	222	7.3		5.5	2.6						
	5/8/2020	9:05:13	6.0	10.0	9.1	81.4	222	7.3		4.5	2.5						
	5/8/2020	9:04:52	7.1	9.7	8.4	74.8	222	7.3		3.5	2.5						
	5/8/2020	9:04:27	7.9	9.6	7.1	63.0	223	7.3		2.8	2.6						
	5/8/2020	9:03:50	8.4	9.6	4.7	41.4	223	7.4		2.5	3.4						
Area of 1st T	5/8/2020	10:48:11	0.6	14.6	11.3	112.2	242	5.7		3.2	5.5						
	5/8/2020	10:47:34	1.2	14.6	11.3	112.7	241	5.3		3.1	5.0						
	5/8/2020	10:46:43	2.7	13.5	11.6	113.1	227	7.0		7.9	4.8						
	5/8/2020	10:48:38	3.7	11.0	11.6	106.7	224	6.0		15.4	5.3						
	5/8/2020	10:49:07	5.5	10.2	10.9	98.7	223	6.1		6.7	4.8						
	5/8/2020	10:49:22	6.5	9.9	10.6	95.4	224	6.1		5.9	4.5						
Area of 1st T	5/8/2020	10:56:42	0.3	14.6	11.4	113.2	235	6.7		2.4	5.7						
	5/8/2020	10:56:19	2.1	14.6	11.3	112.4	239	6.7		3.1	5.4						
	5/8/2020	10:55:46	4.2	10.9	10.5	96.2	224	6.7		13.0	5.5						
	5/8/2020	10:55:25	6.1	10.1	8.8	79.3	223	6.7		4.2	3.6						
Area of 2nd T	5/8/2020	11:34:04	0.9	14.6	11.3	112.3	234	6.2		3.5	5.9						
	5/8/2020	11:34:30	3.1	11.7	12.1	112.9	224	6.4		14.1	5.5						
	5/8/2020	11:34:52	5.6	10.2	10.9	98.7	223	6.5		5.7	4.9						
Area of 2nd T	5/8/2020	11:36:45	0.7	14.7	11.3	112.3	227	6.2		3.9	6.8						
	5/8/2020	11:37:14	3.2	11.7	12.0	112.6	224	6.1		8.5	5.2						
	5/8/2020	11:37:41	6.2	10.0	10.8	96.5	223	6.3		5.7	4.4						
	5/8/2020	11:38:10	8.1	9.6	8.9	79.2	223	6.3		2.9	3.9						
Area of 2nd T	5/8/2020	11:45:06	0.2	14.7	11.3	112.9	239	6.3		4.0	5.8						
	5/8/2020	11:45:23	3.6	11.2	12.2	112.6	224	6.3		8.1	5.8						
	5/8/2020	11:45:42	7.7	9.7	10.4	92.7	226	6.4		3.0	5.2						

Table A.1 – continued

	Date	Time	Depth	Temp	DO	DO	Sp. Cond	pH	Alk	CHL	Turbidity	Secchi	Total P	Total Al	TKN	Nitrate N	Total N
Timing of Assessment	MM.DD.YY	HH:MM:SS	meters	°C	mg/l	% Sat	µS/cm	Units	mg/L	µg/l	NTU	meters	mg/L	mg/L	mg/L	mg/L	mg/L
Drift thru T 5 min after	5/8/2020	11:50:48	2.2	14.6	11.6	115.3	237	6.7		5.6	5.3						
	5/8/2020	11:51:10	2.3	14.6	11.5	114.1	234	6.5		2.9	5.7						
	5/8/2020	11:51:36	2.3	13.8	11.7	114.4	229	6.6		6.3	5.6						
	5/8/2020	11:51:55	2.2	14.2	11.7	115.6	236	6.5		4.2	5.7						
	5/8/2020	11:52:30	2.2	14.5	11.3	112.4	234	6.1		1.2	5.6						
	5/8/2020	11:53:12	2.2	14.6	11.3	112.4	237	6.1		1.2	5.6						
	5/8/2020	11:53:49	2.2	14.5	11.3	112.7	235	5.9		0.9	5.6						
	5/8/2020	11:54:20	2.3	14.6	11.3	112.5	234	6.0		1.4	5.6						
	5/8/2020	11:55:03	2.1	14.5	11.2	111.8	234	6.2		1.9	5.6						
	5/8/2020	11:55:30	2.2	14.5	11.3	112.2	234	6.3		2.6	5.6						
	5/8/2020	11:56:10	2.2	14.6	11.3	112.3	234	6.3		2.6	5.6						
	5/8/2020	11:56:44	2.2	14.6	11.3	112.2	233	6.4		2.4	5.6						
	5/8/2020	11:57:15	2.2	14.6	11.3	112.4	232	6.4		2.8	5.5						
	5/8/2020	11:57:44	2.2	14.6	11.2	111.7	231	6.5		3.1	5.5						
	5/8/2020	11:58:14	2.2	14.5	11.3	112.2	227	6.7		4.7	5.4						
	5/8/2020	11:58:51	2.3	14.5	11.3	112.1	227	6.8		4.2	5.3						
	5/8/2020	11:59:24	2.2	14.6	11.2	111.9	229	6.9		3.6	5.2						
	5/8/2020	11:59:44	2.2	14.6	11.2	112.0	226	6.9		3.5	5.2						
Drift thru T 30+ min after	5/8/2020	12:26:59	2.6	13.1	12.1	116.8	224	7.2		7.1	3.7						
	5/8/2020	12:27:21	2.6	12.7	12.3	117.4	224	7.2		5.0	3.0						
	5/8/2020	12:27:45	2.6	13.1	12.1	116.8	225	7.2		5.3	3.2						
	5/8/2020	12:28:19	2.6	13.0	12.2	117.1	226	7.2		5.3	3.4						
	5/8/2020	12:28:50	2.5	13.9	11.9	115.7	240	7.2		4.9	3.5						
	5/8/2020	12:29:06	2.4	13.2	12.0	116.0	230	7.2		3.7	3.8						
	5/8/2020	12:29:28	2.5	13.6	11.8	115.0	228	7.2		2.6	3.9						
2nd drift thru T 30+ min	5/8/2020	12:31:47	2.6	14.6	11.2	112.1	233	7.0		2.3	4.4						
	5/8/2020	12:31:53	2.5	14.7	11.2	112.1	233	7.0		2.2	4.5						
	5/8/2020	12:32:13	2.5	14.7	11.3	112.5	233	7.0		2.0	4.5						
	5/8/2020	12:32:24	2.5	14.7	11.3	112.6	233	7.0		2.1	4.5						
Profile in T area 30+ min after	5/8/2020	12:34:04	0.5	14.8	11.3	112.7	249	6.8		1.8	5.3						
	5/8/2020	12:34:30	2.0	14.7	11.3	113.0	237	6.7		1.5	5.4						
	5/8/2020	12:34:49	4.0	11.1	11.9	109.6	224	6.8		4.5	5.3						
	5/8/2020	12:35:29	6.0	9.9	10.6	94.7	223	6.8		5.5	5.1						
	5/8/2020	12:36:12	7.9	9.6	6.7	59.2	224	6.7		2.5	4.9						
Profile in T area 5 min after	5/8/2020	12:51:51	0.3	14.7	11.3	112.9	239	6.3		1.4	5.3						
	5/8/2020	12:52:10	2.3	14.7	11.3	113.4	251	6.0		1.3	5.4						
	5/8/2020	12:52:33	4.3	10.9	11.1	101.3	224	6.1		7.1	5.1						
	5/8/2020	12:52:45	6.5	9.8	11.0	98.1	223	6.2		6.0	4.7						
	5/8/2020	12:53:05	8.0	9.7	9.0	80.2	224	6.3		4.1	4.2						

Table A.1 – continued

	Date	Time	Depth	Temp	DO	DO	Sp. Cond	pH	Alk	CHL	Turbidity	Secchi	Total P	Total Al	TKN	Nitrate N	Total N
Timing of Assessment	MM.DD.YY	HH:MM:SS	meters	°C	mg/l	% Sat	µS/cm	Units	mg/L	µg/l	NTU	meters	mg/L	mg/L	mg/L	mg/L	mg/L
Drift thru T 10-15 min after	5/8/2020	12:59:16	2.1	14.7	11.3	112.7	231	6.6		2.5	4.4						
	5/8/2020	12:59:24	2.0	14.7	11.3	112.7	232	6.6		2.7	4.4						
	5/8/2020	12:59:34	1.8	14.7	11.2	112.3	231	6.7		2.7	4.4						
	5/8/2020	12:59:50	1.6	14.7	11.3	112.9	232	6.7		1.7	4.4						
	5/8/2020	13:00:23	2.6	14.6	11.3	112.5	229	6.7		4.6	4.4						
Profile 30 min after T	5/8/2020	13:45:42	0.5	14.8	11.1	111.5	243	6.6		0.6	4.6						
	5/8/2020	13:46:34	2.0	14.7	11.2	112.1	244	6.5		0.6	4.7						
	5/8/2020	13:47:07	4.1	10.9	11.7	106.9	224	6.6		7.4	4.5						
	5/8/2020	13:47:26	6.0	10.0	11.4	102.0	223	6.6		6.6	4.2						
	5/8/2020	13:47:53	8.0	9.7	9.7	86.2	225	6.6		3.8	3.8						
Profie 2 min after T	5/8/2020	13:55:35	1.0	14.8	10.8	107.9	245	5.8		0.9	6.6						
	5/8/2020	13:56:14	2.7	13.5	11.9	116.0	226	6.0		6.6	4.5						
	5/8/2020	13:56:44	4.8	10.3	11.3	102.6	224	6.2		6.5	3.7						
	5/8/2020	13:56:58	6.2	9.9	10.9	97.4	223	6.2		6.2	3.5						
	5/8/2020	13:57:20	7.8	9.8	9.4	83.9	223	6.2		4.5	3.4						
Profile after all T complete	5/8/2020	15:07:04	0.2	14.7	11.1	110.9	253	6.7	5	0.1	3.5						
	5/8/2020	15:07:31	1.0	14.7	11.1	111.2	254	6.5		0.1	3.5						
	5/8/2020	15:07:47	2.0	14.7	11.2	111.6	254	6.4		0.1	3.6						
	5/8/2020	15:08:14	3.0	12.6	11.8	112.1	226	6.4		5.1	3.6						
	5/8/2020	15:08:35	4.0	10.8	11.8	108.3	224	6.5		5.2	3.5						
	5/8/2020	15:09:00	5.0	10.3	11.2	101.3	223	6.5		5.6	3.3						
	5/8/2020	15:09:27	6.0	10.0	10.6	95.1	223	6.6		5.9	3.2						
	5/8/2020	15:10:00	7.0	9.8	9.7	86.3	223	6.6		4.4	3.1						
	5/8/2020	15:10:36	8.0	9.7	7.9	70.2	223	6.5		3.4	3.1						
	5/8/2020	15:11:32	8.7	9.6	5.8	51.4	224	6.4	7	2.4	3.7						
Profile 1 day after T	5/9/2020	2:47:30	0.2	13.6	11.0	107.4	234	6.8	8	0.3	3.3	5.0	<0.0106	0.3410	0.2360	<0.050	0.2860
	5/9/2020	2:47:47	1.0	13.6	11.0	106.7	236	6.9		0.3	3.3						
	5/9/2020	2:48:12	2.0	13.6	11.0	106.7	234	6.8		0.3	3.3						
	5/9/2020	2:48:45	3.0	13.5	11.0	106.8	233	6.9		0.4	3.3						
	5/9/2020	2:49:07	4.0	11.1	11.4	105.2	224	6.9		3.1	3.4						
	5/9/2020	2:49:31	5.0	10.5	11.5	104.5	225	6.9		4.8	3.4						
	5/9/2020	2:49:59	6.0	10.1	10.4	93.7	223	6.9		3.8	3.4						
	5/9/2020	2:50:24	7.0	9.8	9.4	83.5	223	6.9		3.0	3.4						
	5/9/2020	2:50:56	8.0	9.6	7.2	63.7	224	6.8		2.6	3.4						
	5/9/2020	2:51:12	8.6	9.6	6.6	58.9	224	6.8	8	2.2	3.4		0.0276	0.0581	0.4310	<0.050	0.4810

Table A.1 – continued

Timing of Assessment	Date MM.DD.YY	Time HH:MM:SS	Depth meters	Temp °C	DO mg/l	DO % Sat	Sp. Cond µS/cm	pH Units	Alk mg/L	CHL µg/l	Turbidity NTU	Secchi meters	Total P mg/L	Total Al mg/L	TKN mg/L	Nitrate N mg/L	Total N mg/L
Profile 32 days after T	6/10/2020	10:28:19	0.3	22.7	8.8	103.0	248	7.4	6	1.3	2.8	5.3	<0.0106	<0.0500	0.2950	<0.050	0.3450
	6/10/2020	10:28:44	1.0	22.7	8.8	102.9	247	7.3		1.4	2.8						
	6/10/2020	10:29:02	2.0	22.6	8.8	102.8	249	7.3		1.6	2.8						
	6/10/2020	10:29:39	3.0	22.6	8.8	102.7	247	7.3		2.7	2.9						
	6/10/2020	10:29:59	4.0	20.4	9.9	111.2	243	7.3		3.3	2.9						
	6/10/2020	10:30:32	5.0	18.0	11.1	118.7	240	7.3	6	3.8	3.0		0.0191	<0.0500	0.2700	<0.050	0.3200
	6/10/2020	10:30:58	6.0	15.8	10.1	103.2	238	7.3		3.9	3.0						
	6/10/2020	10:31:35	7.0	14.3	6.2	61.0	235	7.1		6.1	3.1						
	6/10/2020	10:32:29	8.0	13.2	2.6	25.3	234	6.8		6.1	3.2						
	6/10/2020	10:33:11	9.0	12.7	0.2	1.8	237	6.6	8	7.5	3.7		0.0213	<0.0500	0.6550	<0.050	0.7050
Profile 62 days after T	7/10/2020	8:53:34	0.3	26.8	8.4	106.4	248	7.7	9	1.9	2.7	5.1	<0.0106	<0.0500	0.3400	<0.0500	0.3900
	7/10/2020	8:53:58	1.0	26.8	8.4	106.4	248	7.7		2.2	2.9						
	7/10/2020	8:54:24	2.0	26.8	8.4	106.1	248	7.7		2.5	2.9						
	7/10/2020	8:54:48	3.0	26.4	8.4	105.8	247	7.7		3.3	3.0						
	7/10/2020	8:55:20	4.0	25.8	8.1	100.6	246	7.6		2.9	3.2						
	7/10/2020	8:56:02	5.0	22.9	6.1	72.0	244	7.4	10	3.7	3.3		0.0128	<0.0500	0.4380	<0.0500	0.4880
	7/10/2020	8:56:41	6.0	18.8	4.3	47.2	242	7.2		3.8	3.3						
	7/10/2020	8:57:43	7.0	15.9	2.1	21.9	239	6.9		1.7	3.1						
	7/10/2020	8:58:34	8.0	14.4	0.2	1.9	238	6.6		4.2	3.7						
	7/10/2020	8:59:46	9.0	13.6	0.0	0.2	252	6.4	13	90.9	20.3		0.0255	<0.0500	0.4940	<0.0500	0.5440
Profile 93 days after T	8/10/2020	9:11:19	0.2	27.4	8.3	106.8	287	7.1	9	2.2	3.8	4.1	<0.0106		0.4270	<0.0500	0.4770
	8/10/2020	9:12:34	1.0	27.3	8.3	106.4	287	7.1		3.1	3.8						
	8/10/2020	9:13:28	2.0	27.3	8.3	105.8	287	7.1		3.5	3.8						
	8/10/2020	9:14:04	3.0	27.2	8.1	103.9	287	7.1		3.3	3.8						
	8/10/2020	9:15:10	4.1	27.1	8.0	102.6	288	7.1		3.9	3.9						
	8/10/2020	9:15:52	5.0	26.5	6.0	76.0	285	7.0	10	3.3	4.0		0.0117		0.4030	<0.0500	0.4530
	8/10/2020	9:16:43	6.0	21.8	1.8	20.4	276	6.7		4.1	4.3						
	8/10/2020	9:17:33	7.0	18.0	0.2	2.0	273	6.5		6.0	4.3						
	8/10/2020	9:18:31	8.0	15.2	0.1	0.6	271	6.3		8.3	4.5						
	8/10/2020	9:19:13	8.7	14.0	0.0	0.0	330	6.1	12	16.6	45.3		0.0489		0.9420	<0.0500	0.9920
Profile 123 days after T	9/9/2020	8:53:10	0.2	24.2	8.9	107.1	288	7.4	10.0	2.9	4.4	3.4	<0.0106		0.4420	<0.0500	0.4920
	9/9/2020	8:53:29	1.0	24.2	8.8	106.9	289	7.4		3.2	4.3						
	9/9/2020	8:53:56	2.0	24.2	8.8	106.1	289	7.4		3.6	4.0						
	9/9/2020	8:54:25	3.0	23.9	8.8	106.1	288	7.4		4.6	4.4						
	9/9/2020	8:55:03	4.0	23.8	8.6	103.1	288	7.4		5.8	4.5						
	9/9/2020	8:55:29	5.0	23.6	8.1	96.5	288	7.4		5.8	4.6						
	9/9/2020	8:56:12	6.0	22.9	4.8	56.1	286	7.2	12.0	5.1	4.7		0.0181		0.4230	<0.0500	0.4720
	9/9/2020	8:57:04	7.0	19.5	0.6	6.8	272	6.8		7.3	5.3						
	9/9/2020	8:57:31	8.0	16.2	0.0	0.0	292	6.6		28.4	5.9						
	9/9/2020	8:58:21	8.8	15.0	0.0	0.0	352	6.4	52.0	16.6	24.6		0.0765		2.4400	0.0509	2.4509

Table A.2 – Phytoplankton data

	PHYTOPLANKTON BIOMASS (UG/L)									
	Crystal	**Crystal**	**Crystal**	**Crysal**	**Crystal**	**Crystal**	**Crystal**	**Crystal**	**Crystal**	**Crystal**
TAXON	**05/14/19**	**06/27/19**	**08/15/19**	**09/05/19**	**05/07/20**	**05/09/20**	**06/10/20**	**07/10/20**	**08/10/20**	**09/09/20**
BACILLARIOPHYTA										
Centric Diatoms										
Cyclotella	19.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Araphid Pennate Diatoms										
Asterionella	0.0	71.2	0.0	10.7	3.1	0.0	7.4	0.0	0.0	0.0
Tabellaria	0.0	0.0	0.0	0.0	62.4	0.0	0.0	21.8	0.0	119.7
Biraphid Pennate Diatoms										
Navicula/related taxa	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CHLOROPHYTA										
Coccoid/Colonial Chlorophytes										
Ankistrodesmus	26.6	4.5	4.8	0.7	0.0	0.0	0.0	1.4	0.8	0.0
Coelastrum	0.0	0.0	64.0	21.4	0.0	0.0	9.9	16.3	98.6	44.9
Crucigenia	0.0	0.0	0.0	0.0	3.1	0.0	0.0	16.3	0.0	44.9
Elakatothrix	0.0	0.0	184.0	187.6	0.0	0.0	223.2	66.6	28.5	3.7
Kirchneriella	0.0	0.0	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oocystis	0.0	0.0	76.8	42.9	0.0	0.0	19.8	21.8	6.2	119.7
Quadrigula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5
Scenedesmus	0.0	0.0	6.4	2.7	3.1	0.0	2.5	5.4	0.0	0.0
Sphaerocystis	0.0	5055.2	179.2	80.4	0.0	0.0	29.8	21.8	98.6	59.8
Tetraedron	0.0	0.0	0.0	0.0	0.0	0.0	7.4	0.0	0.0	0.0
Tetrastrum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0
Filamentous Chlorophytes										
Oedogonium	0.0	0.0	0.0	0.0	31.2	24.8	0.0	0.0	0.0	0.0
Ulothrix	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0
Desmids										
Closterium	0.0	0.0	32.0	0.0	1591.2	396.8	124.0	0.0	0.0	224.4
Cosmarium	0.0	0.0	6.4	0.0	0.0	0.0	5.0	0.0	0.0	0.0
Euastrum	0.0	0.0	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Octacanthium	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	2.3	0.0
Spirogyra	0.0	0.0	0.0	0.0	312.0	0.0	0.0	0.0	0.0	0.0
Staurastrum	17.8	7.1	12.8	5.4	0.0	0.0	0.0	5.4	0.0	15.0
Staurodesmus	0.0	0.0	4.8	0.0	0.0	0.0	3.7	4.1	4.6	11.2
CHRYSOPHYTA										
Flagellated Classic Chrysophytes										
Dinobryon	421.8	0.0	0.0	0.0	0.0	0.0	37.2	0.0	0.0	0.0
Mallomonas	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4
Synura	47.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uroglena	17.8	0.0	0.0	0.0	1107.6	184.8	17.4	0.0	0.0	0.0
Tribophytes/Eustigmatophytes										
Pseudostaurastrum	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0
CRYPTOPHYTA										
Cryptomonas	4.4	0.0	0.0	0.0	0.0	0.0	32.2	0.0	0.0	7.5
CYANOPHYTA										
Unicellular and Colonial Forms										
Aphanocapsa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	0.0
Chroococcus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	50.5	61.3
Microcystis	0.0	0.0	6.4	12.1	0.0	0.0	0.0	0.0	0.0	7.5
Other Coccoid Bluegreens	0.0	0.0	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Filamentous Nitrogen Fixers										
Aphanizomenon	0.0	0.0	1248.0	34.8	0.0	0.0	0.0	66.3	0.0	121.6
Dolichospermum	0.0	0.0	788.0	53.6	0.0	0.0	0.0	0.0	462.0	112.2
EUGLENOPHYTA										
Euglena	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.4
Trachelomonas	14.8	8.9	8.0	62.3	15.6	18.6	6.2	0.0	0.0	37.4
DENSITY (UG/ML) SUMMARY										
BACILLARIOPHYTA	**22.9**	**71.2**	**0.0**	**10.7**	**65.5**	**0.0**	**7.4**	**21.8**	**0.0**	**119.7**
Centric Diatoms	19.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Araphid Pennate Diatoms	0.0	71.2	0.0	10.7	65.5	0.0	7.4	21.8	0.0	119.7
Monoraphid Pennate Diatoms	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Biraphid Pennate Diatoms	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CHLOROPHYTA	**44.4**	**5066.8**	**601.6**	**341.0**	**1943.0**	**437.1**	**425.3**	**165.9**	**239.5**	**531.1**
Flagellated Chlorophytes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coccoid/Colonial Chlorophytes	26.6	5059.7	521.6	335.7	6.2	15.5	292.6	152.3	232.5	280.5
Filamentous Chlorophytes	0.0	0.0	0.0	0.0	31.2	24.8	0.0	4.1	0.0	0.0
Desmids	17.8	7.1	80.0	5.4	1905.5	396.8	132.7	9.5	6.9	250.6
CHRYSOPHYTA	**494.3**	**0.0**	**0.0**	**0.0**	**1107.6**	**184.8**	**59.5**	**0.0**	**0.0**	**9.4**
Flagellated Classic Chrysophytes	494.3	0.0	0.0	0.0	1107.6	184.8	54.6	0.0	0.0	9.4
Non-Motile Classic Chrysophytes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haptophytes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tribophytes/Eustigmatophytes	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0
Raphidophytes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRYPTOPHYTA	**4.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**32.2**	**0.0**	**0.0**	**7.5**
CYANOPHYTA	**0.0**	**0.0**	**2033.6**	**100.5**	**0.0**	**0.0**	**0.0**	**66.8**	**515.6**	**302.6**
Unicellular and Colonial Forms	0.0	0.0	17.6	12.1	0.0	0.0	0.0	0.5	53.6	68.8
Filamentous Nitrogen Fixers	0.0	0.0	2016.0	88.4	0.0	0.0	0.0	66.3	462.0	233.8
Filamentous Non-Nitrogen Fixers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EUGLENOPHYTA	**14.8**	**8.9**	**8.0**	**62.3**	**15.6**	**18.6**	**6.2**	**0.0**	**0.0**	**74.8**
PYRRHOPHYTA	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
TOTAL	**580.9**	**5146.9**	**2643.2**	**514.6**	**3131.7**	**640.5**	**530.7**	**254.5**	**755.1**	**1045.0**

Table A.2 – Zooplankton data

	ZOOPLANKTON BIOMASS (UG/L)								
	Crystal	Crystal	Crystal	Crystal	Crystal	Crystal	Crystal	Crystal	Crystal
TAXON	**5/14/19**	**8/15/19**	**9/5/19**	**5/7/20**	**5/9/20**	**6/10/20**	**7/10/20**	**8/10/20**	**9/9/20**
PROTOZOA									
Ciliophora	0.5	0.0	0.0	0.0	0.0	0.4	0.0	0.3	0.0
Mastigophora	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sarcodina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ROTIFERA									
Asplanchna	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.0	0.0
Conochilus	2.1	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0
Kellicottia	0.0	0.0	0.0	0.1	0.1	0.3	0.1	0.1	0.2
Keratella	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
COPEPODA									
Copepoda-Cyclopoida									
Cyclops	3.2	0.0	0.0	4.8	6.4	11.1	6.7	8.0	1.0
Mesocyclops	0.0	0.8	0.0	2.5	1.7	19.4	0.8	10.5	2.6
Copepoda-Calanoida									
Diaptomus	55.3	77.0	57.7	5.1	5.7	8.2	61.9	338.5	207.7
Other Copepoda-Nauplii	6.9	5.2	6.9	10.5	7.0	12.1	5.2	18.8	8.9
CLADOCERA									
Bosmina	2.5	0.0	0.0	7.8	3.9	5.1	0.0	0.0	0.8
Daphnia ambigua	133.7	29.0	39.1	137.6	118.5	57.5	87.2	44.4	6.2
Daphnia pulex	21.6	17.9	3.8	0.0	0.0	0.0	91.9	17.1	0.0
Diaphanosoma	1.9	50.4	38.7	0.0	0.0	3.8	0.0	41.2	11.0
SUMMARY STATISTICS									
BIOMASS									
PROTOZOA	0.5	0.0	0.0	0.0	0.0	0.4	0.0	0.3	0.0
ROTIFERA	2.1	0.0	0.0	0.2	0.1	6.9	0.1	0.1	0.2
COPEPODA	65.4	82.9	64.6	22.9	20.8	50.7	74.6	375.8	220.3
CLADOCERA	159.9	97.2	81.6	145.4	122.4	66.4	179.1	102.8	18.0
OTHER ZOOPLANKTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ZOOPLANKTON	227.8	180.2	146.3	168.5	143.3	124.5	253.9	478.9	238.5
MEAN LENGTH (mm): ALL FORMS	0.39	0.96	0.92	0.69	0.73	0.31	0.89	0.73	0.78
MEAN LENGTH: CRUSTACEANS	0.88	0.96	0.92	0.73	0.76	0.72	0.98	0.92	0.88