TETRA TECH

TECHNICAL MEMO

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Date:	December 31, 2019
Subject:	2019 Annual Summary Technical Memo

1.0 Introduction

The purpose of the Long Lake Integrated/Adaptive Lake Management Program is to achieve water quality and aquatic habitat goals established during the 2006 – 2010 lake management efforts. The current Long Lake management program is being implemented through the Kitsap County's Long Lake Management District (LLMD) from 2018 through 2022. Targeted management of the lake will lead to an ecologically sustainable and balanced ecosystem with aesthetic appeal that supports water contact recreation, sport fishery, downstream water quality needs, and salmon migration. The lake management program will limit internal phosphorus loading in order to reduce excessive phytoplankton production, will control excessive growth of rooted aquatic plants, and will eliminate, where possible, non-native plants such as Eurasian watermilfoil and Brazilian Elodea. The integrated management program for Long Lake includes six basic elements; project management, integrated/adaptive planning, monitoring, implementation, reporting, and public education. This technical memo provides an annual assessment of in-lake activities and monitoring data collected in 2019, as well as recommended activities for 2020.

Figure 1. Map of Long Lake and surrounding area

Long Lake is a shallow, lowland lake located approximately four miles south of Port Orchard in

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southern Kitsap County in Western Washington State (T2 3N-R2E) (**Figure 1**). Long Lake lies at an elevation of 118 feet (ft.) (36 meters [m]) above sea level. The 339-acre (137 hectare) lake has a historical volume of 2,200 acre-feet (2.69 X 10^6 cubic meters [m^3]), average depth of 6.5 ft. (2 m), and center depth of 12 ft. (4 m) (Bortleson et. al., 1976). Nearly 75% of the lake is less than 10 ft. (3 m) in depth, providing a large littoral area. The drainage area is approximately 9.4 square miles (24.3 square kilometers [km^2]), encompassing an increasingly urbanized watershed. Salmonberry Creek is the major inlet, entering on the western shore. The single outlet, Curley Creek, drains the lake at the northeastern end, eventually flowing into the Puget Sound. Several unnamed streams enter at the southern end of the lake. Long Lake exhibits a rather high flushing rate varying from 3.6 to 8.0 yr^{-1} (Jacoby et. al., 1982).

2.0 2019 In-Lake Activities

2.1 Alum Treatment for Phosphorus Control

Phosphorus management in 2019 was conducted the week of April 22 via a whole lake buffered alum treatment to remove phosphorus from the water column and to inactivate the release of phosphorus from the lake sediments to reduce algal production (**Figure 2**, **Figure 3**). In-situ monitoring of dissolved oxygen (DO), conductivity, temperature, and pH was performed by citizen volunteers and Tetra Tech staff prior to, during, and after treatment.

The 2019 alum treatment was a relatively low dose at 5 mg Al/L throughout the lake due to the unexpected increase in alum cost. Note that the targeted dose to inactivate sediment phosphorus and strip the water column of phosphorus was initially the same as the 2007 dose of 17.5 mgAl/L. Despite the lower dosage, there was a significant increase in water clarity following the 2019 treatment due to the reduction in algal production, and Long Lake did not experience a toxic bloom that had occurred each year for the last four years. The water quality impact of the 2019 treatment should provide effective reduction in potential HAB (Harmful Algal Blooms) event occurrences and intensity for 2 to 5 years, depending upon phosphorus cycling and loading as well as climatic impacts. A beneficial impact lasting 2 to 5 years is similar to the observed effectiveness from the 1980 and 1991 alum treatments that were both dosed as 5.5 mgAl/L. Those doses however, did not include the need to inactivate biogenic phosphorus (metabolizable organically bound phosphorus) whereas the 2017 dose did, hence a much higher dose. The cost-restricted dose of 2019 will need to be repeated within 2 to 5 years to ensure HAB prevention, and if possible, treated at a complete dose as in 2007.

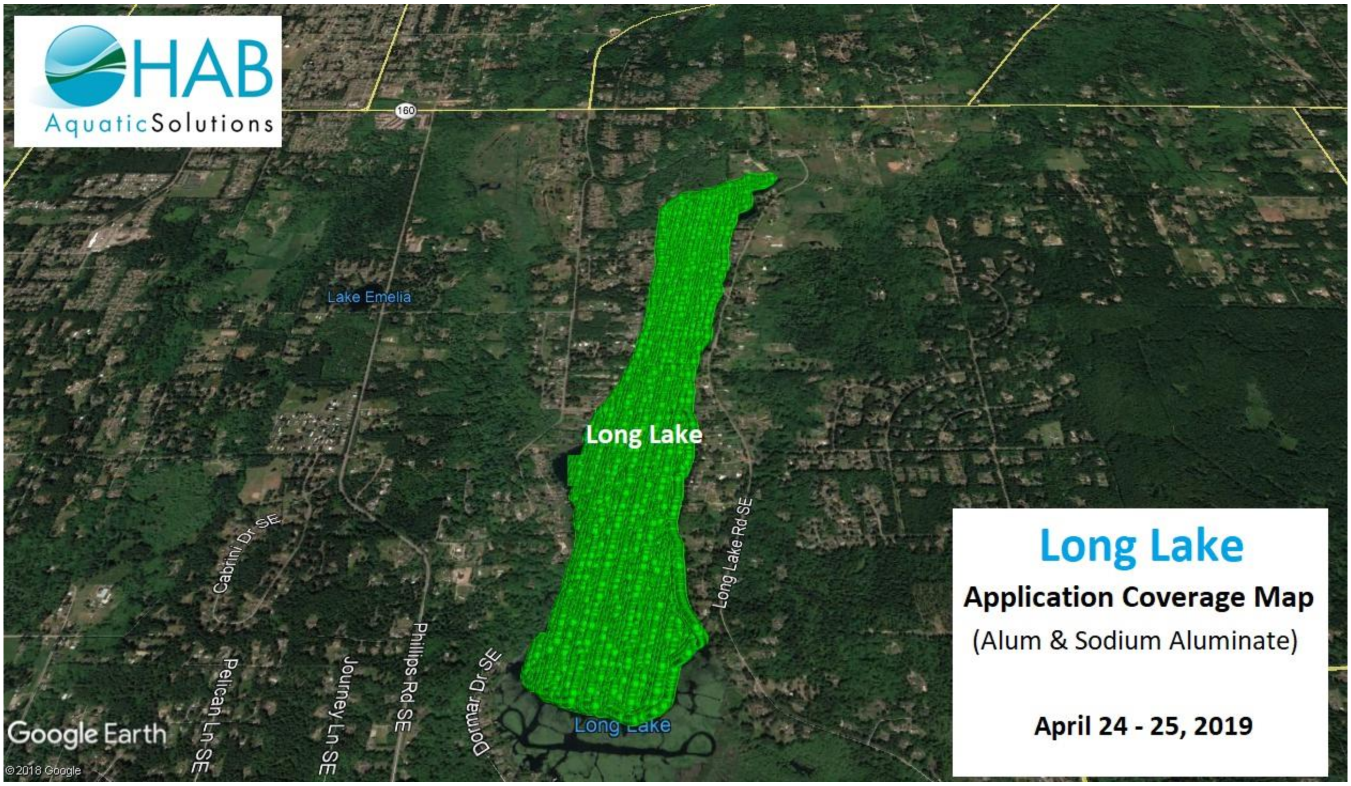

Figure 2. Alum treatment coverage map

Figure 3. Chemical distribution system for April 2019 alum treatment

2.2 Lake Monitoring

Citizen volunteers and Tetra Tech staff conducted in-situ monitoring on September 30 and November 1, 2019. In-situ monitoring was also conducted in April at various times before, during, and after the alum treatment. Monitoring was not conducted during the summer months (May-August) due to scheduling restraints of citizen volunteers.

All monitoring in 2019 included measurements of DO, conductivity, temperature, and pH at three sites in Long Lake and in the inlet of Salmonberry Creek (**Figure 4**). At the lake sites, these parameters were measured at 0.5-meter intervals within the water column. Citizens or staff recorded secchi disk depth, or transparency, at each station, and made notes on the weather and water conditions at the time of sampling.

Water samples were collected for laboratory analysis before and after the alum treatment on April 23 and April 26, as well as on September 30 and November 1. In April, water samples were collected at a depth of 0.5 meters, and a second water sample was collected at a depth of 2.5 meters at the mid-lake site. In the fall, samples were collected at the mid-lake station only, in accordance with the Long Lake Sampling and Analysis Plan (Tetra Tech 2018). Water samples were analyzed to determine total phosphorus (TP), soluble reactive phosphorus (SRP) and chlorophyll (chl) concentrations. During the November 1 monitoring event, a grab sample was collected from Salmonberry Creek. The creek water sample was analyzed for TP. All samples were delivered or packed with ice and sent to IEH Analytical Laboratory on the same day they were collected.

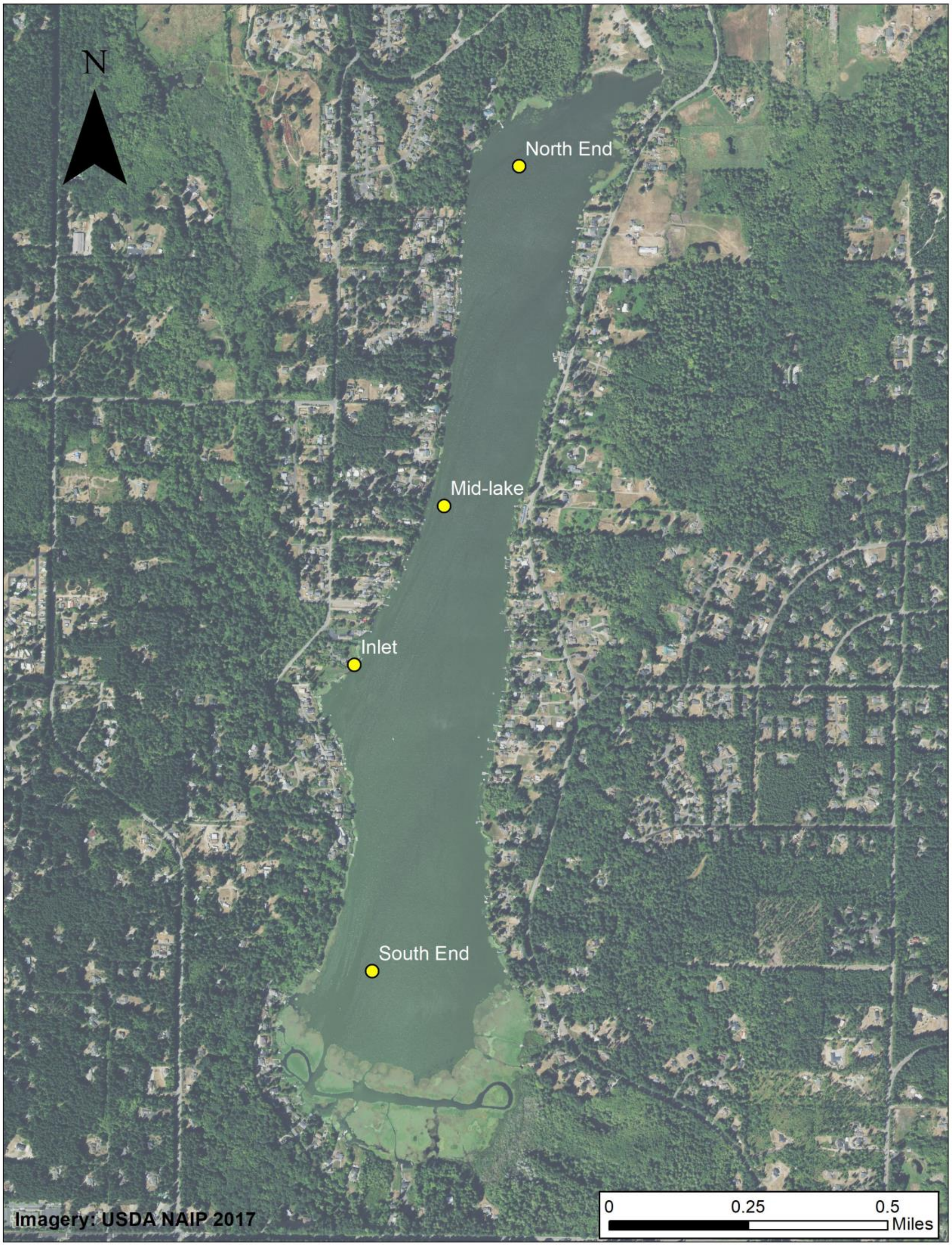

Figure 4. Map showing sampling locations

2.3 Aquatic Plant Management

2.3.1 Aquatic Plant Survey

Brazilian elodea *(Egeria densa*) has existed in the lake for over 40 years. It was not observed in the south end of the lake in the mid-1960s where endemic pond weeds were more abundant. The exotic elodea allegedly was introduced around 1970. During the 20-year study by University of Washington (UW), this plant composed at least 2/3 of the total plant mass (dry weight) and much of that time over ¾ of the biomass (Welch, 1996). In 1985, its abundance dropped to only 10% of total mass and summer TP and chl averaged 66 and 36 µg/L, respectively due to increased internal loading. Harvesting in the 1990s had no effect on the dominance of Brazilian elodea. Eurasian watermilfoil (*Myriophyllum spicatum*) was not present during the 20-year UW study, but it was observed during the 1996 IAVMP study (Water Environmental Services, 1996) so it is a more recent invader. Curly-leaf pondweed (*Potamogeton crispus*) is also a more recent invader and was first observed in 2006. Native pondweed *P. praelongus* has also been targeted for control due to increasing coverage and density since 2008.

Aquatic plant management during 2006-2010 resulted in a more diverse plant community within Long Lake. The density of native macrophytes species in heavy boat use areas declined while the diversity (number of species) increased over that time period. Eurasian watermilfoil had nearly disappeared but the Brazilian elodea population in the open lake and south end had remained stable (Tetra Tech, 2010).

In June 2018, Tetra Tech staff conducted an aquatic plant survey of Long Lake (**Figure 5**). Brazilian elodea was the dominant submersed plant observed during the survey and was observed throughout the lake. Lilies were abundant in the nearshore areas near each end of the lake with the invasive fragrant white lily (*Nymphaea odorata*) as the dominate species. The native yellow pond lily, *Nuphar polysepala*, covered less than 30% of the emergent plant beds. Eurasian watermilfoil was observed throughout the lake but in small groupings of relatively isolated plants. This was also the case for the invasive Curly-leaf pondweed. Several native narrow-leaf pondweed species *Potamogeton zosteriformis, P. pectinatus* and *P. filiformis* (flat stem pondweed, sago pondweed and slender-leaved pondweed) were observed throughout the lake with a relatively small percent cover. However, since 2008 the native pondweed *P. praelongus* has increased its coverage and density to warrant control. Based on the June 2018 survey, several areas at the north and south ends of the lake were identified for treatment (**Figure 5**). In the fall of 2018, shallow littoral zone treatments targeted invasive, non-native white lily, Brazilian elodea, Eurasian watermilfoil, and pondweed *P. praelongus*.

The first plant surveys of 2019 were conducted at the end of April and in mid-May, but only early-season sprouting was observed. On July 1, 2019, a complete aquatic plant survey was conducted (**Figure 6**). All the aquatic plant species mapped in 2018 were again present with two notable changes:

1. The non-native invasive fragrant white lily (*Nymphaea odorata*) was a dominant species and had expanded its nearshore littoral coverage significantly on the west side of the lake and in the northeast littoral areas.
2. Two new species, both native, have taken up dominance along with a third native species already present. *Potamogeton zosteriformis* (flat stem pond weed), was present in the 2018 survey, and in 2019 was observed within the mid-depth littoral areas especially on the east side of the lake and also expanding on the west side. The two new species, observed only rarely since studies began in the 1970s, are *P. pectinatus* and *P. filiformis* (sago pondweed and slender-leaved pondweed) that have displaced *P. praelongus* and are dominant on the east and west shorelines to a depth of 3m, inhibiting boat passage.

Although four of the five species of *Potamogeton* are native, three of the four native species have grown to extreme densities that exceed a balanced habitat and have the potential to adversely impact water quality. By the end of June these species densely covered over 24 acres along the east and west shorelines. This sudden pondweed production is due to several factors including clearer water, abundant solar energy, and nutrients within the shallow sediments.

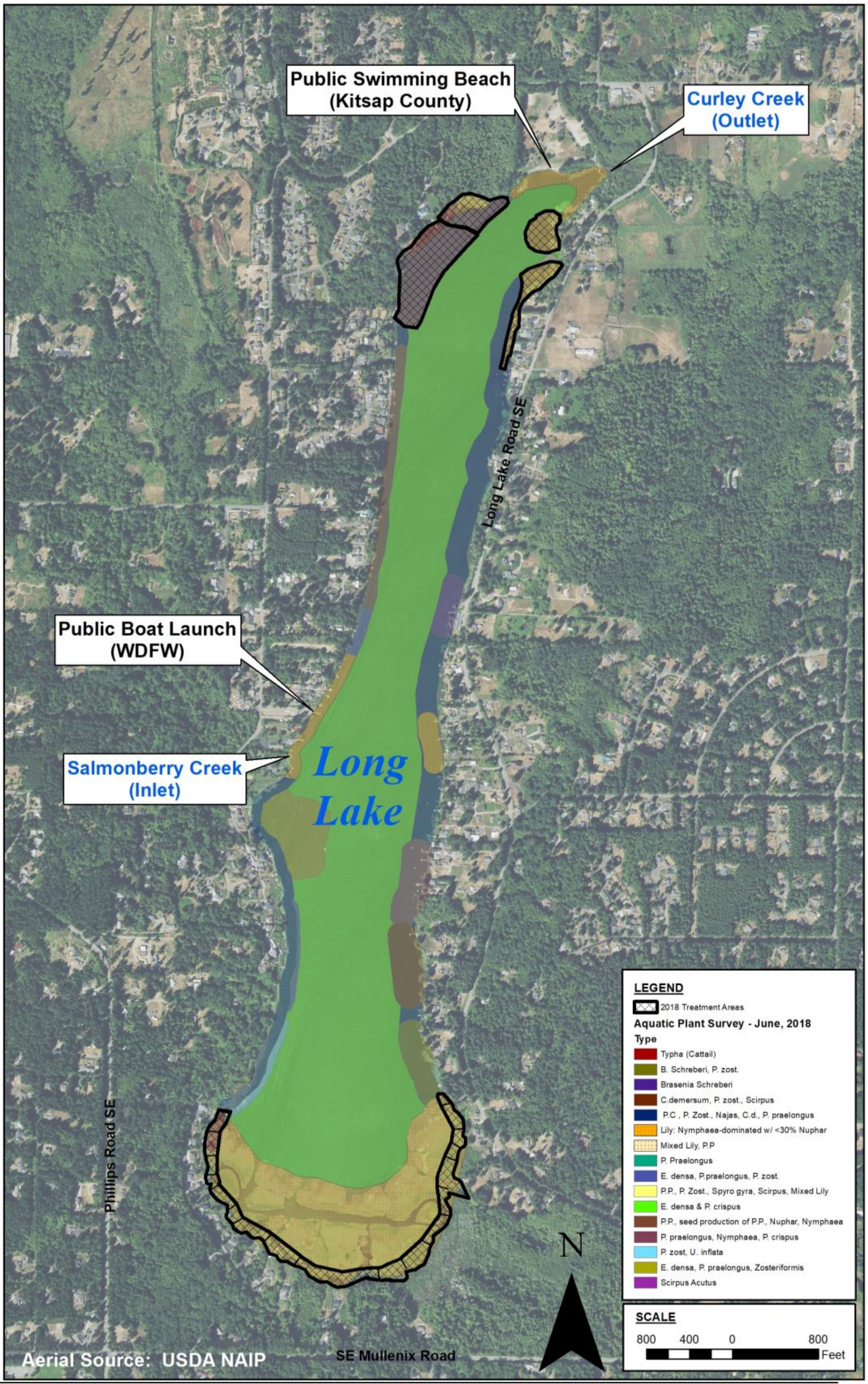

Figure 5. 2018 Aquatic plant distribution and treatment areas

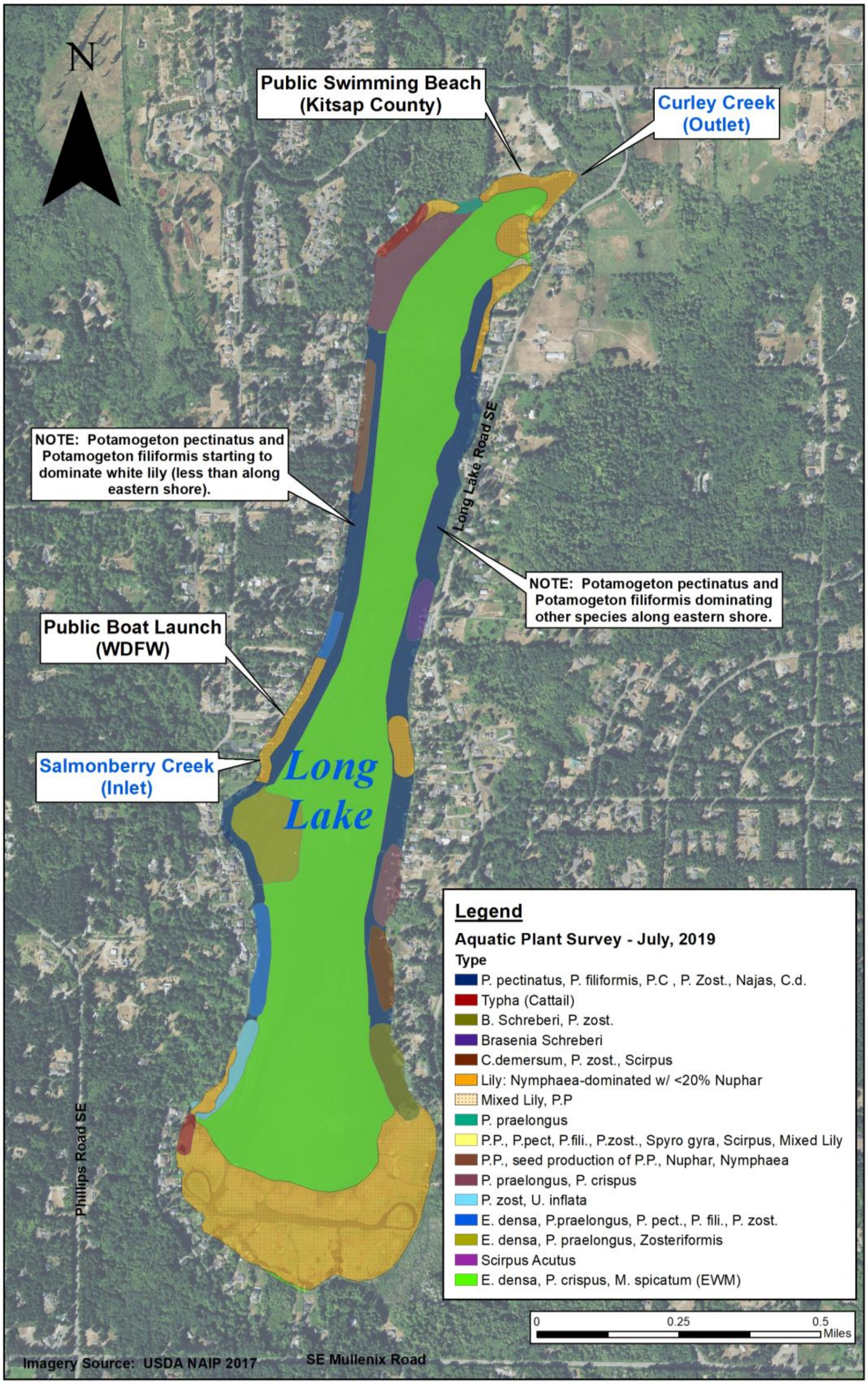

Figure 6. Aquatic plant distribution – July 2019 survey

2.3.2 Aquatic Plant Treatment

The goal of aquatic plant treatment at Long Lake is to target noxious invasive non-native weeds that are already present and were documented in the 2010 report and confirmed during plant surveys in 2018 and 2019. Native species *Potamogeton zosteriformis, P. pectinatus* and *P. filiformis* (flat stem pondweed, sago pondweed and slender-leaved pondweed) that have grown to extreme densities exceeding a balanced habitat may be targeted as well. The excess density of these plants and the dominance of non-native species within the plant community adversely impacts aquatic habitat, fisheries, and direct recreation. It also decreases water quality, leading to the release of phosphorus, which in turn leads to cyanobacteria toxic blooms. Following the pattern of rotating treatment sites used for aquatic plant treatment in 2006-2010, small areas of the littoral zone are anticipated to be treated each year in Long Lake. As in past studies, the expected result is a dramatic decrease in the density of non-native species, a dramatic increase in the presence of native species, and a reduction in the overall density of nuisance species (including non-natives), leading to an improvement in aquatic habitat. Controlling both cyanobacteria blooms and invasive plant species in 2006-2010 improved aquatic habitat, increased plant community diversity, reduced release of phosphorus that stimulated excess production, and improved conditions for recreational use.

In the fall of 2018, shallow littoral zone treatments targeted invasive, non-native white lily, Brazilian elodea, Eurasian watermilfoil, and pondweed, *P. praelongus*. In April 2019, initial carryover effectiveness of the 2018 treatment was evaluated prior to the alum treatment, and early-season sprouting of the non-native white lily indicated a limited carryover in species reduction. Based on the July 2019 survey, carryover reduction of the white lily was roughly 30%, while treatment of *P. praelongus* was more effective, with a carryover reduction of 60-70%.

In July 2019, proposed treatment areas were identified along the east and west shores of the lake (**Figure 7**) for treatment in 2020. Targeted areas will be the expanded white lily beds and the extensive native pondweed coverage in the littoral areas. High density areas of native pondweed are targeted for treatment with the knowledge that over time bringing these species back into a balanced littoral habitat will be easier than controlling non-native species, such as the white lily. Treatments were not applied in 2019, as the use of a contact herbicide to quickly reduce the plant biomass within the lake would have resulted in a massive release of phosphorus, which may have induced an algal bloom. Furthermore, by mid-August the newly dominant species of *Potamogeton* were already senescing, or declining in photosynthetic and seed production to send organic carbon to their roots for over-wintering. The result was that the preferred and less environmental stressful control would not be cost effective carryover control for 2020. Instead, proposed treatments are planned for spring of 2020.

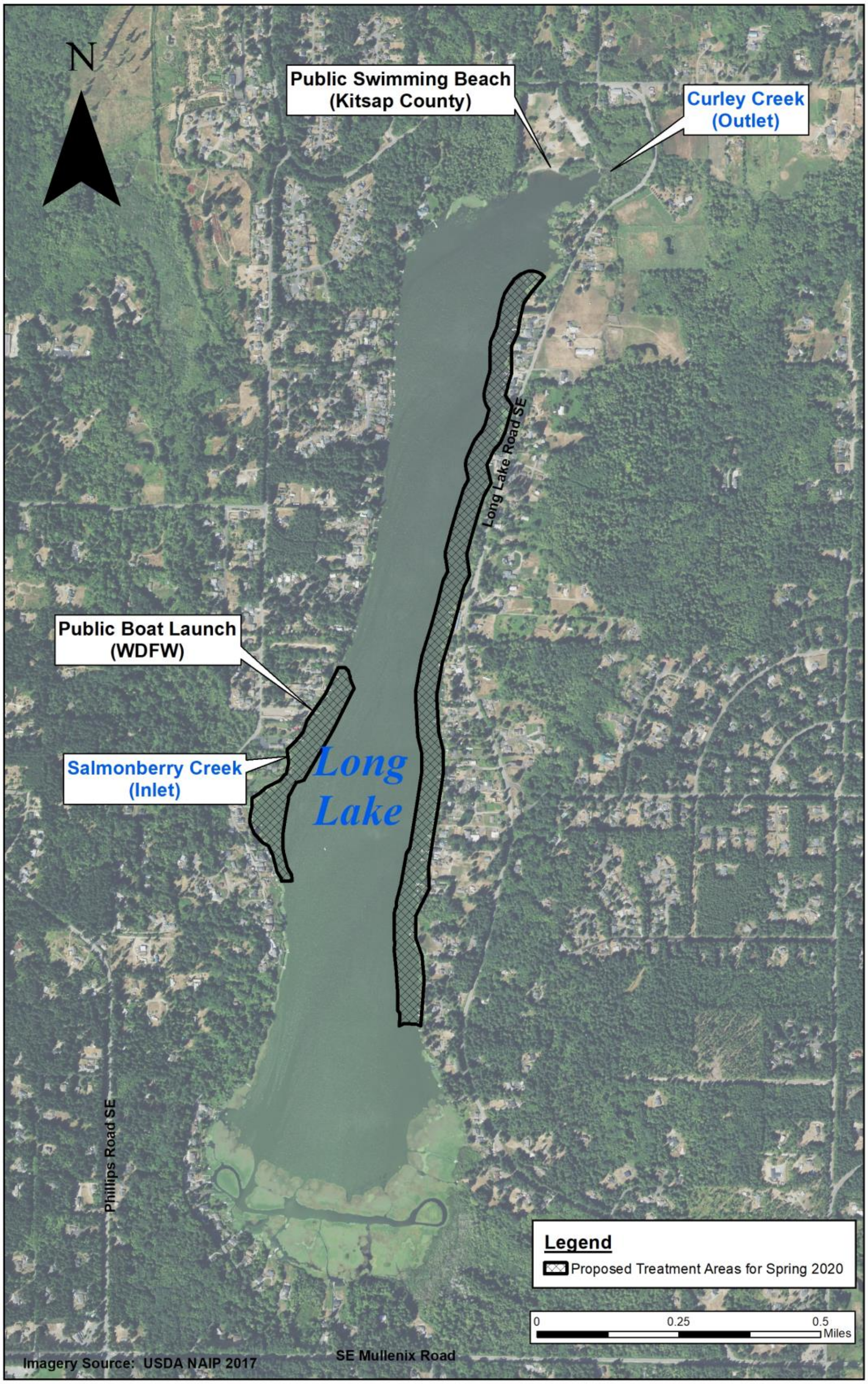

Figure 7: Proposed areas for spring 2020 aquatic plant treatment

3.0 Monitoring Results

3.1.1 Water Level

A data logger that records water level in Long Lake was installed in June 2018 on a homeowner's private dock. The logger records lake level continuously at hourly intervals. Logger data from June 2018 – April 2019 (**Figure 8**) does not have a strong correlation with precipitation records, indicating that the level in Long Lake is not responsive to local rainfall, and instead may depend more on recharge from groundwater or upstream storage.

Efforts to install a data logger in Salmonberry Creek, the main inlet to Long Lake, were unsuccessful. Kitsap County does not maintain a gage on the creek, and loggers that were previously installed on Salmonberry Creek have been subject to vandalization and theft. In 2019, citizens along the creek were contacted for potential access to a protected location near the mouth of Salmonberry Creek. However, access to private property for installation and maintenance was not granted and other options will be explored for 2020.

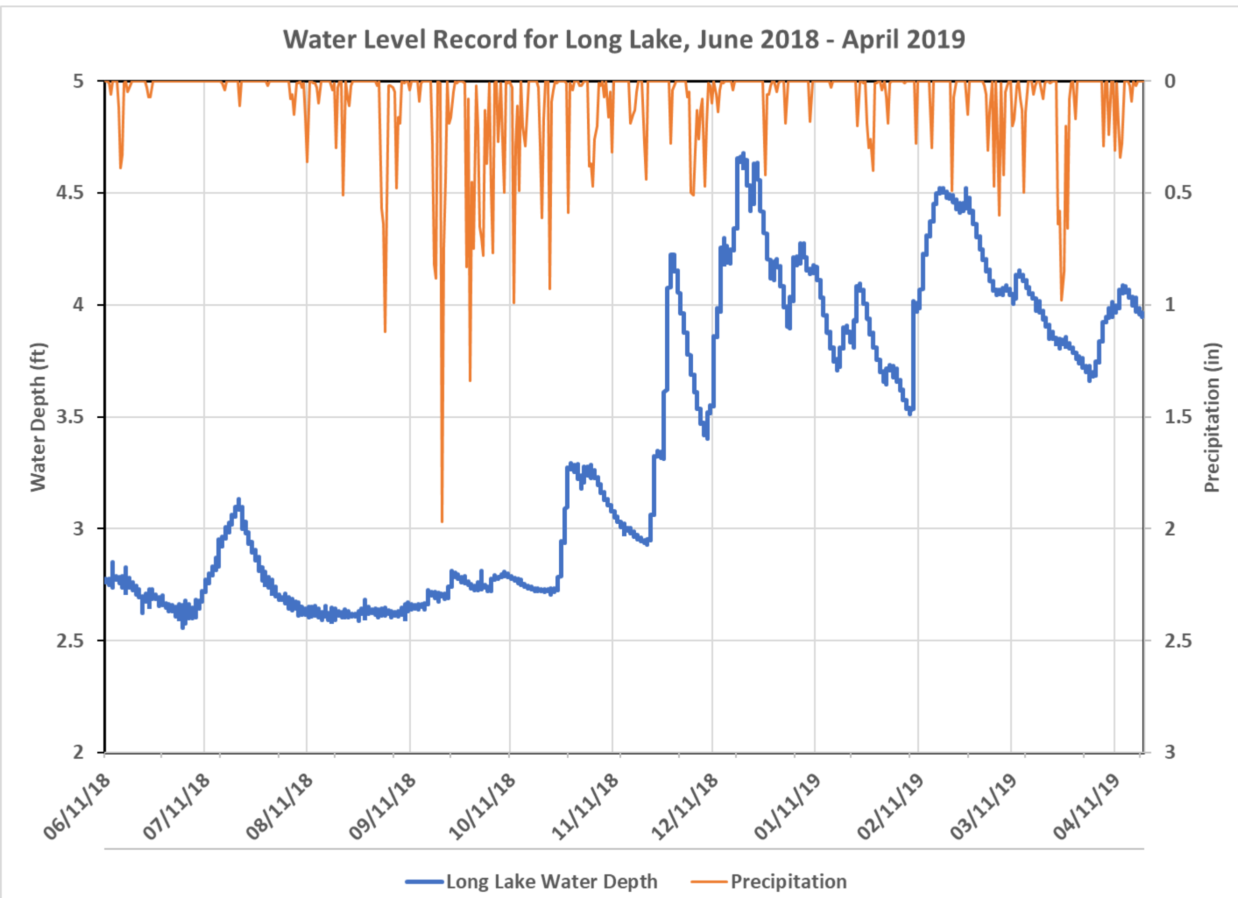

Figure 8: Water level and precipitation records

3.1.2 Total and Soluble Phosphorus

Surface concentrations of TP at the mid-lake station averaged 18 µg/L and ranged from 16 to 20 µg/L during 2019 observations (**Table 1**). On April 23, 2019, prior to the alum treatment, the observed concentration of TP near the lake bottom (2.5 m) was 45 µg/L at the mid-lake station. One day after the alum treatment, TP concentration at the same location had dropped to 21 µg/L, indicating that the treatment was successful in removing phosphorus from the water column. Post-treatment TP concentrations of 22 µg/L were again observed in early November at the mid-lake station. Surface concentrations of TP observed in 2019 are generally consistent with 2018 surface concentrations between 18-34 µg/L. In 2018, the lowest TP concentrations were observed in the spring and fall, and mid-lake TP concentrations were slightly higher near the lake bottom.

Before and after the alum treatment on April 23rd and April 26th, water samples were collected at the north and south stations in addition to the mid-lake station. At the north end, surface TP concentrations were not affected by the alum treatment and were consistent with the mid-lake surface average of 18 µg/L. At the south end, surface TP concentrations were higher, at 28 µg/L before the alum treatment and 48 µg/L after the alum treatment but this likely reflected captured phosphorus, as the sample was taken within the floc zone. A sample was also collected at approximately 2.5 m depth at the south end before the alum treatment in April. However, as the lake bottom was found to be at 2.45 meters, the measured concentration of TP is not considered valid due to the high likelihood of sediment in the water sample.

The concentration of TP at the inflow, Salmonberry Creek, was 24 µg/L in early November, which is higher than the surface TP concentrations at the mid-lake and north end stations. However, the inflow concentration was lower than observed TP concentrations at the south end and near the lake bottom. Salmonberry Creek was only sampled once in 2019, but the TP concentration is consistent with 2018 observations, when the average TP concentration from May-October was 30.8 µg/L, and the TP concentration in October was 20 µg/L.

Soluble Reactive Phosphorus (SRP) concentrations were low for all observations, with concentrations below 5 µg/L (**Table 1**). Soluble reactive phosphorus concentrations in 2019 were consistent with concentrations observed in 2018.

Table 1. TP and SRP concentrations in Long Lake and Salmonberry Creek in 2019

Date	Station	Depth (m)	TP (µg/L)	SRP (µg/L)
4/23/2019 (before alum treatment)	Mid-Lake	0.5	20	3
		2.5	45	3
	North End	0.5	18	3
	South End	.05	28	4
4/26/2019 (after alum treatment)	Mid-Lake	0.5	19	2
		2.5	21	1
	North End	0.5	18	2
	South End	0.5	48	2
9/29/2019	Mid-Lake	0.5	16	<1
		2.5	--	--
11/1/2019	Mid-Lake	0.5	18	2
		2.5	22	2
	Salmonberry Creek	--	24	--

3.1.3 Chlorophyll-*a*

Surface concentrations of chl at the mid-lake station averaged 12.7 µg/L and ranged from 4.5 to 16 µg/L during 2019 observations (**Table 2**). At a depth of 2.5 m, the average mid-lake chl concentration was 10.4 µg/L, slightly lower than at the surface. Average chl concentrations observed in 2019 are consistent with 2018 observations, when surface concentrations averaged 12.1 µg/L at the surface and 8.1 µg/L at 2.5m. In 2018, maximum chl (39 µg/L) was observed in August, along with maximum surface TP concentrations in the lake.

In April 2019, the surface concentration of chl was measured at all stations before and after the alum treatment. Before the alum treatment, the average surface concentration was 12.7 µg/L and after treatment the average surface concentration dropped to 9.4 µg/L. Mid-lake concentrations at 2.5 m dropped from 11 µg/L before treatment to 8.5 µg/L after treatment. No excessive surface algal scum was observed in 2019.

Table 2. Chlorophyll concentrations in Long Lake in 2019

Date	Station	Depth (m)	CHL-a (µg/L)
4/23/2019 (before alum treatment)	Mid-Lake	0.5	13
		2.5	11
	North End	0.5	14
	South End	0.5	11
4/26/2019 (after alum treatment)	Mid-Lake	0.5	9.1
		2.5	8.5
	North End	0.5	8
	South End	0.5	11
9/29/2019	Mid-Lake	0.5	4.5
		2.5	5.1
11/1/2019	Mid-Lake	0.5	16
		2.5	17
	Salmonberry Creek	--	--

3.1.4 Water Clarity

Water clarity, or transparency, as measured with a secchi disk, ranged from 1.7 to 2.5 m at the mid-lake station, 1.5 to 1.8 m at the north lake station, and 1.45 to 2.0 m at the south station (**Figure 9**). In the spring, water clarity was generally consistent across all stations, with an average secchi depth of 1.8 meters. Fall measurements of water clarity varied more between dates and sites, with the minimum secchi disk depth (1.3 m) observed at the south lake station in early November and maximum secchi disk depth observed in September at the mid-lake station. The higher level of water clarity in September corresponds with lower observed chl concentrations and a reduction in algal production due to the April 2019 alum treatment. Even though secchi disk measurements were not recorded during the summer months, observations during the aquatic plant surveying and accounts from local residents indicate that the increase in water clarity was persistent. In 2018, water clarity was over 2 meters in June, but quickly dropped to around 1.6 meters in July and was less than 1 meter throughout August. In 2019, clearer water and abundant solar energy allowed for an increase in aquatic plant production, including a high density of native *Potamogeton* species that had not previously taken up dominance.

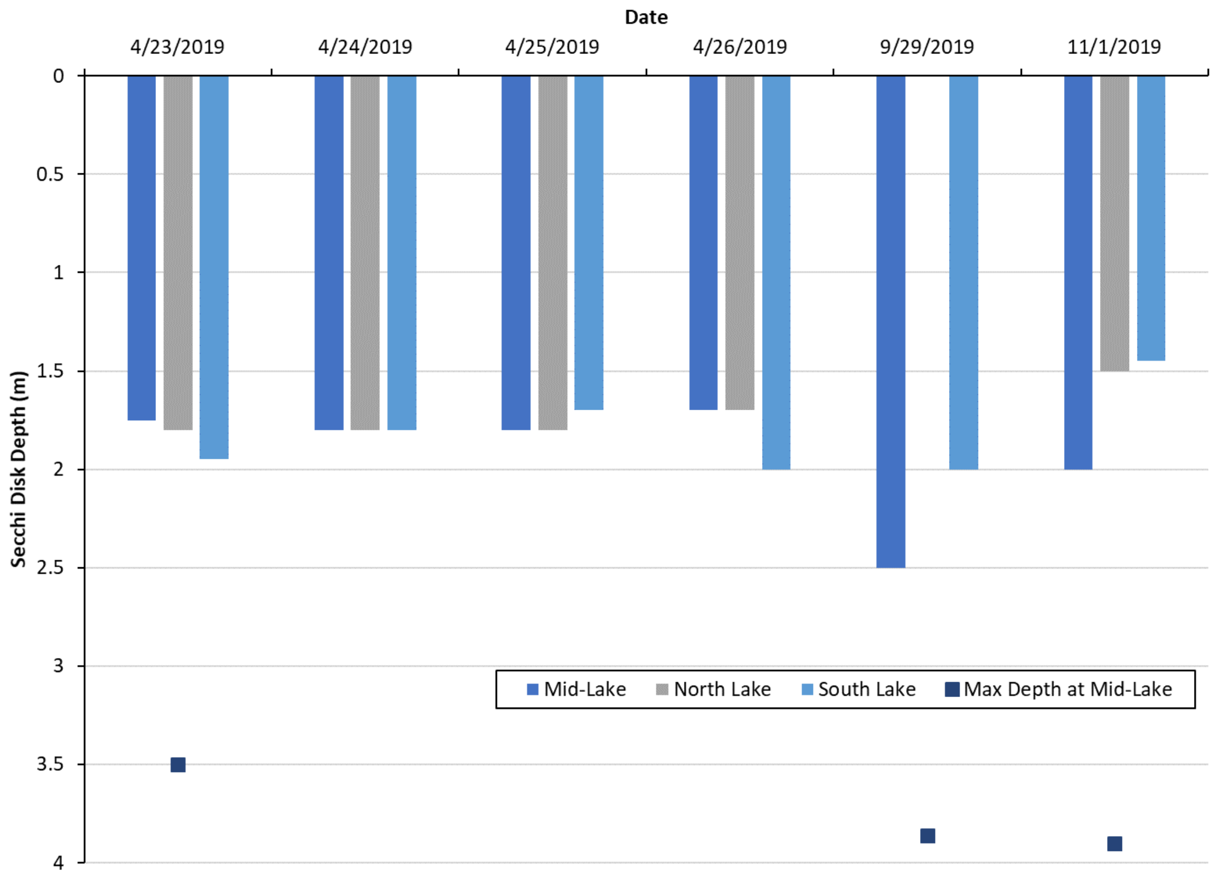

Figure 9. Secchi disk depth (water transparency) in Long Lake during 2019

3.1.5 Water Temperature, Dissolved Oxygen, Conductivity, and pH

Profiles of water temperature, DO, conductivity, and pH were measured at 0.5-meter intervals at each station in the spring and fall of 2019. At the north and south stations, profiles to the lake bottom ranged from 2.5 to 3 meters deep. At the mid-lake station, profiles extended 3.5 to 4 meters deep.

Although there were a limited number of sampling events in 2019, and no data for the summer months (May through August), the profiles are generally representative of 2019 conditions on Long Lake. **Figure 10** shows monthly averages from 2019 compared to monthly averages of profile data from 2006-2010. Compared to observations from 2006-2010, 2019 profiles of temperature, pH, DO, and conductivity are consistent with the historical data, with the exception of April 2019 when higher pH, higher conductivity, and lower DO were observed.

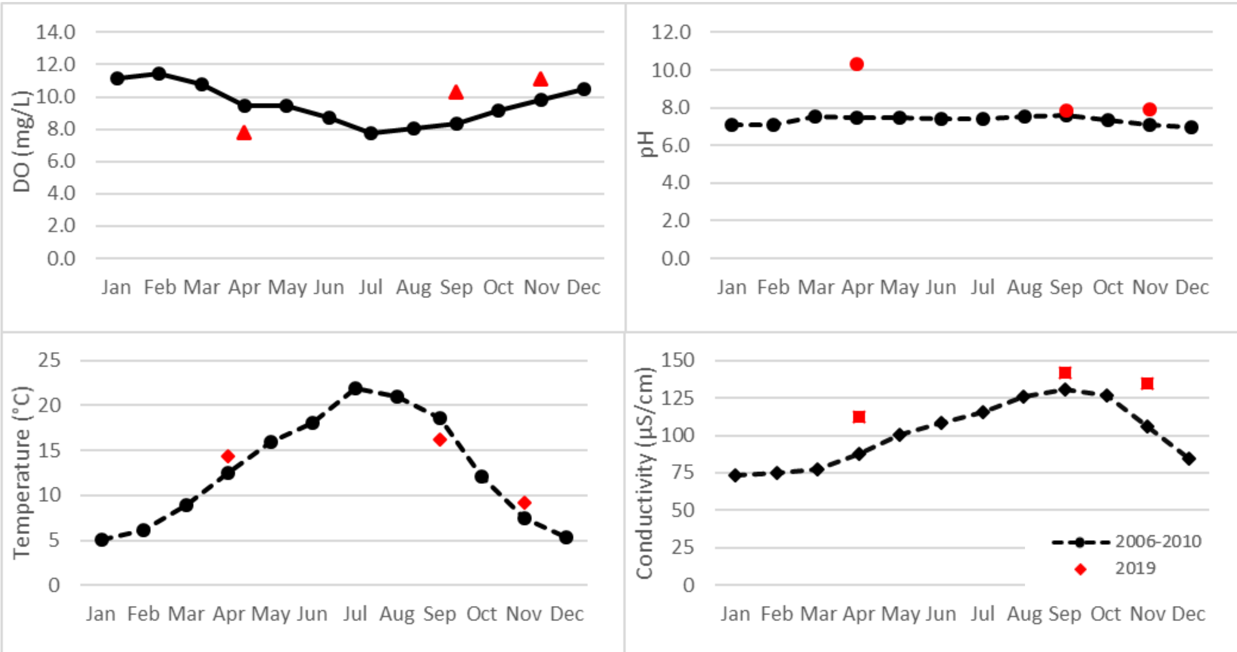

Figure 10. Monthly averages of DO, pH, temperature, and conductivity in 2019 compared to 2006-2010

Water Temperature

Water temperature profiles are shown in **Figure 11**. Temperatures ranged from 8.5°C to 16.5°C at all stations, which is notably lower than past years due to the lack of summertime measurements. The hottest temperatures were observed in September while the lowest temperatures were observed in early November. During the summer months, temperatures were likely similar to those measured in 2018, when temperatures ranged from 15.4°C to 25.7°C at all stations, with maximum temperatures occurring in July. For most observations in 2019, temperature does not vary significantly throughout the water column, as Long Lake is a shallow lake that mixes frequently throughout the year. Weak stratification was observed in September of 2019 (**Figure 11**), which is consistent with 2018 observations of mid-late summer stratification. Water temperatures in 2019 were similar at all 3 stations, with average values differing by no more than 0.5°C.

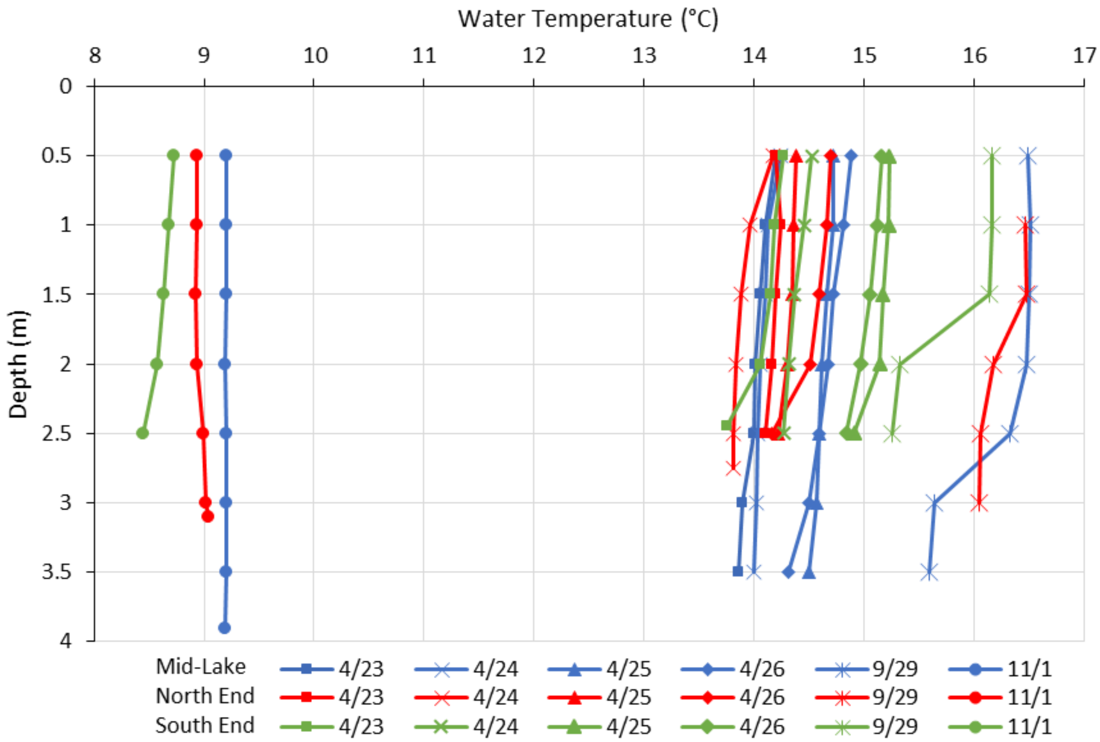

Figure 11. Water temperatures in Long Lake, 2019

Dissolved Oxygen

Dissolved oxygen concentrations ranged from 6.9 to 11.3 mg/L across all stations. At the south lake station, concentrations were at the low end of the range, between 6.9 and 9.2 mg/L. (**Figure 12**). Minimum DO occurred near the bottom at all stations and was lowest at the south lake station in September, when the water column was stratified. Maximum DO recorded in 2019 for all stations occurred in November near the surface. High dissolved oxygen concentrations in November are likely due to the 5 degree decrease in water temperature, which increases the DO saturation level, and a resulting decrease in metabolic respiration.

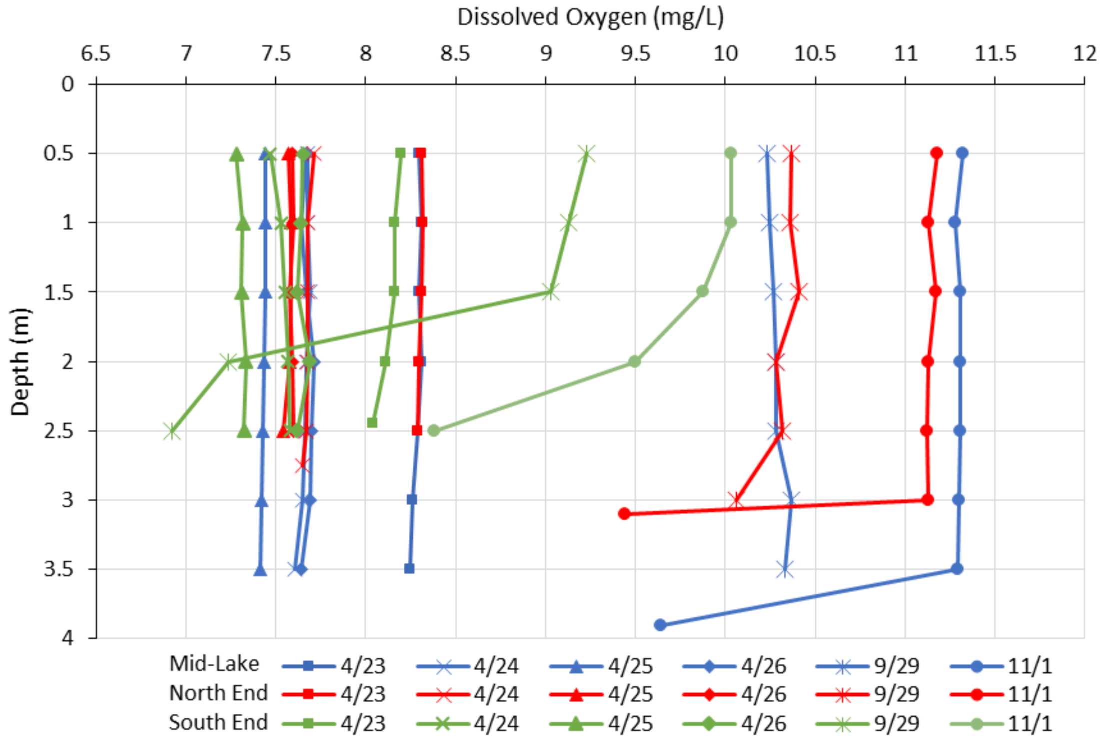

Figure 12. Dissolved oxygen in Long Lake, 2019

pH

pH varied throughout the water column and ranged from 7.2 to 10.8 at all stations for 2019 monitoring dates (**Figure 13**). Observed pH was higher in 2019 than in 2018, when pH ranged from 6.5-8.7. The higher pH values were observed in April, especially at the surface during mid-day and late afternoon monitoring.

Water column pH did not vary significantly with depth but did typically follow a pattern of higher values near the surface and lower values measured near the bottom. At the north lake site, pH was more uniform throughout the water column than the south lake site and to some extent the mid-lake site. The pH was most likely influenced by photosynthesis both from phytoplankton in the water column as well as aquatic plants.

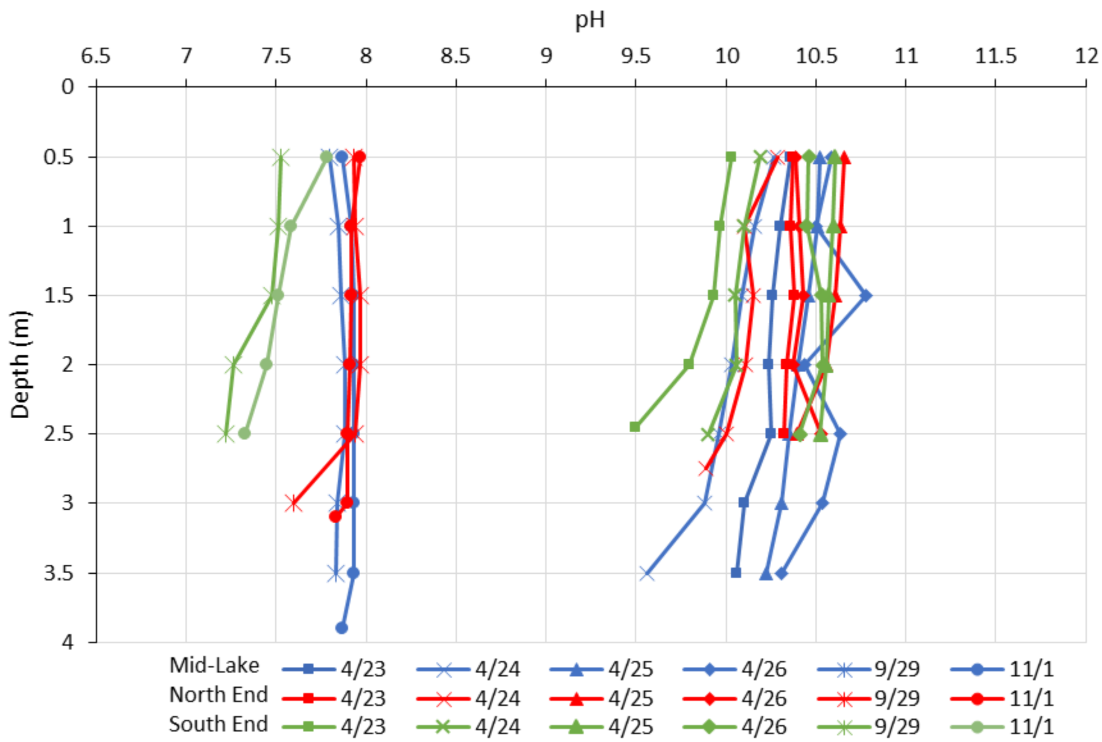

Figure 13. pH in Long Lake, 2019

Conductivity

Conductivity varied over the course of the monitoring period (**Figure 14**). Conductivity ranged from maximums around 140 µS/cm in late September to a minimum of 104 µS/cm in late April. Conductivity was generally uniform throughout the water column, varying only at the bottom of the profile, especially at the north end station, likely due to interaction with lake-bottom sediments.

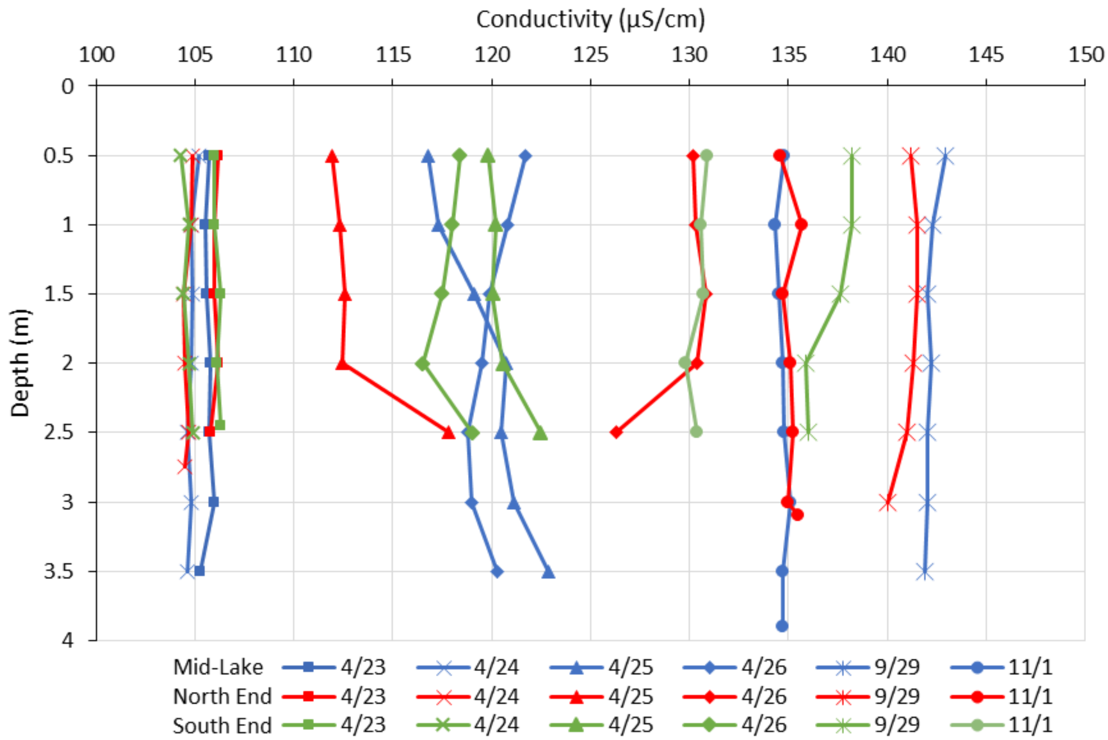

Figure 14. Conductivity in Long Lake, 2019

4.0 Water Quality Summary Discussion

This was an interesting year for lake water quality in Long Lake. In late April of 2019, a whole lake buffered alum treatment was conducted to remove phosphorus from the water column and to inactivate the release of phosphorus from the lake sediments to reduce algal production. In-situ monitoring was conducted before, during, and after the alum treatment, with water samples collected for laboratory analysis before and after treatment. Citizen volunteers and Tetra Tech staff also conducted in-situ monitoring and collected water samples for analysis on September 30 and November 1, 2019. Below is a summary of noteworthy findings from the 2019 monitoring season.

- Water level in Long Lake does not appear to respond to precipitation.
  - Apparent correlation between logger data and rainfall records is weak.
- Alum treatment reduced phosphorus loading in Long Lake.
  - Long Lake did not experience a toxic bloom that had occurred each year for the last four years.
  - Increased water clarity was observed in 2019.
- Compared to observations from 2006-2010, 2019 averages of temperature, pH, DO, and conductivity are consistent with the historical data, with the exception of April 2019 when higher pH, higher conductivity, and lower DO were observed pre-alum treatment.
- Improved water quality in 2019 compared to historical averages.
  - Compared to 2018, average concentrations of TP and ChL were lower and transparency was higher.
  - A historical record of water quality indicators and alum treatments in Long Lake is shown in **Figure 15**.

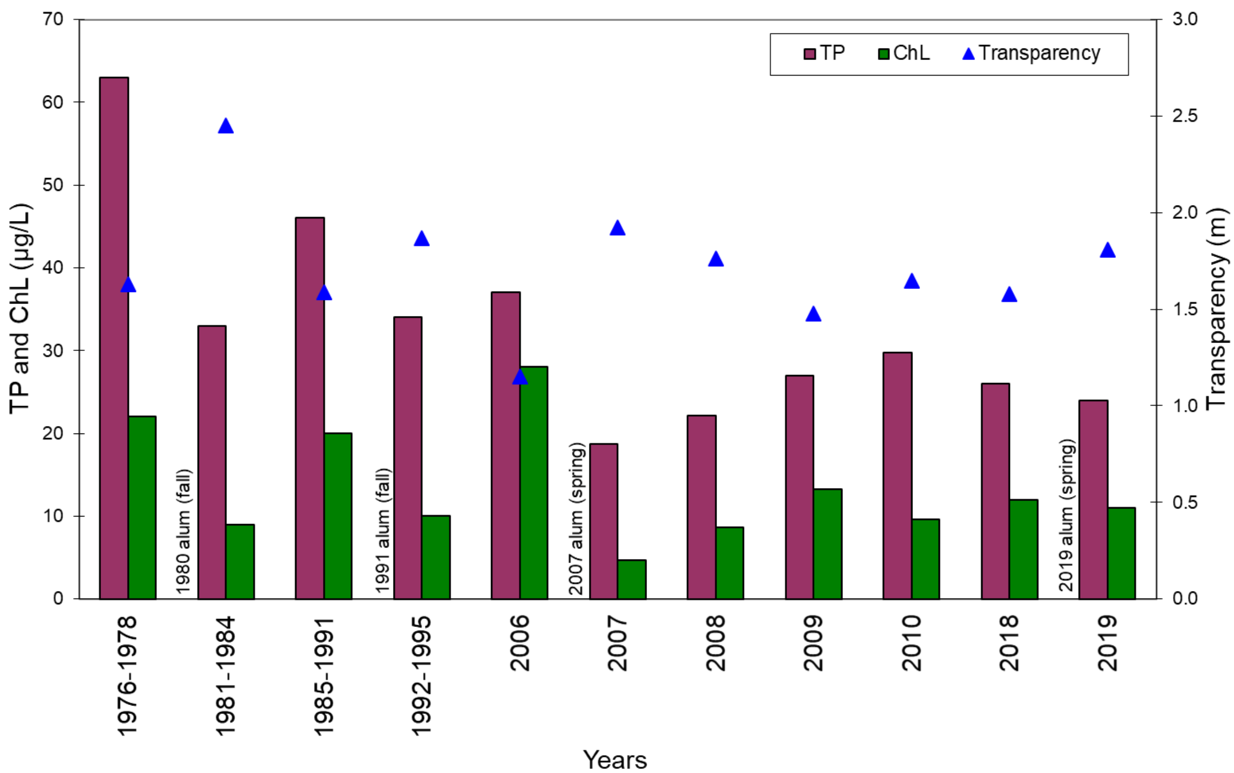

Figure 15. Historical water quality averages

5.0 Recommendations for Future Work

Based on the positive results of the aquatic plant adaptive management plan developed in 2006 to maintain a sustainable aquatic habitat that also helps to limit HAB events, a portion of the lake's littoral area (5 to 25%) should be managed on a rotational 4-year adaptive program to ensure the re-establishment of native plant communities for aquatic ecosystem recovery, while maximizing the direct beneficial uses of the lake. Unfortunately, the planned 2019 treatment was delayed until spring 2020, in order to address the change in plant community and density observed in July and August 2019 and to avoid untimely release of phosphorus that could have enabled a HAB event in the late summer of 2019. The treatment plan for 2020 is multiple applications of a slow release herbicide, pellet fluridone, at the end of April or beginning of May and again in mid-June. This would be followed by another in mid to late July and possibly mid-September. The result would be a significant reduction in aquatic plant production in 2020 and that would carry over to 2021 as well, allowing other areas and plants to be targeted in 2021. At the same time this would not directly enhance the cycling of phosphorus to cause a spike in phosphorus availability leading to an algal bloom.

In order to enhance the adaptive aquatic plant management program, it is recommended that the LLMD apply for an integrated aquatic vegetation grant to update the current plant and seek funding to expand the treatment options. Specifically, through bottom barrier planning and implementation that would involve burlap barrier to be purchased and to train and citizen on how to install the bottom barriers near their shorelines. This would result in increased lake habitat diversity and shallow open water for recreation. It would also over time reduce the amount of herbicide treatment required to manage the littoral lake area.

To limit the phosphorus and thereby limit the phytoplankton potential for algal bloom production, a phosphorus inactivation and water column stripping alum treatment was implemented in late April of 2019. This helped limit the potential for an algal bloom and improve overall lake water quality. However, due to cost increases in materials to perform this action the dose was 3.5 times less than the successful 2007 alum treatment. To continue to limit HAB events, additional alum treatments to limit phosphorus will be needed in the near future. It is recommended that LLMD seek a grant to update the algae control plan, which would then allow the LLMD to seek a grant to help fund future phosphorus inactivation treatments.

Note all three of the grants outlined above are available through Washington State Department of Ecology.

6.0 Revisions to the Adaptive Plan

Currently, the data does not dictate any revisions to the adaptive plan, only for enhancements through grant funding as outlined in Section 5.

7.0 References

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