2020 Hicks Lake Water Quality Report

Prepared by Thurston County Environmental Health Division

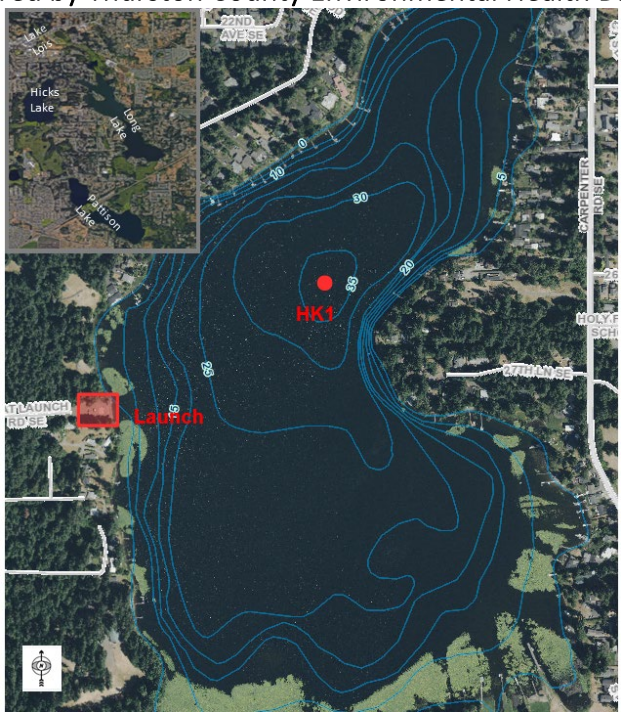

Figure 1. Hicks Lake map showing location of sample site HK1.

HENDERSON INLET WATERSHED

- **SHORELINE LENGTH**: 2.4 miles
- **LAKE SIZE**: 0.25 square miles
- **BASIN SIZE**: 1.8 square miles
- **MEAN DEPTH**: 18 feet (5.5 meters)
- **MAXIMUM DEPTH**: 35 feet (10.7 meters)
- **VOLUME**: 2,700 acre-feet

PRIMARY LAND USES:
The watershed is primarily urban and sub-urban residential with a small percentage in undeveloped forest cover.

PRIMARY LAKE USES:
Fishing, boating, water sports, and swimming.

PUBLIC ACCESS:
Washington Department of Fish and Wildlife public boat launch and City of Lacey Wanschers Park.

GENERAL TOPOGRAPHY:
Approximate altitude of the lake is 162 feet. The watershed is relatively flat with extensive wetlands between lakes including one south of Hicks Lake.

2020 GENERAL WATER QUALITY:
Good –Water quality is generally considered good based on Trophic State Indices (TSIs) and supports the beneficial uses of this mesotrophic lake. In 2020, the average surface phosphorus concentration of 0.018 mg/L was above to the long-term average (0.015 mg/L), and below the state action level of 0.020 mg/L.

DESCRIPTION

Hicks Lake is a relatively small lake, popular for fishing, boating, and swimming. It is the first lake in a chain of four hydraulically connected lakes. The four, Hicks, Pattison, Long and Lois, eventually discharge to Henderson Inlet via Woodland Creek. The lake has public access open six months per year provided by a Washington Department of Fish and Wildlife (WDFW) boat launch. WDFW stocks the lake with rainbow trout yearly, and periodically with brown trout. The City of Lacey's Wanschers Community Park, on the west side of the lake, provides good shoreline access.

METHODS

In 2020, Thurston County Environmental Health (TCEH) conducted monthly monitoring (Table 1) at the site identified as HK1 at Hicks Lake from May to October. Figure 1 shows the sample site, located in the deepest basin of the lake.

Table 1. List of parameters, units, method, and sampling locations

Parameter	Units	Method	Sampling Location
Transparency	meters	Secchi Disk	Depth where disk is no longer visible
Color	#1 to #11	Custer Color Strip	Color of water on white portion of Secchi Desk
Vertical Water Quality Profile	• Water Temperature (°C) • Dissolved Oxygen (mg/L) • pH (standard units) • Specific Conductivity (µS/cm)	YSI EXO1 Multi-parameter Sonde	~ 0.5 meter below the water surface to ~ 0.5 meter above the bottom sediments
Total Phosphorus	mg/L	Grab Samples with Kemmerer	Surface Sample: ~ 0.5 meter below the surface Bottom Sample: ~ 0.5 meter above the benthos
Total Nitrogen	mg/L	Grab Samples with Kemmerer	Surface Sample: ~ 0.5 meter below the surface Bottom Sample: ~ 0.5 meter above the benthos
Chlorohyll-a	µg/L	Composite of Multiple Grab Samples	Photic Zone
Phaeo-a	µg/L	Composite of Multiple Grab Samples	Photic Zone
Algae Identification*	Genera, Present, Dominant, Subdominant	Composite of Multiple Grab Samples	Photic Zone

TCEH observed the color of the water against the white background of the Secchi disk at one-meter depth and compared it to the Custer Color Strip (Figure 2).

Figure 2. TCEH compared the color of the water on the Secchi disk (1 m) to the Custer Color Strip

Quality Assurance and Quality Control (QA/QC)

Each sample day TCEH collected 10% replicate samples and trip blanks to assess total variation for laboratory samples (TCEH samples 3-4 lakes per day). Water quality data was collected with a Yellow Springs Instrument (YSI) EXO 1. The instrument was calibrated before each sample day. Instrument drift data were routinely collected within 24 hours of the sampling event. See Appendix C for QA/QC data.

RESULTS

Weather Conditions

Weather conditions based on the Olympia Regional Airport weather station, during the 2020 sample season are provided in Table 2.

Table 2. Weather on sample days and the monthly average, minimum, and maximum air temperatures.

Month	Weather on Sample Day (average temp)	Temperature (° C) Monthly Average (low/high)
May	Cloudy (13.3° C); 0-15 mph SW wind	13.3 (0.0/30.6)
June	Cloudy (18.3° C); 0-15 mph SW wind	15.25 (4.4/29.4)
July	Cloudy (17.8° C); 0-10 mph SW wind	17.5 (6.7/36.7)
August	Fair, (17.5° C); 0-8 mph N wind	18 (5.6/37.2)
September	Rain (16.1° C); 0-20 mph SW wind	17 (5.6/32.8)
October	Cloudy (8.3° C); 0-15 W wind	10.9 (-3.3/23.3)

Vertical Water Quality Profiles

During the summer, lakes often stratify into layers based on temperature and density differences.

- Epilimnion: upper warm, circulating strata in contact with the atmosphere
- Metalimnion: middle layer with steep thermal gradient (thermocline)
- Hypolimnion: deepest layer of colder, relatively stagnant water

The vertical water quality profiles illustrate how the water column at Hicks Lake changed over the 2020 sample season. (Figures 3 to 5).

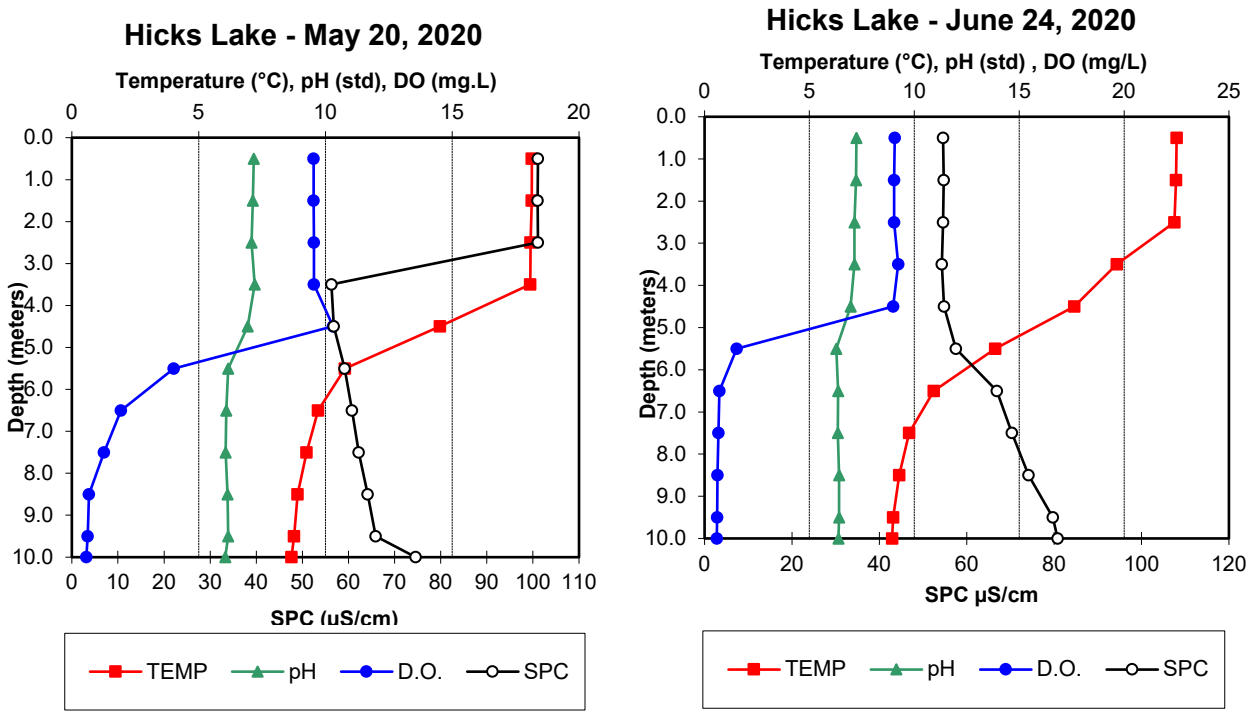

Figure 3. Vertical water quality profiles collected at HK1 for May and June 2020.

In May, Hicks Lake was in the process of stratifying. DO at the surface was relatively high, and there was a positive heterograde in the metalimnion.

- May Epilimnion – Mean Temperature 18.1 °C; Mean DO 9.5 mg/L
- May Hypolimnion – Mean Temperature 9.1°C; Mean DO 1.0 mg/L

In June, the mean and minimum air temperatures increased. Surface water retained heat; it was 2.8°C warmer than in May. DO declined slightly.

- June Epilimnion – Mean Temperature 20.9°C; Mean DO 9.1 mg/L
- June Hypolimnion – Mean Temperature 9.6°C; Mean DO 0.6 mg/L

Thermal stratification created density differences, which impaired mixing of the water column. The dissolved oxygen (DO) profile during June was a clinograde curve. The hypolimnion, cut-off from the atmosphere after stratification, lost oxygen to redox processes like decomposition and advection of low DO groundwater. The epilimnion had much higher DO because this layer gained oxygen from the atmosphere and photosynthesis.

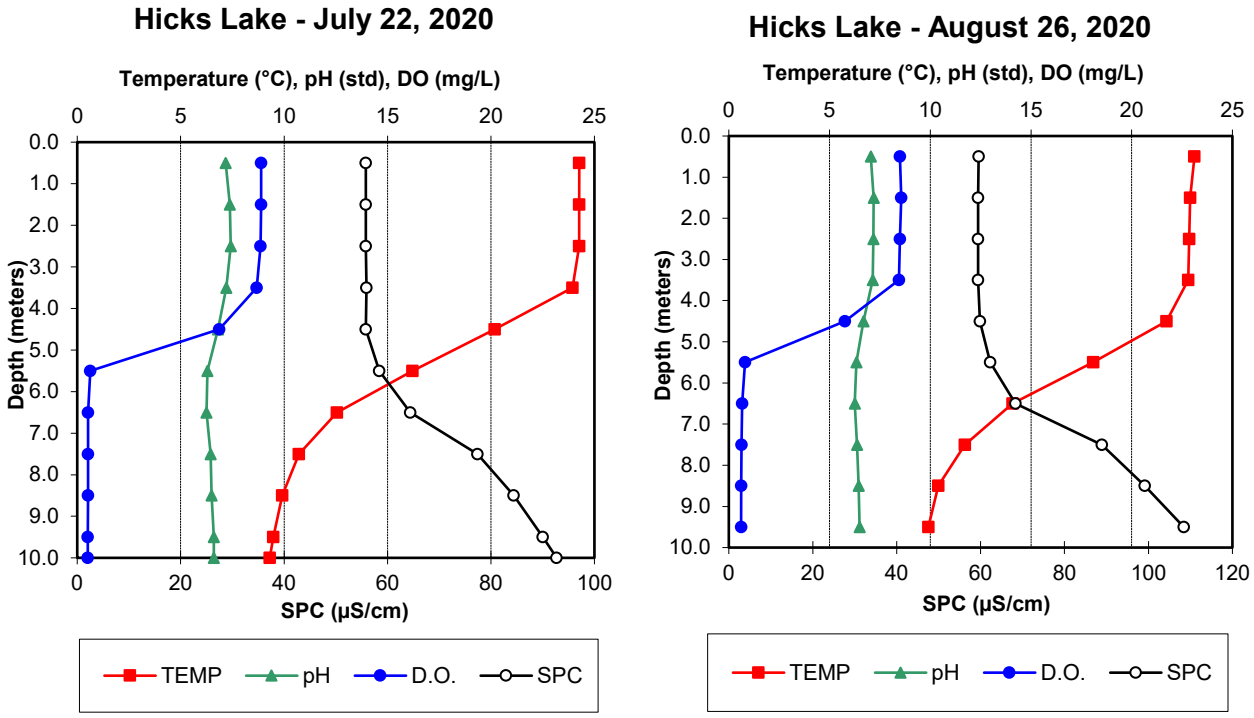

Figure 4. Vertical water quality profiles collected at HK1 for July and August 2020.

In July, the air temperature was the highest of the 2020 sample season. Likewise, the water temperature of the epilimnion increased to the summer's peak. DO continued to decline. Three distinct layers were readily discernable, indicating that density differences hindered mixing of the water column.

- July Epilimnion – Mean Temperature 24.2°C; DO 8.8 mg/L
- July Hypolimnion – Mean Temperature 11.4°C; Mean DO 0.5 mg/L

The average air temperature remained the same in August. The epilimnion grew deeper and increased productivity produced a greater supply of oxygen compared to July.

- August Epilimnion – Mean Temperature 22.9°C; Mean DO 8.5 mg/L
- August Hypolimnion – Mean Temperature 12.3°C; Mean DO 0.7 mg/L

The DO curve was clinograde in July and August 2020. The concentration of DO in the hypolimnion was low due to redox processes, which was isolated from more oxygenated water above by density differences during thermal stratification.

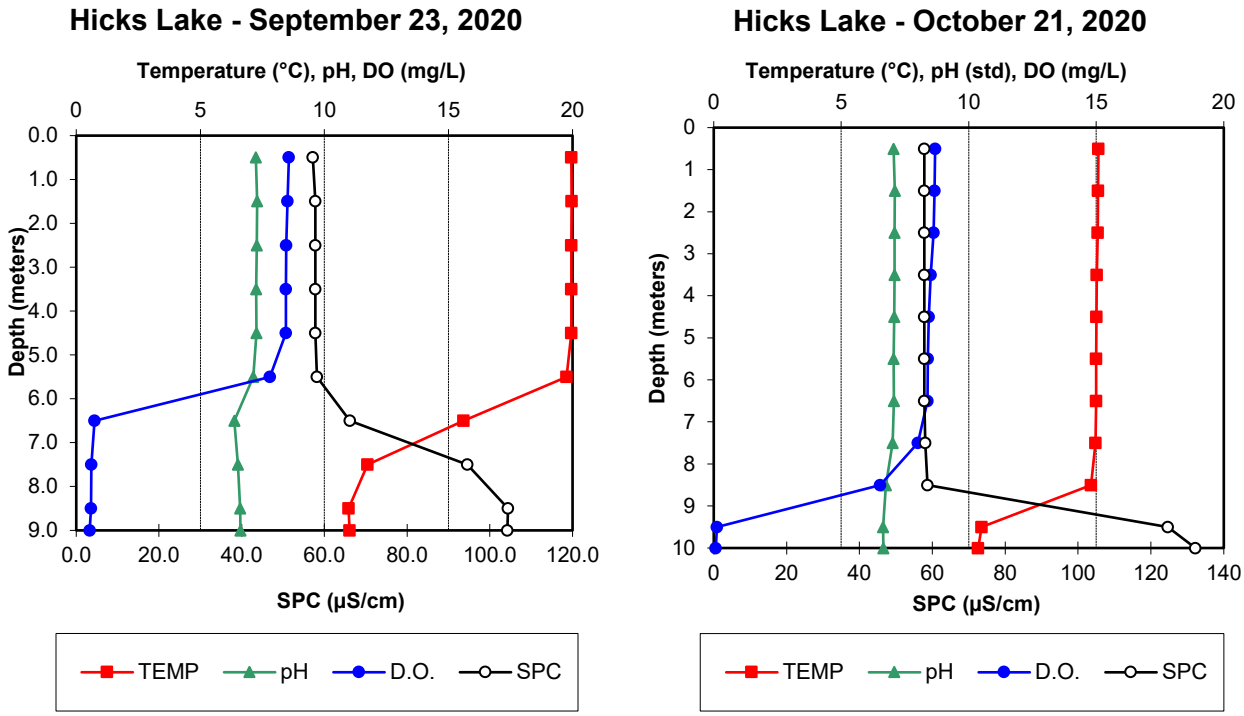

Figure 5. Vertical water quality profiles collected at HK1 for September and October 2020.

In September, overnight air temperatures declined. The surface water cooled and sank, which diminished temperature variation in the upper six meters of the water column. The DO curve remained clinograde.

- September Epilimnion – Mean Temperature 20.0°C; DO 8.5 mg/L
- September Hypolimnion– Mean Temperature 12.3°C; DO 0.6 mg/L

The change of seasons was evident in October. Air temperatures declined, surface waters cooled and sank, and water columns mixed. The water column was almost completely mixed during the October sampling event, with a deep DO clinograde curve below eight meters.

- October Epilimnion – Mean Temperature 15.0°C; DO 8.5 mg/L
- October Hypolimnion– Mean Temperature 10.4°C; DO 0.1 mg/L

Transparency and Color

Color can reveal information about a lake's nutrient load, algal growth, water quality and surrounding landscape. The water color (not apparent color) observed each month is provided in Appendix A and Figure 6. High concentrations of algae cause the water color to appear green, golden, or red. Weather, rocks and soil, land use practices, and types of trees and plants influence dissolved and suspended materials in the lake. Tannins and lignins, naturally occurring organic compounds from decomposition, can color the water yellow to brown.

Transparency of water to light has been used to approximate turbidity and phytoplankton populations. Secchi depth is closely correlated with the percentage of light transmission through water. The depth at which the Secchi disk is no longer visible approximates 10% of surface light; however, suspended particles in the water affect accuracy. TCEH recommends visibility of at least 1.2 meters, or four feet, at public swimming beaches.

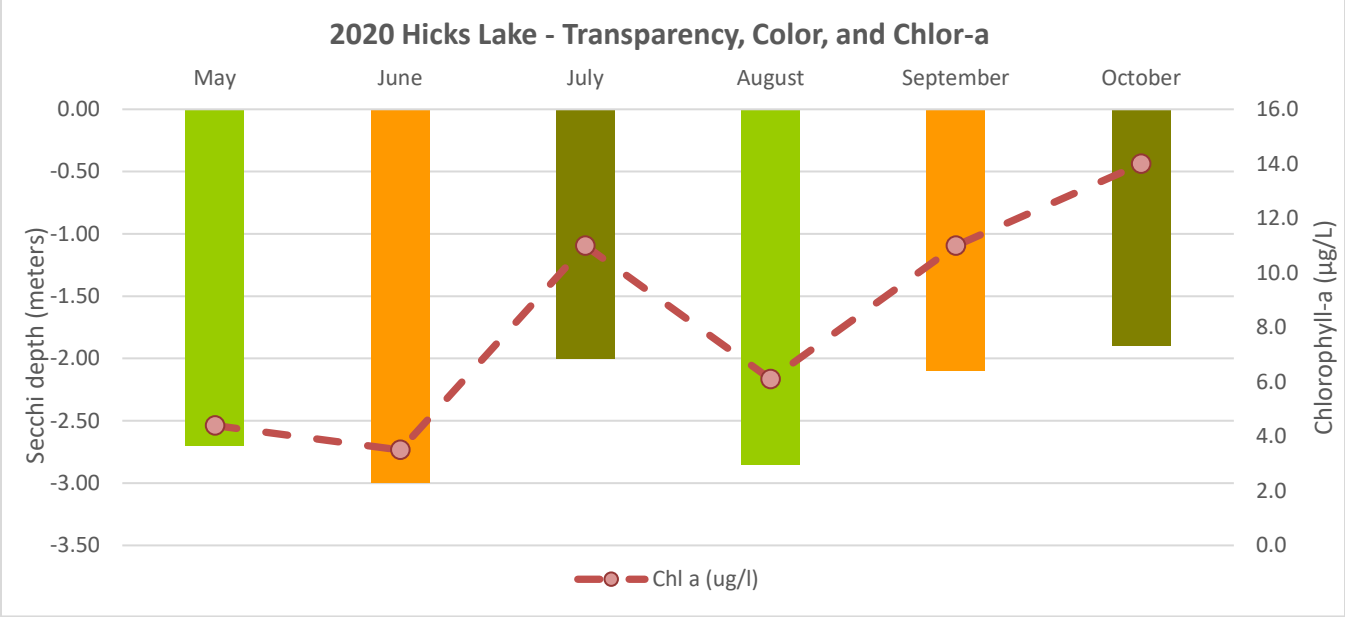

Figure 6. Color of lake water (bar color), Secchi depth (bar length), and chlorophyll-a concentration (dashed line) from May to October 2020.

In 2020, mean and median transparency was 2.43 meters, ranging from the high of 3.0 meters in June to the low of 1.9 meters in October.

Figure 7 shows the transparency annual average compared to the long-term average. Positive values reflect transparency better than the long-term average. The annual average for 2020 was slightly lower than the longer-term average as shown by Figure 7.

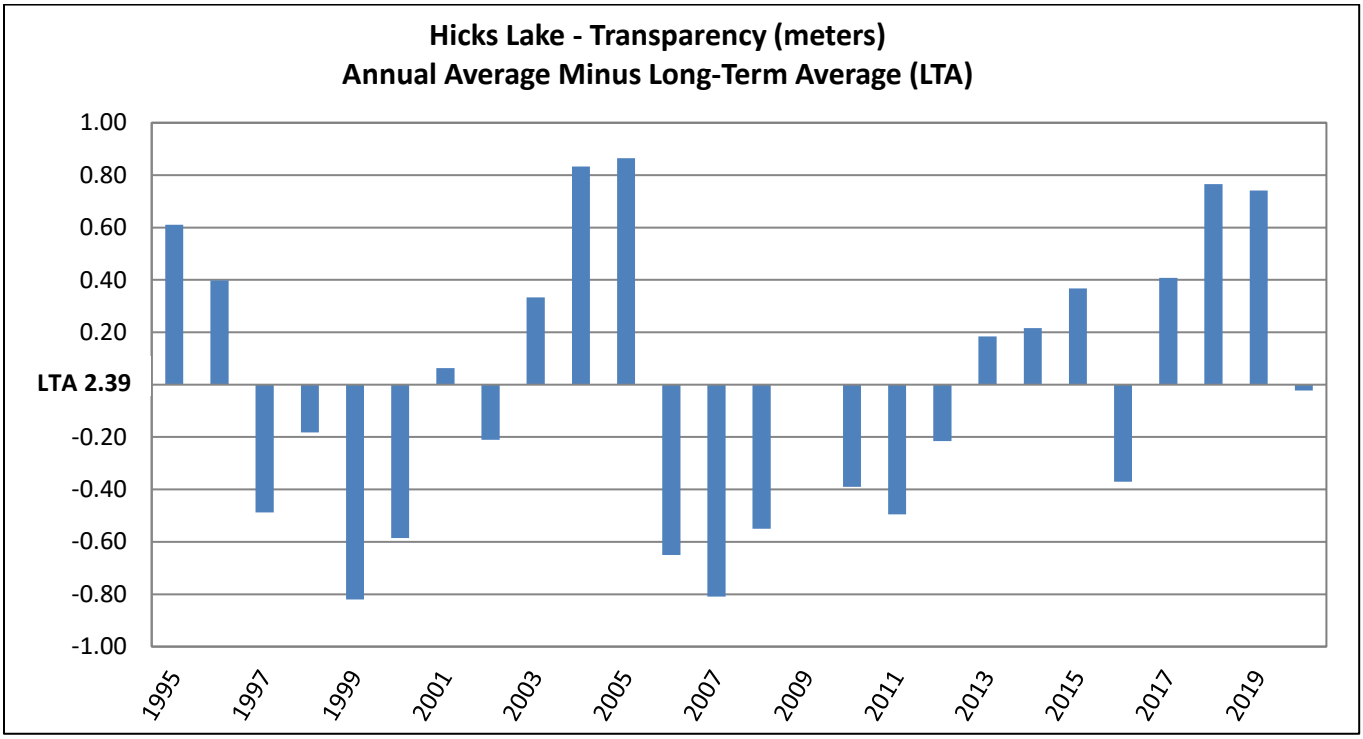

Figure 7. 2020 transparency at HK1 compared to the long-term average (LTA).

Productivity

Pigments

Chlorophyll-a pigment is present in all algae and is widely used to assess the abundance of algae in suspension. Phaeophytin is also a pigment, but it is not active in photosynthesis. It is a breakdown product of chlorophyll and is present in dead suspended material (Moss, 1967). Phaeophytin absorbs light in the same region of the spectrum as chlorophyll-a, and if present, can interfere with acquiring an accurate chlorophyll-a value. The ratio of chlorophyll-a to phaeophytin-a has been used as an indicator of the physiological condition of phytoplankton in the sample.

2020 Productivity Data

In 2020, the chlorophyll-a concentration:

- mean 8.3 µg/L
- median 8.6 µg/L

The mean chlorophyll-a concentration was higher during the second half of the sampling season:

- 10.4 µg/L from August to October
- 6.3 µg/L from May to July

Figure 8 shows that the highest productivity occurred in October (14.0 µg/L) after turn-over. The ratio of chlorophyll-a to phaeophytin-a peaked in July, indicating a breakdown of chlorophyll-a during that month. Surface DO remained relatively stable throughout the sampling season, with a maximum of 9.54 mg/L in May and minimum of 8.49 mg/L in August.

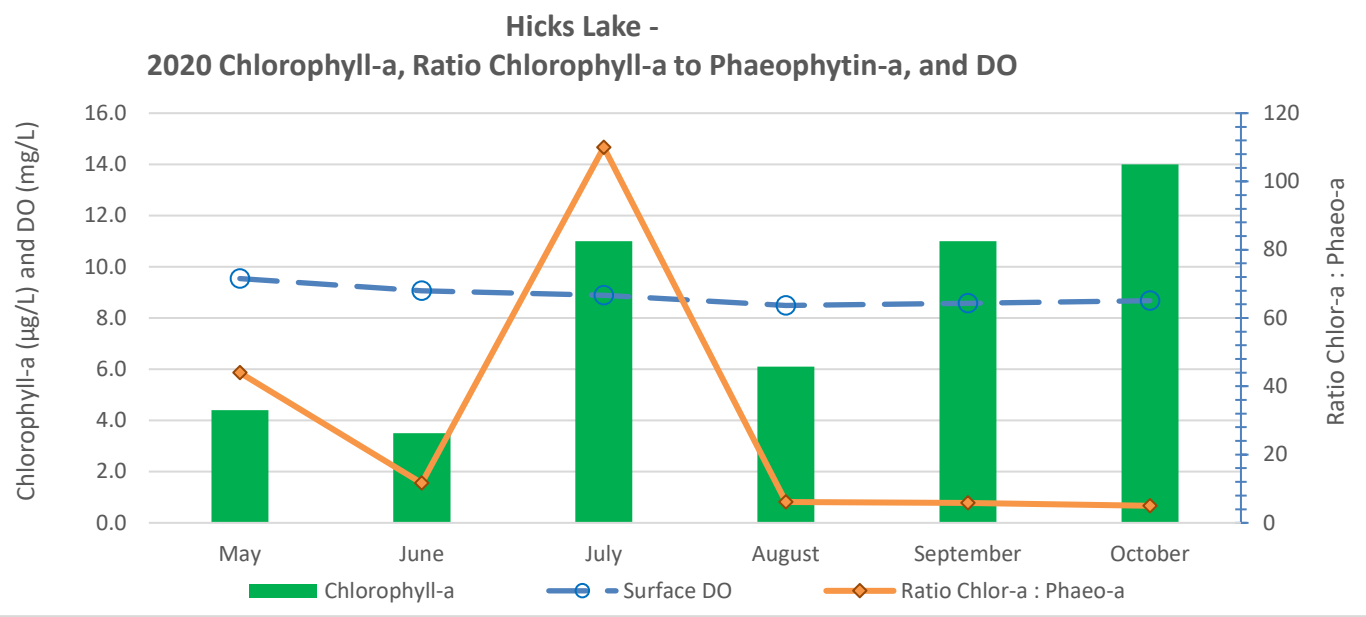

Figure 8. Chlorophyll-a concentration, ratio of chlorophyll-a to phaeophytin-a pigments and mean DO in the epilimnion at HK1 in 2020.

Phytoplankton Identification

Appendix B provides a list of phytoplankton collected from the epilimnion at HK1 during 2020 sample events from Hicks Lake. The dominant genus in May and July, and present for the whole sampling season, was *Dinobryon* sp., a type of golden algae or chrysophyte. These species are mixotrophic; they can consume bacteria (phagotrophy) or use photosynthesis to produce energy. Spores rested on the bottom of Hicks Lake over winter. Increased sunlight in the spring induce germination of motile cells, which move to the surface to proliferate.

In June, August, and October the dominant genus was *Ceratium* sp., a single-celled, armor-plated freshwater dinoflagellate. These species are also mixotrophic; they can consume other plankton or use photosynthesis to produce energy. Due to increased water temperatures in the summer months causing density differences and stratification within lakes, these species tend to dominate the water column.

In September, the dominant genus was Dolichospermun sp., a type of cyanobacteria found in nutrient rich lakes. Other genera of cyanobacteria were present but not dominant in the samples collected through the season and are shown in the table below. Dolichospermun sp. was present in all months, although not dominant in most. No algae blooms were reported to or sampled by TCEH in Hicks Lake during 2020.

Table 3. Cyanobacteria present in monthly samples taken at Hicks Lake 2020.

Month	Genus of Cyanobacteria present in Sample
May	Aphanizomenon sp., Dolichospermun sp.
June	Planktothrix sp., Dolichospermun sp.
July	Phormidium sp., Dolichospermun sp.
August	Aphanizomenon sp., Dolichospermun sp., Microcystis sp.
September	Aphanizomenon sp., Dolichospermun sp., Phormidium sp.
October	Aphanizomenon sp., Dolichospermun sp.

Nutrients

Surface Nutrients

Total Phosphorus

Compared to the rich supply of other elements required for nutrition or structure, phosphorus is the least abundant and most commonly limits biological productivity. Lakes in this region experience undesirable algae growth when the annual average surface phosphorus level reaches 0.030 mg/L (Gilliom, 1983). The action level is 0.020 mg/L (WAC, 2019).

The monthly TP results are displayed in Figure 9. A summary of 2020 statistics are:

- Surface Mean 0.018 mg/L
- Surface Median 0.017mg/L
- Surface Standard Deviation 0.005 mg/L
- Bottom Mean 0.239 mg/L
- Bottom Median 0.233 mg/L
- Bottom Standard Deviation 0.100 mg/L

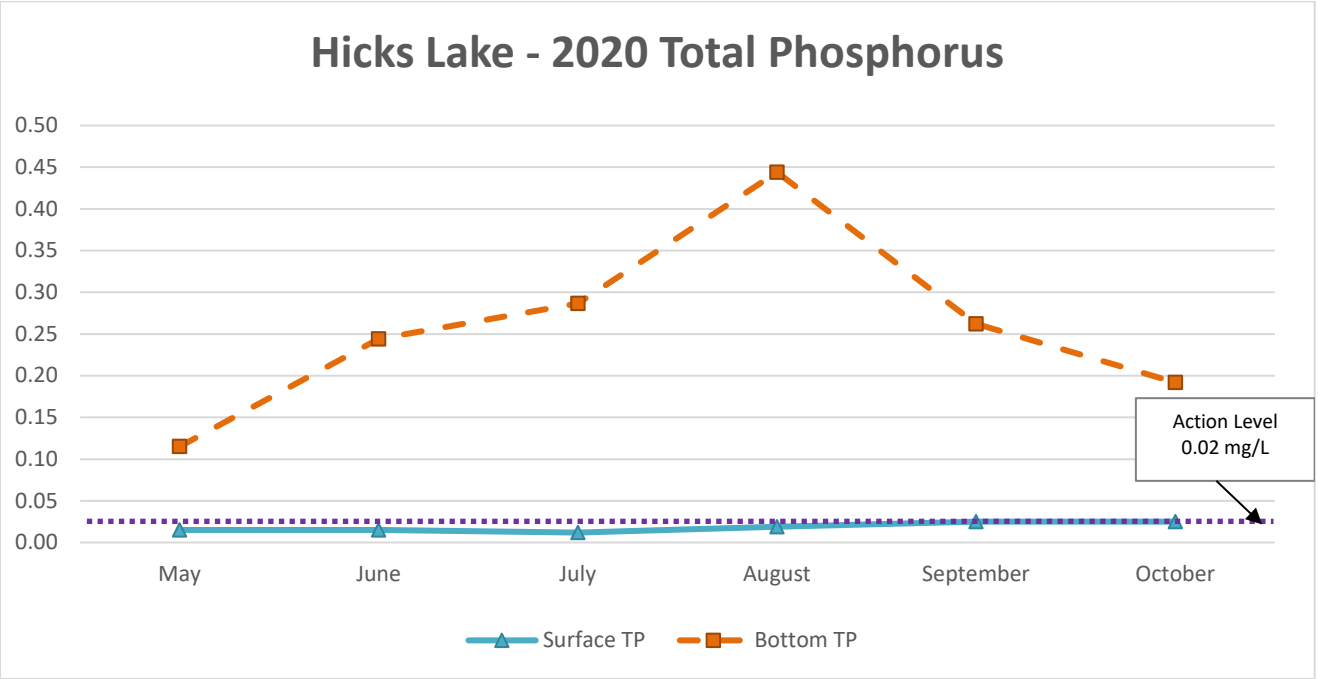

Figure 9. TP at the surface and bottom at HK1 in 2020.

The vertical profile graphs (Figures 3-5) show that Hicks Lake exhibited a clinograde oxygen curve from May until September, diminishing in October. Water in the hypolimnion was not mixing with the warmer, oxygenated water above. Decomposition and redox processes consumed oxygen in the hypolimnion: DO was 0.5 to 0.6 mg/L from May to September, dropping to minimum of 0.1 mg/L in October. Due to the lack of oxygen, phosphorus stored in the sediments was released into the water column and accumulated in the hypolimnion, peaking in August. The concentration of TP at the bottom was then reduced when the water columns began mixing in September and October.

Figure 10 displays the average annual concentration of TP at HK1 from 1995 to 2020. The mean annual surface TP was above the state action level (dotted line at 0.020 mg/L) twice, in 1999 and 2001.

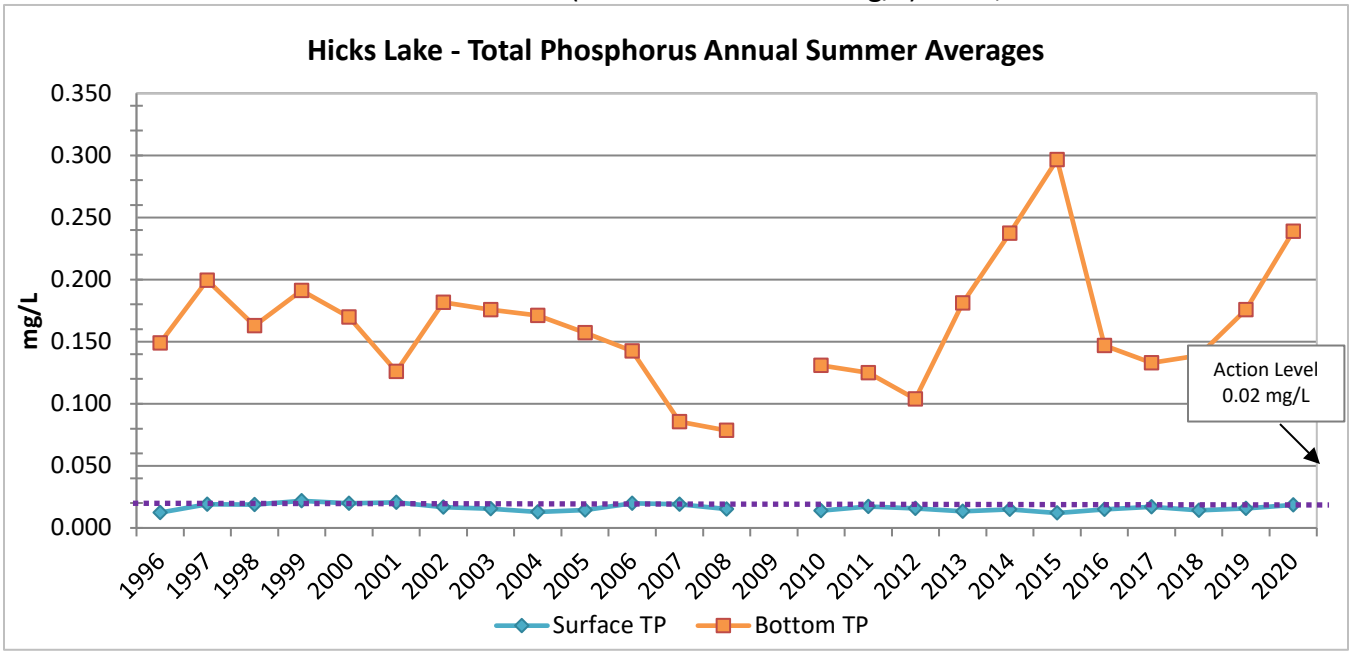

Figure 10. Mean concentration of TP at the surface and bottom at HK1 from 1995 to 2019.

The TP statistics from 1995 to 2020 are:

- Mean Surface 0.015 mg/L
- Median Surface 0.015 mg/L
- Standard Deviation Surface 0.003 mg/L
- Maximum Surface 0.022 mg/L in 1999
- Minimum Surface 0.012 mg/L in 1996 and 2015
- Mean Bottom 0.173 mg/L
- Median Bottom 0.147 mg/L
- Standard Deviation Bottom 0.049 mg/L
- Maximum Bottom 0.297 mg/L in 2015
- Minimum Bottom 0.079 mg/L in 2008

Total Nitrogen

Nitrogen is also limiting to lake productivity, but supplies are more readily augmented by inputs from external sources. The State of Washington does not have established action or cleanup levels for surface total nitrogen.

The TN statistics for 2020 are:

- Surface Mean 0.461 mg/L
- Surface Median 0.430 mg/L
- Surface Standard Deviation 0.148 mg/L
- Bottom Mean 1.213 mg/L
- Bottom Median 1.180 mg/L
- Bottom Standard Deviation 0.455 mg/L

The total nitrogen concentration was higher at the bottom (shown in Figure 11) because the hypolimnion was hypoxic during stratification; ammonia-nitrogen was released from the bottom sediments and accumulated in the hypolimnion.

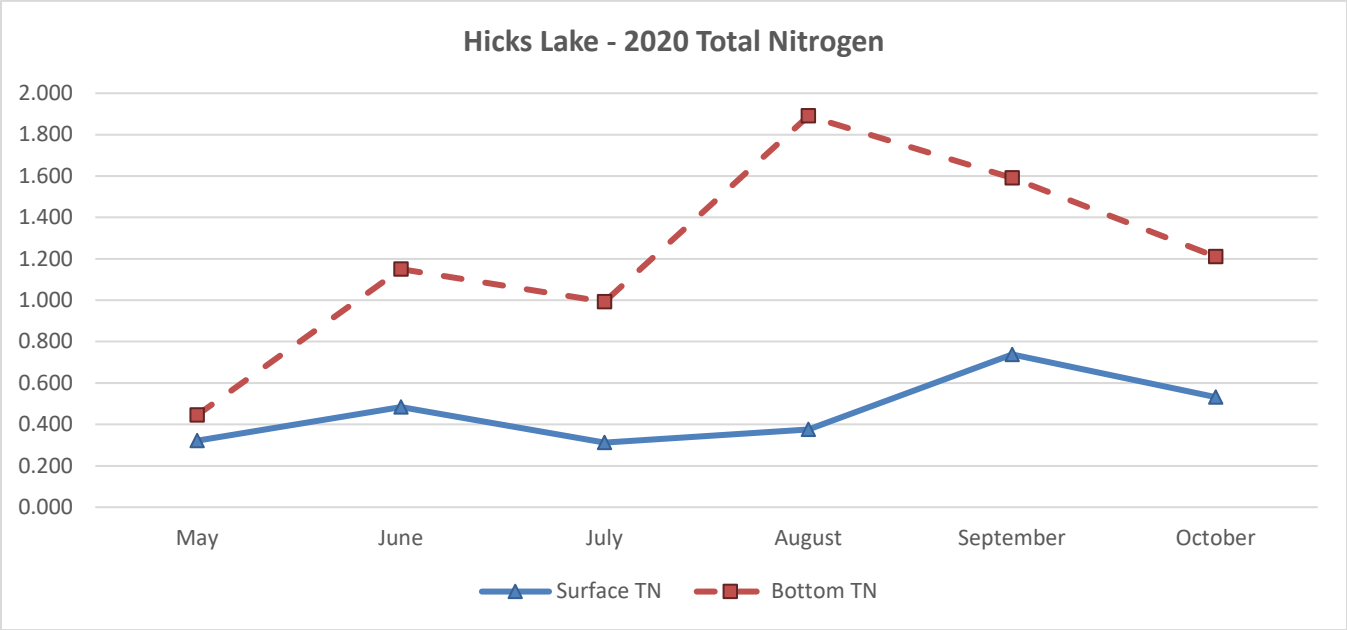

Figure 11. Concentration of TN at the surface and bottom at HK1 in 2020.

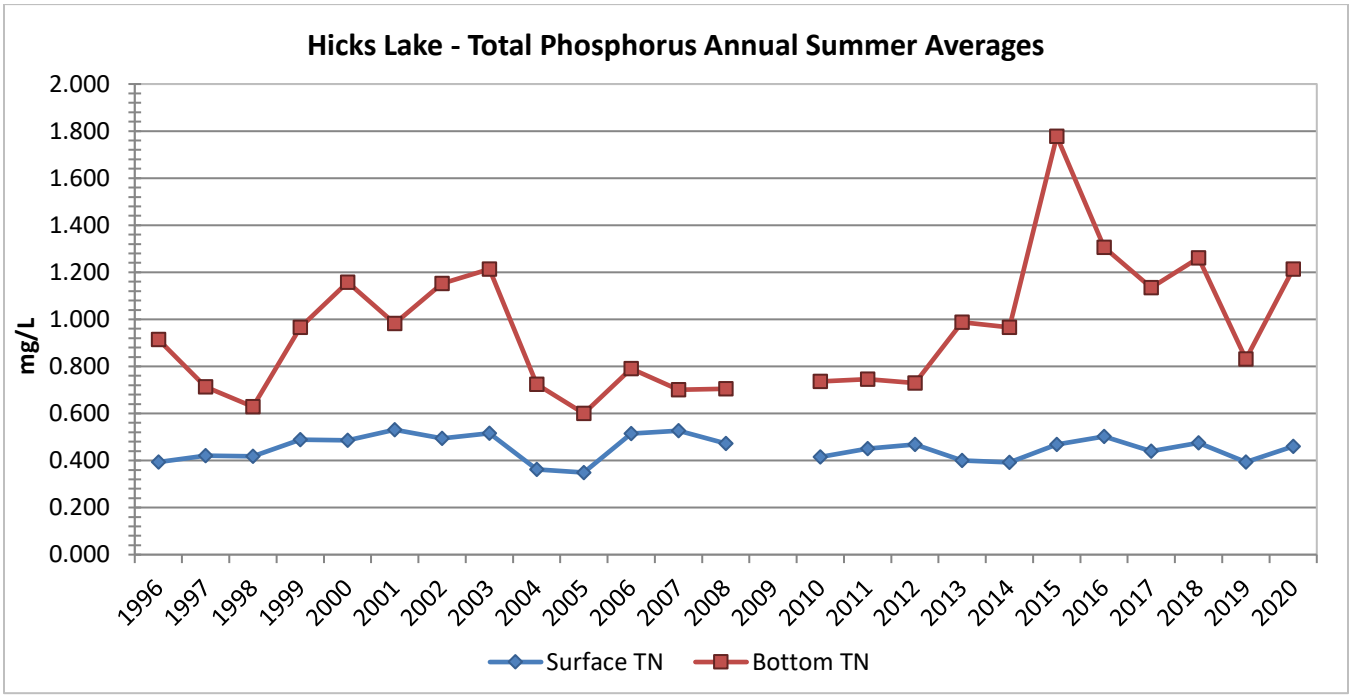

Figure 12. Average Annual Summer TN at HK1 from 1995 to 2020.

The TN statistics from 1995 to 2020 are:

- Mean Surface 0.442 mg/L
- Median Surface 0.451 mg/L
- Standard Deviation Surface 0.051 mg/L
- Maximum Surface 0.531 mg/L in 2001
- Minimum Surface 0.349 mg/L in 2005
- Mean Bottom 1.063 mg/L
- Median Bottom 0.988 mg/L
- Standard Deviation Bottom 0.338 mg/L
- Maximum Bottom 2.007 mg/L in 1995
- Minimum Bottom 0.600 mg/L in 2005

Nitrogen to Phosphorus Ratios

Inorganic nutrients, particularly the elements phosphorus and nitrogen, are vital for algal nutrition and cellular constituents. Over enrichment of surface waters leads to excessive production of autotrophs, especially algae and cyanobacteria (Correll, 1998) Figure 9 shows the total phosphorus (TP) and total nitrogen (TN) present in the surface waters at HK1. Hicks Lake has been phosphorus limited since 1995.

The concentration of TN and TP in surface waters was highest in September, the month when mixing began. Thermal stratification reduced internal loading to surface waters from May to August; changes in the phytoplankton community and external sources likely affect nutrient levels during stratification.

To prevent dominance by cyanobacteria (blue-green algae), the TN to TP ratio (TN:TP) should be above 10:1 (Moore and Hicks, 2004). Figure 13 shows the TN to TP ratio in 2020. Hicks Lake is phosphorus limited.

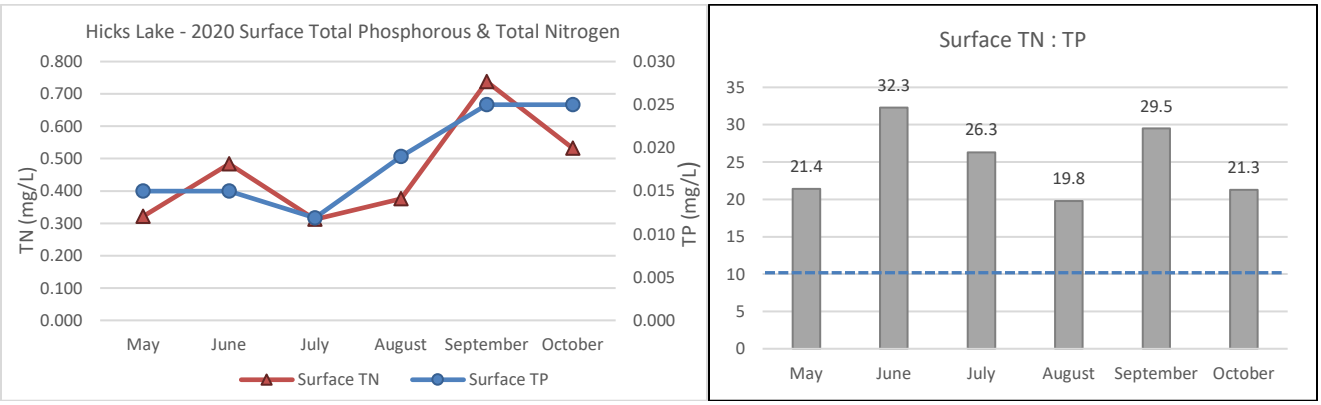

Figure 13. TP, TN, and TN:TP at the surface of Hicks Lake in 2020.

Trophic State Indices (TSI)

The most used method to classify lakes is called the Carlson's Trophic State Index (Carlson, 1977). Based on the productivity, this method uses three index variables: transparency (secchi disk depth), chlorophyll-a, and phosphorus concentrations. Table 3 provides the index values for each trophic classification.

Table 3. Trophic State Index variables

TSI Value	Trophic State	Productivity
0 to 40	oligotrophic	Low
41 to 50	mesotrophic	Medium
> 50	eutrophic	High

The TSI calculated from the 2020 results are:

- Chlorophyll-a: 51 eutrophic
- Total Phosphorus: 46 mesotrophic
- Secchi Disk: 47 mesotrophic

The average of the three TSI variables is 48, which categorizes Hicks Lake as mesotrophic in 2020, which is how it was classified in 1981 by the USGS.

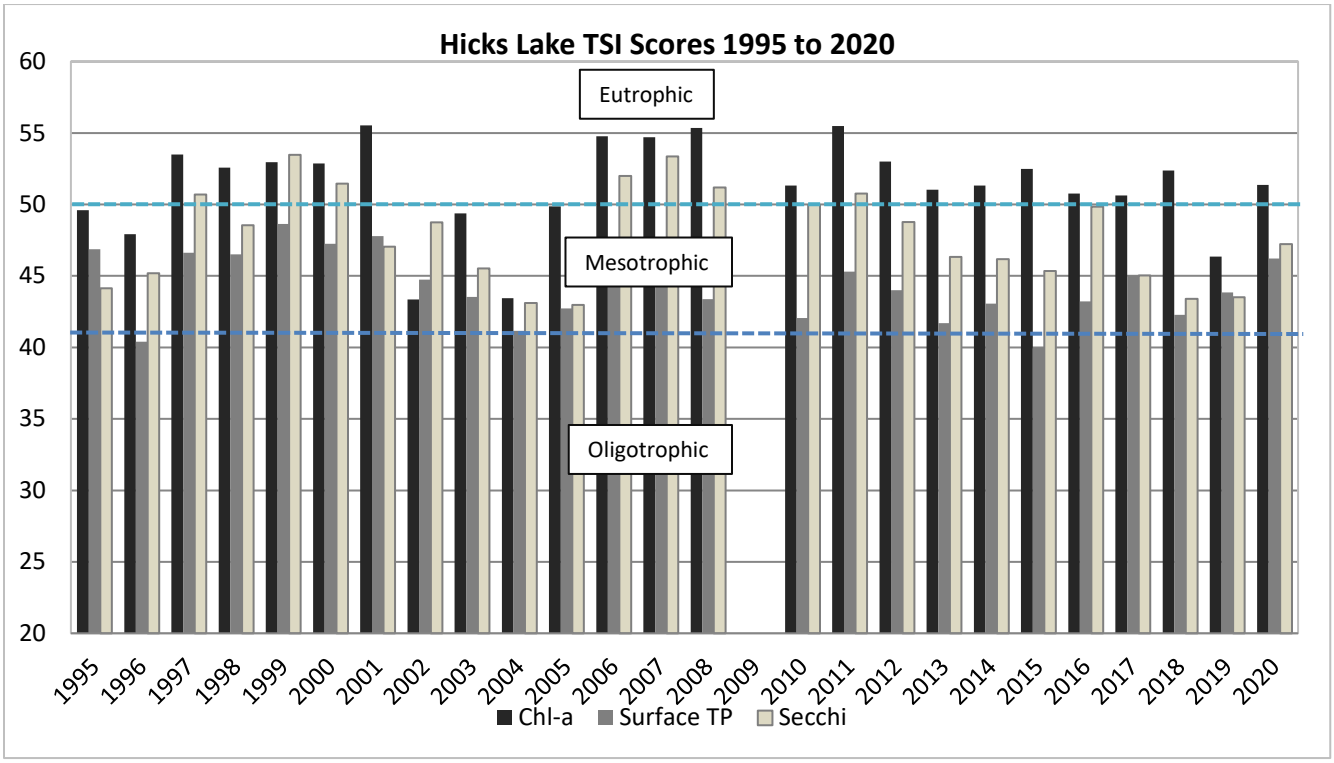

Figure 8. Hicks Lake Mean Trophic State Index scores from 1995 to 2020.

From 1995 to 2020, 72% of the TSI scores for chlorophyll-a and 28% for Secchi depth indicate eutrophic conditions (Figure 14). However, the seasonal Kendall test (Thurston County Environmental Health, 2018) indicate that the chlorophyll-a concentration had a significant ($p < 0.05$) decreasing trend from 2007 to 2018 for June, July, August, and September.

SUMMARY

Thermal Stratification

In 2020, the water column at Hicks Lake was thermally stratified into three distinct layers from May to August. In September, Hicks Lake began to turn over and by October the water column was mixed.

Higher than Average Transparency

In 2020, transparency (mean 2.43 m and median 2.4 m) was minimally higher than the long-term average 2.39 m. Transparency was greater in May, June, and August when the chlorophyll-a concentration was lower. Transparency declined later in the summer as productivity increased from September until turnover in October. Transparency was also lower in July when productivity was higher.

Greater Productivity Late Summer

The chlorophyll-a concentration (season mean 8.3, median 8.6 µg/L) was higher from August to October (mean 10.4 µg/L). Cyanobacteria dominated the phytoplankton only in September, but genera were present during all monthly sampling. A type of golden algae was abundant early in May and July. In September, as Hicks Lake began to turnover, the chlorophyll-a concentration peaked, and the highest variety of cyanobacteria was observed.

Nutrient Concentrations

TP peaked at the lake bottom in August. At the surface, TP peaked in September/October after fall turn over mixed the water column. In 2020, the mean surface TP was 0.018 mg/L, which is 0.003 mg/L higher than the long-term (1995 to 2020) mean and median of 0.015 mg/L. The mean surface TP concentration has not been above the action level (0.020 mg/L) since 2001.

In May, at the start of the summer, surface TN was at the season's low point. The concentration grew greater until August. After productivity increased in August, the TN surface concentration declined each successive month. Internal loading did not increase TN at the surface in October. The surface and bottom TN concentrations were greater than the long-term (1995 to 2020) mean and medians.

Classified as Mesotrophic

Hicks Lake was classified as mesotrophic in 2020 based on an average of the three TSI variables.

DATA SOURCES:

Thurston County Community Planning and Economic Development
(360) 867-2075 or
https://www.thurstoncountywa.gov/planning/Pages/water-gateway.aspx

Thurston County Environmental Health
(360) 867-2626 or https://www.co.thurston.wa.us/health/ehrp/annualreport.html

For correction, questions, and suggestions, contact the author of the 2020 report:
Sarah.Ashworth@co.thurston.wa.us

FUNDING SOURCE:

City of Lacey funded monitoring in 2020.

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Appendices

Appendix A. Raw Data
Appendix B. Algae and Cyanobacteria Identification
Appendix C. Quality Assurance/Quality Control

Appendix A. Raw data

Site INFO			Profile															Samples					
							Temp (C)		pH		DO (m/l)		Conductivity (Sp)		Turb (FNU)			TP		TN		Composite Sample	
Site	Date	Time	Total Depth (m)	Secchi (m)	Water Color	Bottom Profile Depth (m)	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Bottom Sample Depth (m)	Surface	Bottom	Surface	Bottom	Chl a	Phae a
Hicks	5/20/2020	9:07	10.6	2.70	6	10.0	18.136	8.661	7.18	6.05	9.54	0.57	101.1	74.6	10.0	0.015	0.100	0.015	0.100	0.321	0.445	4.4	<0.1
Hicks	6/24/2020	11:03	10.2	3.00	7	10.0	22.507	8.940	7.24	6.38	9.06	0.58	54.6	80.8	9.75	0.015	0.229	0.015	0.229	0.484	1.150	3.5	0.3
Hicks	7/22/2020	11:37	10.23	2.00	3	10.0	24.260	9.306	7.17	6.61	8.89	0.51	55.8	92.7	9.7	0.012	0.275	0.012	0.275	0.312	0.993	11.0	<0.1
Hicks	8/26/2020	11:14	9.9	2.85	6	9.8	23.116	9.843	7.05	6.42	8.49	0.59	59.5	110.4	9.5	0.019	0.425	0.019	0.425	0.376	1.890	6.1	1.0
Hicks	9/23/2020	11:46	9.2	2.10	7	9.0	19.953	11.015	7.24	6.62	8.57	0.54	57.2	104.2	8.7	0.025	0.237	0.025	0.237	0.738	1.590	11.0	1.9
Hicks	10/21/2020	11:28	10.55	1.90	3	10.0	15.085	10.370	7.05	6.65	8.68	0.08	57.8	132.2	10.0	0.025	0.167	0.025	0.167	0.532	1.210	14.0	2.8

Appendix B. Phytoplankton Identification

	Project:	421874-991				Project:	421874-991				Project:	421874-991			
	Locator:	NONE				Locator:	NONE				Locator:	NONE			
	Descrip:	UNKNOWN LOCATOR				Descrip:	UNKNOWN LOCATOR				Descrip:	UNKNOWN LOCATOR			
	Sample:	L74675-1				Sample:	L74699-1				Sample:	L74784-1			
	Matrix:	LK FRESH WTR				Matrix:	LK FRESH WTR				Matrix:	LK FRESH WTR			
	CalDate:	5/20/20 9:15				CalDate:	6/24/20 11:10				CalDate:	7/22/20 12:00			
	ClientLoc:	Hicks Lake				ClientLoc:	Hicks Lake				ClientLoc:	Hicks Lake			
	WET Weight Basis					**WET Weight Basis**					**WET Weight Basis**				
Parameters	**Value**	**Qual**	**MDL**	**RDL**	**Units**	**Value**	**Qual**	**MDL**	**RDL**	**Units**	**Value**	**Qual**	**MDL**	**RDL**	**Units**
HC PRESCOTT 1954															
Ankistrodesmus sp.															
Aphanizomenon sp.		P			none										
Aphanocapsa sp.		P			none		P			none		P			none
Arthrodesmus sp.															
Aulacoseira sp.							P			none		P			none
Ceratium sp.							D			none		S			none
Closterium sp.		P			none		P			none					
Cosmarium sp.															
Crucigenia sp.		P			none										
Cryptomonas sp.		P			none										
Cyclotella sp.		P			none		P			none					
Dictyosphaerium sp.															
Dinobryon sp.		D			none		S			none		D			none
Dolichospermum sp. - irregularly twisted		P			none		P			none		P			none
Dolichospermum sp. - regularly coiled															
Dolichospermum sp. - straight		P			none							P			none
Elakatothrix sp.							P			none					
Encyonema sp.												P			none
Eudorina sp.															
Euglena sp.							P			none					
Fragilaria sp.												P			none
Gomphonema sp.												P			none
Kirchneriella sp.															
Lepocinclis sp.															
Mallomonas sp.															
Melosira sp.												P			none
Micractinium sp.															
Microcystis sp.															
Navicula sp.							P			none		P			none
Nephrocytium sp.												P			none
Nitzschia sp.		P			none		P			none					
Oocystis sp.		P			none		P			none		P			none
Pediastrum sp.							P			none		P			none
Peridiniopsis sp.															
Peridinium sp.		P			none		P			none					
Phacus sp.															
Pharmidium sp.												P			none
Planktosphaeria sp.		P			none		P			none		P			none
Planktothrix sp.							P			none					
Pseudopediastrum sp.												P			none
Quadrigula sp.		P			none		P			none					
Rhodomonas sp.		P			none										
Scenedesmus sp.		P			none		P			none		P			none
Snowella sp.															
Sphaerocystis sp.		P			none		P			none		P			none
Spondylarium sp.		P			none										
Staurastrum sp.		P			none		P			none		P			none
Staurodesmus sp.		P			none		P			none					
Stephanodiscus sp.		S			none							P			none
Synedra sp.															
Synura sp.												P			none
Tabellaria sp.		P			none		P			none		P			none
Trachelomonas sp.		P			none		P			none		P			none
Undetermined Diatom: Pennate		P			none										
Undetermined Dinophyceae															
Undetermined Filament															
Undetermined Spherical: 4-7 micron		P			none										
Woronichinia sp.		P			none										
D - Dominant															
P - Present															
S - Subdominant															

	Project:	421874-991				Project:	421874-991				Project:	421874-991			
	Locator:	NONE				Locator:	NONE				Locator:	NONE			
	Descrip:	UNKNOWN LOCATOR				Descrip:	UNKNOWN LOCATOR				Descrip:	UNKNOWN LOCATOR			
	Sample:	L74785-1				Sample:	L74786-1				Sample:	L75768-1			
	Matrix:	LK FRESH WTR				Matrix:	LK FRESH WTR				Matrix:	LK FRESH WTR			
	CalDate:	8/26/2011:25				CalDate:	9/23/2011:48				CalDate:	10/22/2011:50			
	ClientLoc:	Hicks Lake				ClientLoc:	Hicks Lake				ClientLoc:	Hicks Lake			
	WET Weight Basis					**WET Weight Basis**					**WET Weight Basis**				
Parameters	**Value**	**Qual**	**MDL**	**RDL**	**Units**	**Value**	**Qual**	**MDL**	**RDL**	**Units**	**Value**	**Qual**	**MDL**	**RDL**	**Units**
NC PRESCOTT 1954															
Ankistrodesmus sp.		P			none		P			none		P			none
Aphanizomenon sp.		P			none		P			none		P			none
Aphanocapsa sp.		P			none		P			none		P			none
Arthrodesmus sp.							P			none		P			none
Aulacoseira sp.		P			none		P			none		P			none
Ceratium sp.		D			none		S			none		D			none
Carmarium sp.		P			none		P			none		P			none
Cratichula sp.												P			none
Crucigenia sp.		P			none		P			none					
Cryptomonas sp.		P			none		P			none					
Cyclotella sp.							P			none		P			none
Dictyosphaerium sp.							P			none					
Dinobryon sp.		P			none		P			none		P			none
Dolichospermum sp. - irregularly twisted		S			none		P			none					
Dolichospermum sp. - regularly coiled		P			none										
Dolichospermum sp. - straight		P			none		D			none		P			none
Elakatothrix sp.		P			none		P			none		P			none
Encyonema sp.															
Eudorina sp.							P			none					
Euglena sp.															
Fragilaria sp.												P			none
Gomphonema sp.															
Kirchneriella sp.							P			none					
Lepocinclis sp.							P			none					
Mallomonas sp.		P			none										
Melosira sp.															
Micractinium sp.												P			none
Microcystis sp.		P			none										
Navicula sp.		P			none		P			none					
Nephrocytium sp.															
Nitzschia sp.							P			none		P			none
Oocystis sp.		P			none		P			none		P			none
Pediastrum sp.							P			none					
Peridiniopsis sp.												P			none
Peridinium sp.															
Phacus sp.							P			none					
Pharmidium sp.							P			none					
Planktosphaeria sp.															
Planktothrix sp.															
Pseudopediastrum sp.															
Quadrigula sp.							P			none		P			none
Rhodomonas sp.															
Scenedesmus sp.							P			none					
Snowella sp.							P			none		P			none
Sphaerocystis sp.							P			none					
Spondylosium sp.															
Staurastrum sp.		P			none		P			none		P			none
Staurodesmus sp.															
Stephanodiscus sp.		P			none										
Synedra sp.		P			none		P			none		S			none
Synura sp.															
Tabellaria sp.							P			none		P			none
Trachelomonas sp.		P			none		P			none		P			none
Undetermined Diatom: Pennate		P			none		P			none					
Undetermined Dinophyceae							P			none					
Undetermined Filament							P			none					
Undetermined Spherical: 4-7 micron		P			none							P			none
Woronichinia sp.												P			none
D - Dominant															
P - Present															
S - Subdominant															

Appendix C. Quality Assurance/Quality Control

Table B-1 provides the amount of instrument drift for specific conductivity, dissolved oxygen (collected with optical sensor), and pH. The temperature thermistor was checked against a NIST thermometer on October 24, 2019 and difference was 0.03° C. TCEH collected 15% field replicates and blanks for TP, TN. Chlorophyll-a, and Phaeophytin-a.

Table B-1. Instrument drift during the 2020 sample season.

Lakes Monitored	Date	Time	Percent Difference		
			DO	SPC	pH (7)
St Clair, Summit, Black	5/19/2020	7:50	4.33	0.06	0.43
Deep, Offut, Lawrence	5/20/2020	7:15	0.40	0.08	1.57
Hicks, Pattison, Long, Ward	5/21/2020	13:00	0.82	0.39	1.43
St Clair, Summit, Black	6/23/2020	7:35	0.14	4.32	0.43
Deep, Offut, Lawrence	6/24/2020	7:30	1.05	0.26	1.57
Hicks, Pattison, Long, Ward	6/26/2020	9:45	0.52	3.83	0.86
St Clair, Summit, Black	7/21/2020	7:40	0.26	0.07	0.00
Deep, Offut, Lawrence	7/22/2020	7:45	0.29	0.01	0.43
Hicks, Pattison, Long, Ward	7/23/2020	17:30	0.10	0.11	0.14
St Clair, Summit, Black	8/25/2020	8:00	1.28	0.49	0.29
Deep, Offut, Lawrence	8/26/2020	7:40	0.10	0.24	0.43
Hicks, Pattison, Long, Ward	8/27/2020	13:10	0.21	0.49	0.29
St Clair, Summit, Black	9/21/2020	18:10	0.51	0.07	0.29
Deep, Offut, Lawrence	9/22/2020	7:30	0.27	0.02	0.57
Hicks, Pattison, Long, Ward	9/23/2020	15:40	0.54	0.09	0.86
St Clair, Summit, Black	10/20/2020	7:52	0.22	0.01	0.14
Deep, Offut, Lawrence	10/21/2020	7:40	0.09	0.23	0.29
Hicks, Pattison, Long, Ward	10/22/2020	missing	0.17	0.15	0.14
Median Percent Difference:			0.28	0.13	0.43
Mean Percent Difference:			0.63	0.61	0.56

Table B-2. Relative Percent Difference of field replicates collected during the 2020 sample season.

				TP						TN						Composite Sample					
Site	Date	Time PDT	TP Surface (mg/L)	TP Surface Dup (mg/L)	Surface TP %RPD	TP Bottom (mg/L)	TP Bottom Dup (mg/L)	Bottom TP %RPD	TN Surface (mg/L)	TN Surface Dup (mg/L)	Surface TN %RPD	TN Bottom (mg/L)	TN Bottom Dup (mg/L)	Bottom TN %RPD	Chl a Comp (µg/L)	Chl a Comp Dup (µg/L)	Chl a Comp % RPD	Phae a Comp (µg/L)	Phae a Comp Dup (µg/L)	Phae a Comp % RPD	Lake Notes
Black QA	5/18/2020	15:41	0.017	0.017	0.000	0.054	0.061	12.174	0.306	0.318	3.846	0.401	0.344	15.302	3.6	3.2	11.765	0.7	0.8	13.33	
Deep QA	5/19/2020	9:55	0.023	0.029	23.077	0.020	0.021	4.878	0.373	0.436	15.575	0.894	0.963	7.431	3.6	3.5	2.817	0.4	0.1	120.00	phae <0.1
Summit QA	6/22/2020	12:41	0.005	0.006	18.182	0.022	0.022	0.000	0.235	0.152	42.894	0.361	0.341	5.698	1.3	1.3	0.000	<0.1	<0.1	0.00	
Offut QA	6/23/2020	11:17	0.019	0.020	5.128	0.785	0.776	1.153	0.602	0.544	10.122	2.410	2.330	3.376	5.9	5.9	0.000	0.7	0.3	80.00	
Lake St Clair 1 QA	7/20/2020	10:34	0.028	0.033	14.639	3.9131	4.4263	12.309	0.2654	0.2806	5.589	12.5479	12.4226	1.003	13	11	16.667	2.5	1.1	76.47	
Lawrence 1 QA	7/21/2020	14:20	0.038	0.041	6.474	0.130	0.142	8.858	1.0166	1.0858	6.585	1.6402	1.6779	2.271	13	19	37.500	1.0	0.1	164.11	phae <0.1
LO3 QA	8/26/2020	13:47	0.026	0.028	7.407	0.086	0.081	5.988	0.515	0.528	2.493	0.929	0.933	0.430	9.0	13	36.364	0.1	1.0	163.64	
Ward QA	8/26/2020	9:50	0.013	0.016	20.690	0.476	0.476	0.000	0.383	0.386	0.780	1.680	1.660	1.198	4.0	4.0	0.000	0.1	0.4	120.00	phae <0.1
Lake St Clair 2 QA	9/22/2020	10:05	0.011	0.010	9.524	0.567	0.56	1.242	0.355	0.394	10.414	1.510	1.430	5.442	1.90	1.6	17.143	0.9	1	10.53	
Lawrence 2 QA	9/23/2020	14:35	0.051	0.049	4.000	0.067	0.068	1.481	1.270	1.110	13.445	1.500	1.530	1.980	15	14	6.897	6.0	6.10	1.65	
Summit QA	10/19/2020	13:50	0.007	0.006	15.385	0.120	0.096	22.222	0.128	0.219	52.450	0.300	0.410	30.986	2.3	missing	N/A	<0.1	missing	N/A	
Deep QA	10/20/2020	10:24	0.009	0.009	0.000	0.016	0.018	11.765	0.324	0.314	3.135	0.489	0.516	5.373	1.6	1.6	0.000	0.6	0.6	0.00	
Hicks QA	10/21/2021	11:28	0.025	0.024	4.082	0.167	0.165	1.205	0.532	0.327	47.730	1.210	0.754	46.436	14	17	19.355	2.8	2.1	28.57	

Table B-3. Field blanks collected during the 2020 sample season.

				TP		TN		Composite Sample		
Site	Date	Time	Bottom Sample Depth (m)	Surface	Bottom	Surface	Bottom	Chl a	Phae a	Comments
Black QAB	5/18/2020	15:41	8.5	<0.002	<0.002	<0.05	<0.05	<0.1	<0.1	
Deep QAB	5/19/2020	9:55	5.0	<0.002	<0.002	<0.05	<0.05	<0.1	<0.1	
Summit QAB	6/22/2020	12:41	25.0	-	-	-	-	<0.1	<0.1	missing from lab results
Offut QAB	6/23/2020	11:17	6.0	-	-	-	-	<0.1	<0.1	missing from lab results
Lake St Clair 1 QAB	7/20/2020	10:34	18.5	<0.002	<0.002	<0.050	<0.050	<0.1	<0.1	
Lawrence 1 QAB	7/21/2020	14:20	6.3	<0.002	<0.002	<0.050	<0.050	<0.1	<0.1	
LO3 QAB	8/26/2020	13:47	5.0	<0.002	<0.002	<0.050	<0.050	<0.1	<0.1	
Ward QAB	8/26/2020	9:50	18.5	<0.002	<0.002	<0.050	<0.050	<0.1	<0.1	
Lake St Clair 2 QAB	9/22/2020	10:15	19.2	<0.002	<0.002	<0.050	<0.050	<0.1	<0.1	
Lawrence 2 QAB	9/23/2020	14:35	5.1	<0.002	<0.002	<0.050	<0.050	<0.1	<0.1	
Summit QAB	10/19/2020	13:50	25.0	<0.002	<0.002	<0.050	<0.050	<0.1	<0.1	
Deep QAB	10/20/2020	10:24	4.7	<0.002	<0.002	<0.050	<0.050	<0.1	<0.1	