



Henderson Lake  
Bill Olsen – Primary Contact  
2937 Chippewa Trail  
Lupton MI. 48635

March 14<sup>th</sup>, 2022

Henderson Lake Property Owners,

It has really been a pleasure managing Henderson Lake over the years. Every year seems to bring a unique set of challenges and we welcome the opportunity to meet these challenges for you every single year. We hope that you continue to feel that your lake was managed professionally, economically, and effectively. I have prepared and attached to this document the 2021 annual report for Henderson Lake. This report includes a descriptive timeline of services rendered, a summary, the 2021 treatment maps, and the water quality report for Henderson Lake.

Please keep in mind that we are a fully integrated lakes management company offering solutions including but not limited to mechanical harvesting, herbicide control, dredging, bio-augmentation, and aeration. Savin Lake Services also offers a complete range of water quality testing, depth contour mapping, individual property solutions, and even aquatic plant density reporting.

We look forward to continuing as the Lakes Management service provider for Henderson Lake again next year. Until then; if you have any questions, comments, or require additional information, feel free to contact us.

Sincerely,

Paul Barber – Sales and Marketing Development Manager

*Savin Lake Services Inc.*



## Henderson Lake - 2021 Lake Management Report

In 2021, Savin Lake Services was on Henderson Lake a total of 8 times to provide services. Henderson Lake received 3 herbicide/algaeicide applications, and 3 bacterial augmentation (Muck Buster) treatments. In addition to the treatments, we also conducted water quality testing twice. Below is a descriptive timeline and information pertaining to the services we completed.

### Timeline of Services Rendered

#### May 14<sup>th</sup>, 2021

- Savin Lake Services conducted spring portion of the water quality studies.
  - Our Aquatic Biologist collected data and samples to test the water quality of Henderson Lake.
  - Water samples and data were collected and analyzed from three sites on the lake.
  - Data is collected for 9 different parameters at each site.
    - Parameters we tested for are Temperature, Dissolved Oxygen, Secchi Disk, pH, Chlorophyll a, Nitrate, Phosphorus, Alkalinity, and Conductivity.
  - Report was generated from data and can be found after the treatment maps of this document.

#### June 15<sup>th</sup>, 2021

- Savin Lake Services conducted our initial herbicide/algaeicide treatment.
  - This treatment was for any non-native invasive plant communities that existed throughout the entire lake.
    - 2.5 acres of the lake was treated for curly leaf pondweed.
  - We also treated for algae and nuisance natives in the near shore developed areas of the lake that required treatment.
    - 17.5 acres of the lake for algae.
    - 7.5 acres was treated for the native plants: bladderwort, naiads, and duckweed.
    - 10 acres of various native pondweeds like large leaf pondweed, Richardson's pondweed, and Robbin's pondweed.
- Observations
  - Less curly leaf pondweed than previous season.
  - No Eurasian watermilfoil detected again in 2021.
  - Natives could be found in all the typical areas we have found them in the past.

#### June 28<sup>th</sup>, 2021

- Savin Lake Services conducted our initial bacterial augmentation (Muck Buster) treatment.
  - 5.5 acres received treatment.
    - Same areas that we treated in 2020.



## July 26<sup>th</sup>, 2021

- Savin Lake Services completed our second herbicide/algaecide treatment.
  - This treatment was for algae and nuisance native plant communities in the near shore developed areas of the lake.
    - 12.5 acres of the lake was treated for algae.
    - 7.5 acres of the lake was treated for nuisance large-leaf pondweed, white-stemmed pondweed, and Robbin's pondweed.
    - 7.5 acres of the lake was treated for bladderwort and naiad.
- Observations
  - Only native vegetation present.
    - Native plants could be found in several areas but still below the surface of the water.
  - Lake looked great contained minimal nuisance plant and algae growth that required treatment.
    - Only areas of the lake that contained nuisance natives that reached a level to impede desired recreational use were treated.

## July 30<sup>th</sup>, 2021

- Savin Lake Services conducted second bacterial augmentation treatment.
  - Treated the same 5.5 acres we did earlier in the year.

## August 24<sup>th</sup>, 2021

- Savin Lake Services conducted our final herbicide/algaecide application of the year.
  - This treatment was for algae, nuisance natives, and emergent plants in near shore developed areas.
    - 12.5 acres of the lake was treated for algae.
    - 9 acres of the lake was treated for various pondweeds like large leaf pondweed, Robbin's pondweed, Richardson's pondweed, and thin leaf pondweed.
    - 3.5 acres of the lake was treated for naiad.
    - Approximately (12) 40 ft. X 40 ft. areas of the lake were treated with Imazapyr for Emergent plants in near shore developed areas.
      - Emergent plants treated include lily pads, watershield, and phragmites.
- Observations
  - The lake was in good shape and just needed some touching up in some areas.
  - Invasive emergent plant (phragmites) treated.
  - Only native submerged plant species found.
  - Continue to see an increase in native plant densities.





### September 7<sup>th</sup>, 2021

- Savin Lake Services conducted the final bacterial augmentation treatment for the season.
  - Same 5.5 acres treated as earlier in the season.
- Observations of bacterial augmentation treatments.
  - Same as observations in the management report for 2020.
    - Noticeable difference in canal we continue to see improvement each year.
    - We see a difference in the area we have been doing by the boat launch in the northeast portion of the lake.
    - In southeast portion of the lake receiving bacteria treatment improvement is not as noticeable.

### September 17<sup>th</sup>, 2021

- Savin Lake Services conducted fall portion of the water quality studies.
  - Our aquatic biologist collected data and samples to test the water quality of Henderson Lake.
  - Water samples and data were collected and analyzed from three sites on the lake.
  - Data is collected for 9 different parameters at each site.
    - Parameters we tested for are Temperature, Dissolved Oxygen, Secchi Disk, pH, Chlorophyll a, Nitrate, Phosphorus, Alkalinity, and Conductivity.
  - Report was generated from data and can be found after the treatment maps of this document.

### Summary:

The main objective for aquatic plant management is to mitigate and prevent non-native invasive plant infestations to create and/or sustain a healthy and diverse balance of plants. We successfully complete this objective by conducting routine monitoring (surveys and water quality studies) and utilizing the best management practices (BMP) to selectively manage aquatic plants.

Routine water quality monitoring provides us baseline data of current lake conditions to raise awareness and provide the available options to remediate any current ecological concerns. The productivity (the variety and number of aquatic organisms of food web) depends on the availability of energy (usually solar) and raw materials (nutrients, minerals) within the ecosystem. By limiting the availability of any these required resources you can limit the amount of productivity in ecosystem and vice-versa. Conducting water quality testing provides us the opportunity to be proactive instead of reactive in our management approach, reducing mitigation costs and financial burden imposed on stakeholders. We can “take control before things get out of control”.



Conducting routine plant surveys allows us to identify areas of the lake containing invasive plant communities capable of negatively impacting the lake's ecology. Conducting these surveys also allows us to identify the developed near shore areas of the lake containing native plants that are detrimentally impeding recreational use. The information contained from the surveys is utilized to evaluate available control methods to reduce the nuisance plants.

Best management practices for aquatic plant management include aggressively target invasive plant communities utilizing selective systemic herbicides whenever possible, and only control native plant populations in areas they are detrimentally impeding the recreational use of the lake. This keeps the invasive plant species in check and allows native flora to outcompete the invasive plants reducing their probability of further establishment throughout the lake. This reduces the potential threat invasive plant species pose on a lake's ecosystem, and aid in prevention of new infestations without detrimentally impacting other aquatic life in the process. Allowing native plant communities, the opportunity to outcompete the invasive plants will prevent, reduce, and/or remove invasive plant presence in a waterbody.

Henderson Lake is proof that this management strategy works. Henderson Lake is a mildly productive extremely healthy lake that becomes nutrient limited in the summer months. This limits the amount of additional biomass the ecosystem can produce. We continue to see success in the lake management strategy. The water quality data collected and analyzed shows no signs of any immediate imminent threat. Water quality parameters are in line or better than many of the other lakes in the area. No significant difference in the 2021 data collected when compared to previous years.

The 2021 season was another great year for Henderson Lake. Eurasian watermilfoil was not detected in the lake anywhere for the second consecutive season. We continued to see decreases in invasive plant presence, while also maintaining and/or increasing native plant densities and plant diversity/species richness. The lake continues to respond greatly to the herbicide management approach. Initial treatment acreages for curly leaf pondweed continue to decrease. In 2019, we treated 8 acres. In 2020, we treated 5 acres. In 2021, we only treated 2.5 acres. Early season treatments effectively control the curly leaf pondweed before its reproductive turions are spread.

This report confirms the success and achievements, that were accomplished by the collaborative provision and continuous communication between Savin Lake Services and the Henderson Lake Milfoil Committee. By strategically working together we were able implement an efficient, effective, and successful lakes management plan for Henderson Lake.

The management approach for 2022 will be consistent and targeted to accomplish the same primary objects as the approach taken in previous season. We will be monitoring the lake regularly, aggressively managing the invasive plants throughout the entire lake, and manage nuisance natives





(when necessary) in the near shore developed areas. We will continue to monitor the native plants offshore and implement a change to manage them if they reach the nuisance level threshold.

Savin Lake Services has continued to grow as a company year after year. Every year we expand our professional portfolio along with providing additional lakes management services. We are currently in the process of acquiring ownership of Alcona Dredge, LLC. We have had a long-term relationship with Alcona Dredge and have partnered with them to complete several dredging projects. We recently were presented with the opportunity to purchase the dredging company. The change in ownership is now in the process and Savin Lake Services will soon own 2 W&S Cutterhead suction dredges and all the equipment to complete dredging projects. With acquiring ownership of Alcona Dredge we are now the only vertically integrated lakes management firm in the state.

The addition of Alcona dredge has required us to make some personnel changes to our management structure and add additional staff to allow us to meet the demand for services. I have been promoted to the Sales and Marketing Development Manager for Savin Lake Services and will no longer be the lakes manager for Henderson Lake. Mike Kujawa will be the new lakes manager and primary contact for Henderson Lake. Mike is very familiar and passionate about the lake. Mike has been with us for over 12 years, and I'm sure he will do an amazing job managing the lake for you. However, I will still be available to answer any questions and provide any information or assistance needed as we make the transition into our new roles. It has really been a pleasure being involved with the project and seeing the progress that has been made over the past 13 years. We look forward to another successful, efficient, and effective treatment season this year.

Until then, if you have any questions, comments, or require any additional information, please feel free to contact us.

Sincerely,

A handwritten signature in cursive script that reads "Paul Barber". The signature is written in black ink and is positioned below the word "Sincerely,".

Paul Barber – Sales and Marketing Development Manager

*Savin Lake Services Inc.*



**Treatment Maps:**

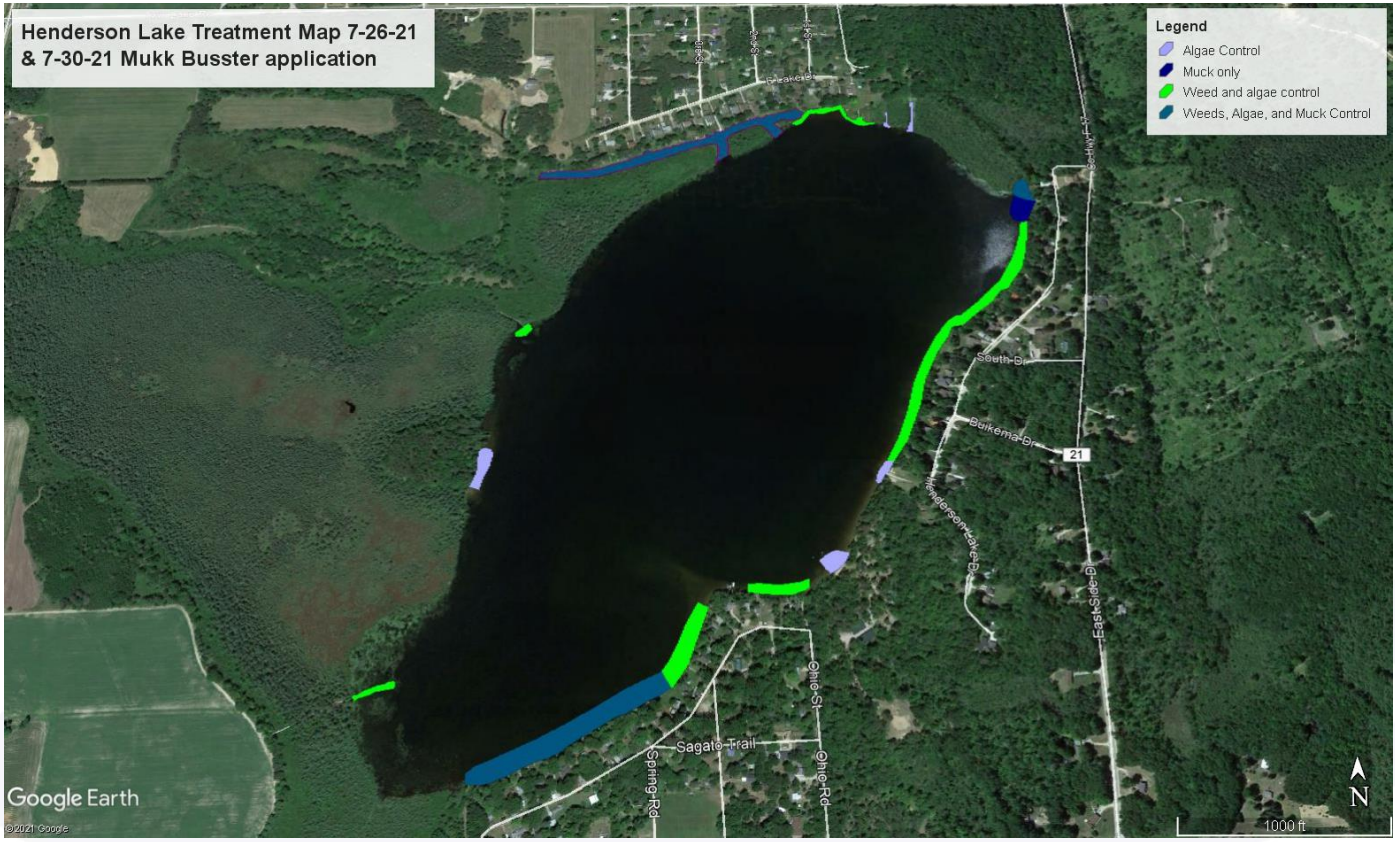
**June 15<sup>th</sup>, 2021 treatment & June 28<sup>th</sup>, 2021 Muck Busster Application**







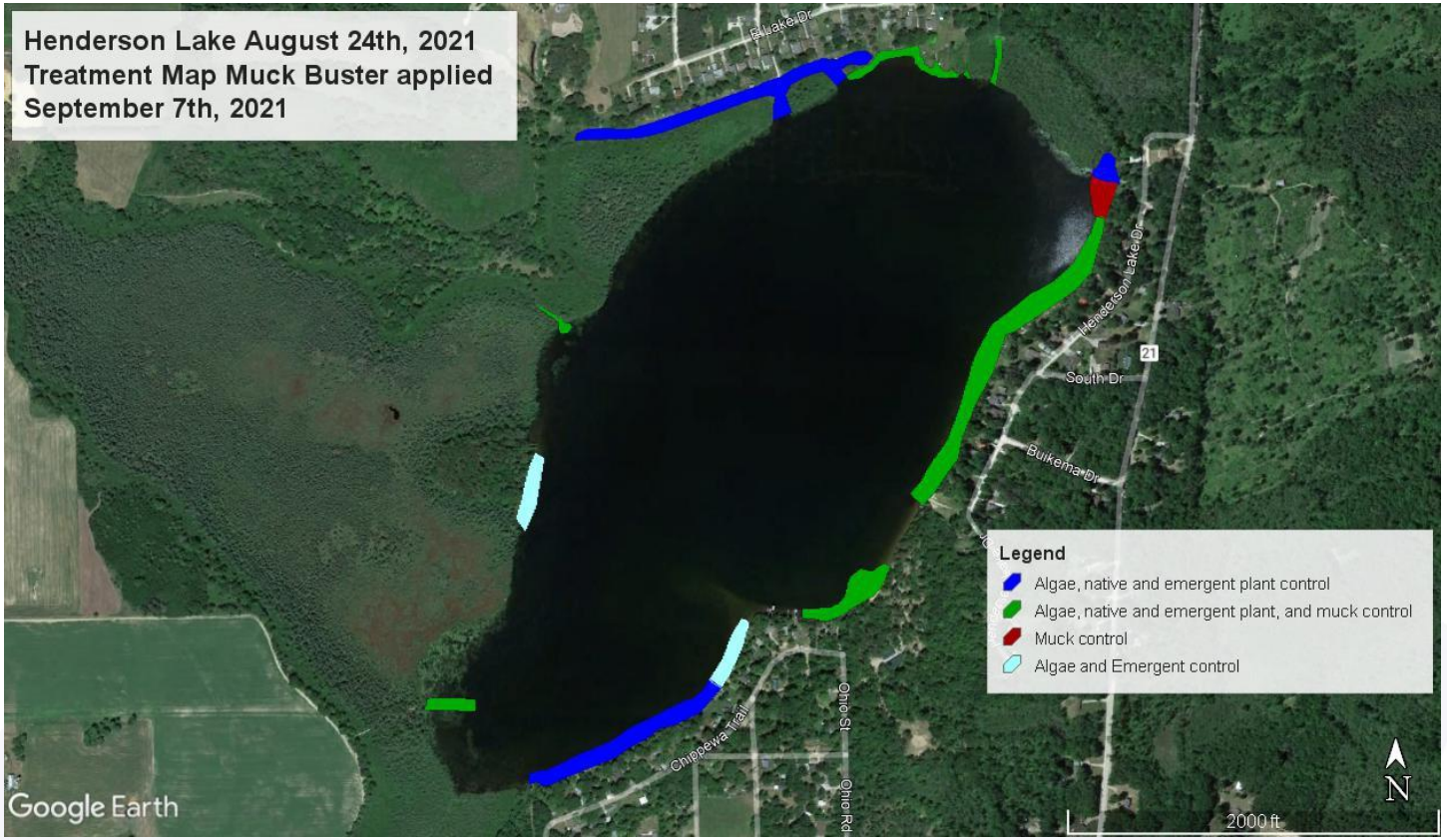
**July 26<sup>th</sup>, 2021 treatment & July 30<sup>th</sup>, 2021 Muck Buster Application**







**August 24<sup>th</sup>, 2021, Herbicide Treatment & September 7<sup>th</sup>, 2021, Muck Buster Treatment**





3088 Hottis Rd. Hale, MI 48739    Hale: 989.728.2200    Clare: 989.386.0600    Fax: 989.516.5900

## Henderson Lake 2021 Water Quality Report

### Summary:

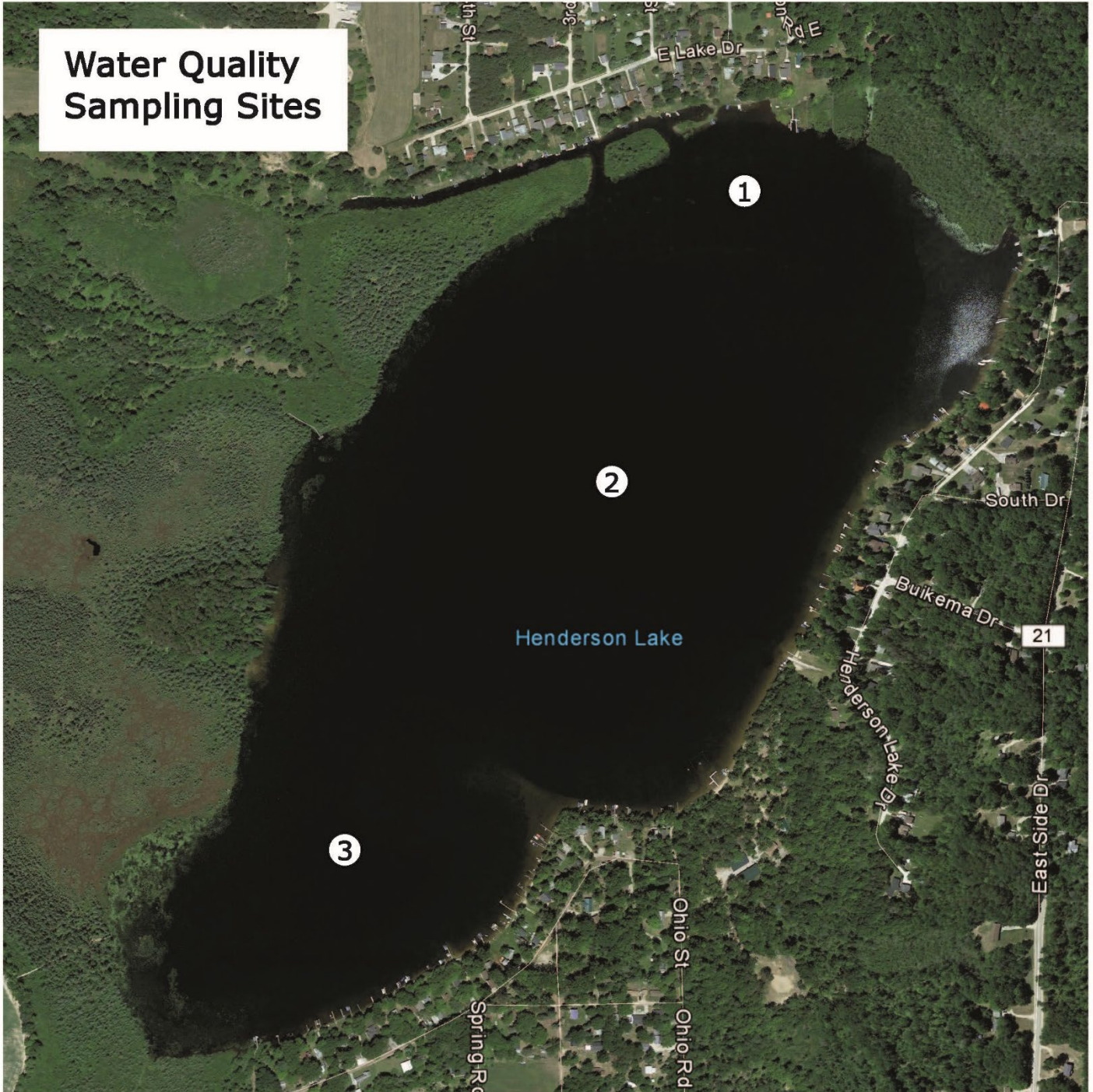
Water Quality Testing was completed 2 times on Henderson Lake at 3 different locations around the lake. Of the parameters tested, Temperature, Dissolved Oxygen, Secchi Disk, and pH were sampled while on the lake. Chlorophyll  $\alpha$ , Nitrate-N, Phosphorus, Alkalinity, and Conductivity were sampled by sending the water in sample bottles to an independent laboratory, White Water Associates located in Amasa, MI, where the analysis was ran.

A well known limnologist named Wally Fusilier developed a grading scale for various parameters of water quality. Data collected in 2021 is shown below and given a grade based on Fusilier's scale. Additionally, historical data and parameter descriptions are provided at the end of this report.

Because herbicide treatment of aquatic vegetation has occurred on Henderson Lake, it should be noted that the application of herbicide no direct impact to the water quality of Henderson Lake.

Overall in 2021 based on the analysis results, Henderson Lake had excellent water quality figures again. Everything seems to fall in line with what has been seen in previous years with no parameters significantly differing from past sampling results. Monitoring should be continued with no corrective action being required at this time.









3088 Hottis Rd. Hale, MI 48739    Hale: 989.728.2200    Clare: 989.386.0600    Fax: 989.516.5900

### 2021 Results:

Date	5/14/2021		5/14/2021		5/14/2021		9/17/2021		9/17/2021		9/17/2021	
Station Number	1		2		3		1		2		3	
Temp (°C)	15.9	A	15.5	A	15.0	A	20.6	A	20.8	A	20.1	A
Dissolved Oxygen (mg/L)	11.5		12.18		11.78		9.23		9.53		9.70	
Dissolved Oxygen (%saturation)	116.7	B	123.9	C	117.2	B	103.4	A	106.7	A	106.9	A
Chlorophyll a (ug/L)	1.1	A	0.3	A	0.3	A	1.3	A	1.4	A	1.4	A
Secchi Disk Depth (ft)	Bottom	B	17.0	B	Bottom	B	Bottom	D	9.1	D	8.5	F
Total Nitrate Nitrogen (ug/L)	ND	A	ND	A	140	A	ND	A	ND	A	ND	A
Alkalinity (mg/L)	74.0	A	74	A	73	A	69	A	66	A	77	A
pH	8.4	B	8.25	A	8.24	A	8.30	B	8.12	A	8.34	B
Conductivity (umhos/cm)	180.0	A	180	A	190	A	190	A	190	A	190	A
Total Phosphorus (ug/L)	<8	A	18	A	12	A	<8	A	<8	A	11	A
Overall Grade		A		A		A		A		A		B

### Scale:

Grade	Temp	Dissolved Oxygen	Chlorophyll α	Secchi Disk Depth	Total Nitrate Nitrogen	Alkalinity	pH	Conductivity	Total Phosphorus
<b>A</b>	0-26.5	85-115	0-2	>19	0-275	50-225	5.75-8.27	0-380	0-20
<b>B</b>	26.5-28.5	85-77; 115-122	2-3	19-16	275-360	50-35; 225-255	5.75-5.55; 8.27-8.47	380-590	20-28
<b>C</b>	28.5-30	77-69; 122-131	3-4	16-12	360-450	35-23; 255-280	5.55-5.33; 8.47-8.69	590-720	28-39
<b>D</b>	30-31.5	69-62; 131-140	4-5	12-9	450-540	23-17; 280-310	5.33-5.14; 8.69-8.88	720-800	39-46
<b>F</b>	>31.5	<62; >140	>5	<9	>540	<17; >310	<5.14; >8.88	>800	>46

Preserving Our Lakes Today for Our Generations Tomorrow

[www.LakeAndPond.com](http://www.LakeAndPond.com)

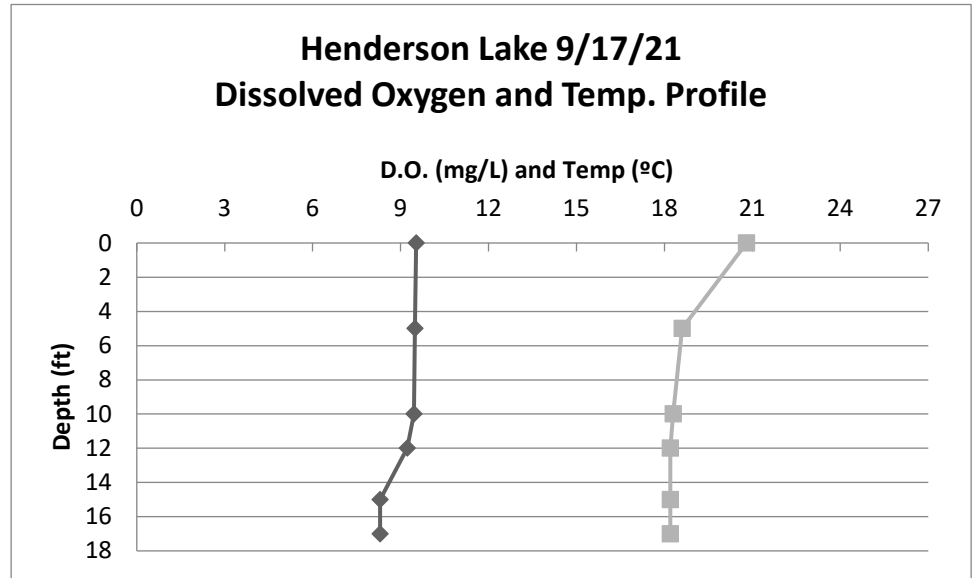




3088 Hottis Rd. Hale, MI 48739    Hale: 989.728.2200    Clare: 989.386.0600    Fax: 989.516.5900

**Dissolved Oxygen and Temp. Profile:**

Temp (°C)	D.O. (mg/L)	Depth (ft)
20.8	9.53	0
18.6	9.49	5
18.3	9.45	10
18.2	9.23	12
18.2	8.30	15
18.2	8.30	17



Matt Novotny

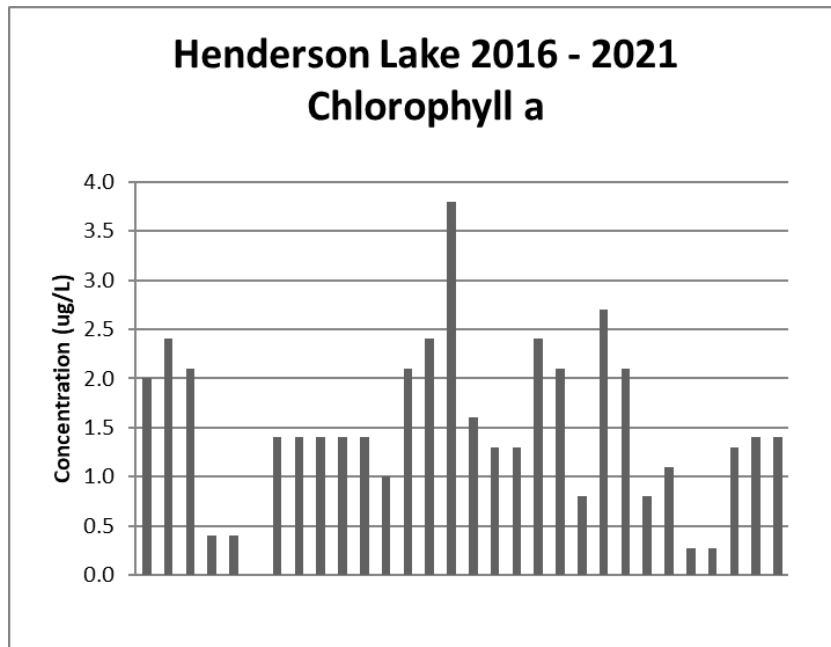
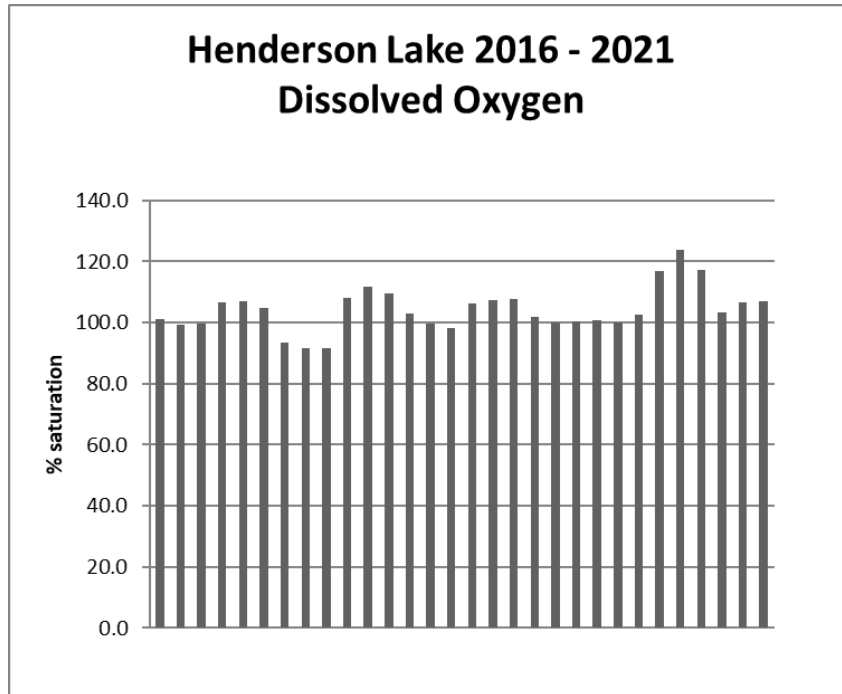
*Matthew Novotny*

Environmental Scientist

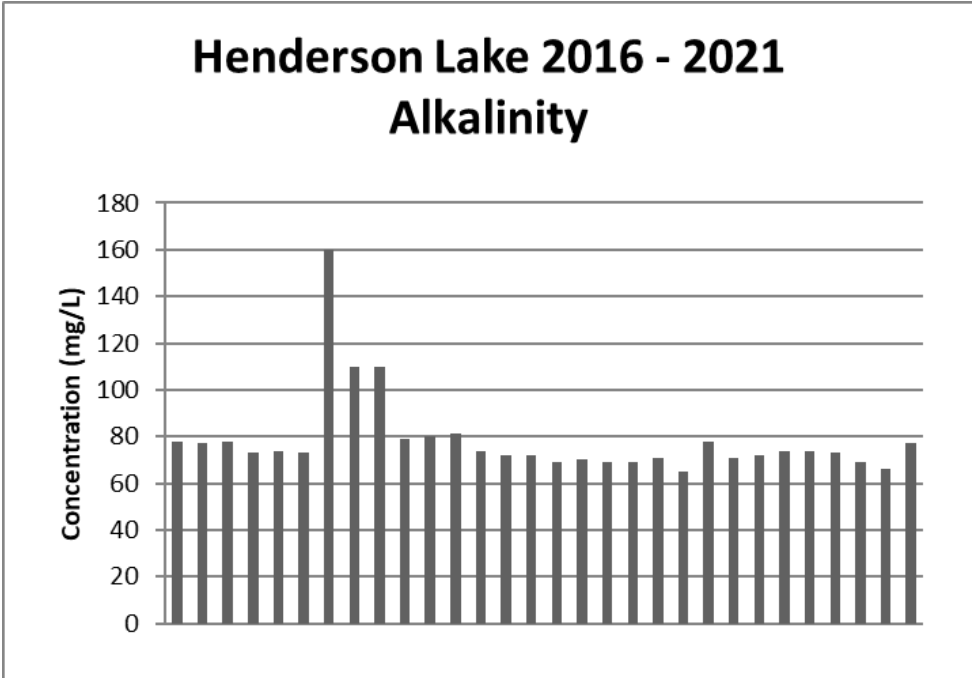
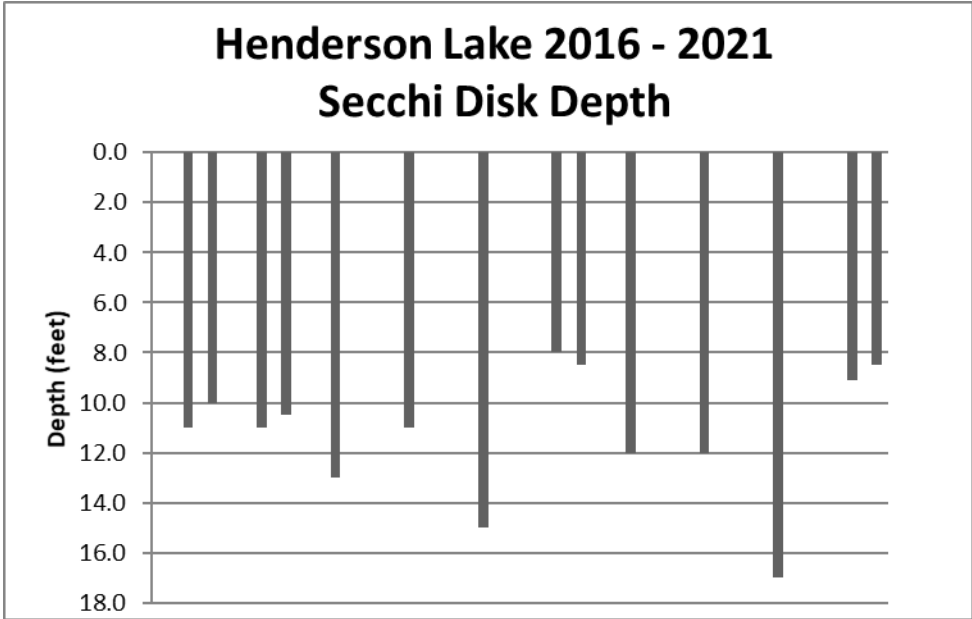
Preserving Our Lakes Today for Our Generations Tomorrow

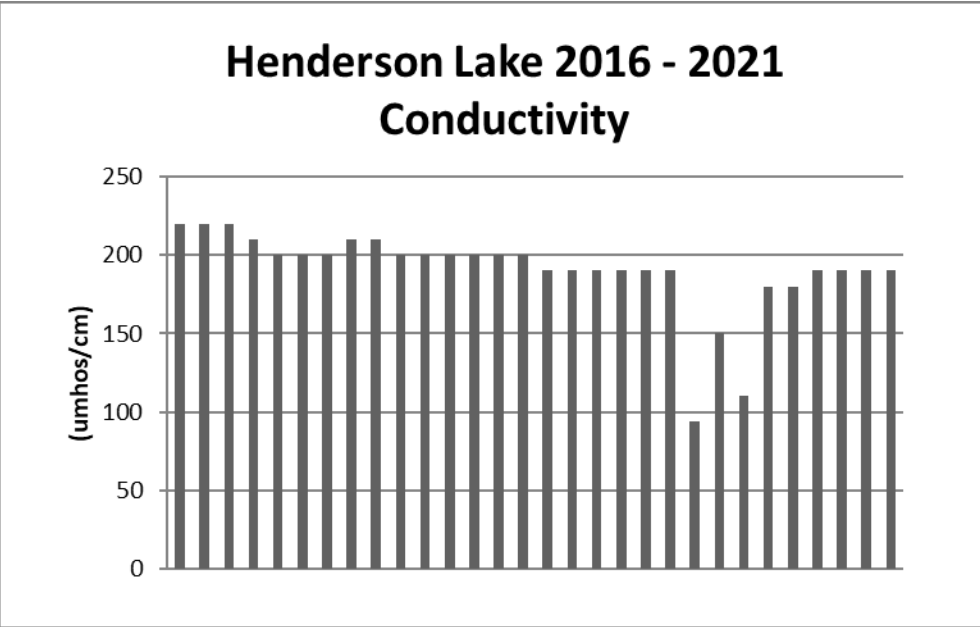
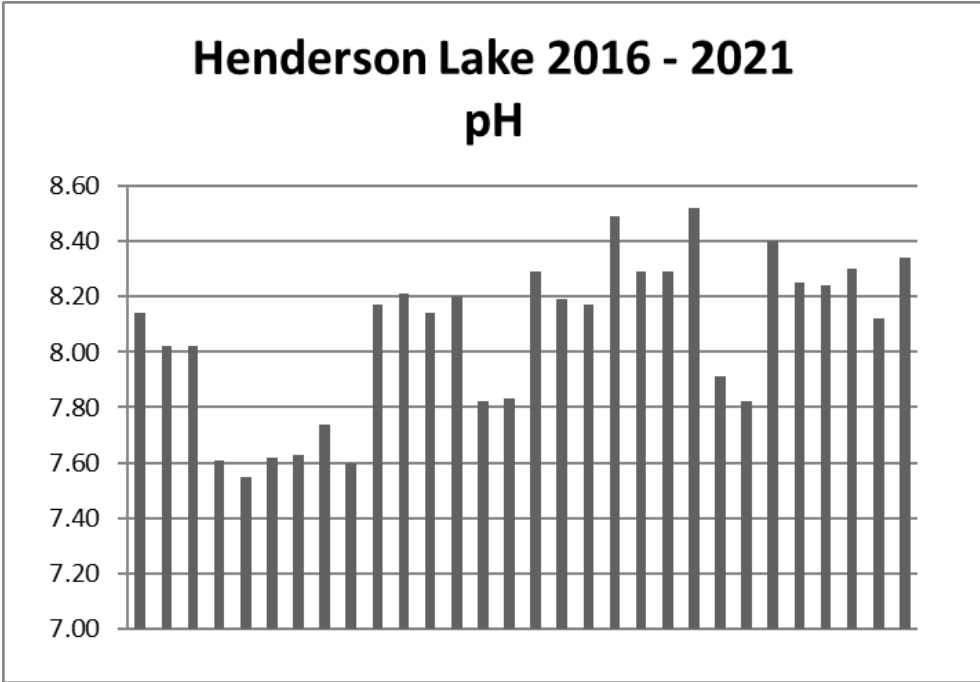
[www.LakeAndPond.com](http://www.LakeAndPond.com)

**Historical Data:**









*(Nitrate and Total Phosphorus not shown due to majority of undefined values. Information contained in data on next page)*





3088 Hottis Rd. Hale, MI 48739    Hale: 989.728.2200    Clare: 989.386.0600    Fax: 989.516.5900

Henderson Lake Water Quality Data												
Date	Sample Station Number	Temperature (°C)	Dissolved Oxygen		Chlorophyll α (ug/L)	Secchi Disk Depth (ft)	Total Nitrate Nitrogen (ug/L)	Alkalinity (mg/L)	pH	Conductivity umhos per cm at 25 °C	Total Phosphorus (ug/L)	Grade
			(mg/L)	Percent Saturation								
9/28/2016	1	17.2	9.77	101.2	2.0	Bottom	ND	78	8.14	220	<9	A
9/28/2016	2	17.0	9.58	99.3	2.4	11.0	ND	77	8.02	220	<9	A
9/28/2016	3	16.9	9.62	99.7	2.1	10.0	ND	78	8.02	220	<9	A
6/7/2017	1	23.4	9.14	106.8	0.4	Bottom	ND	73	7.61	210	13	A
6/7/2017	2	23.1	9.17	107.1	0.4	11.0	ND	74	7.55	200	13	A
6/7/2017	3	22.4	9.13	104.7	0.0	10.5	ND	73	7.62	200	41	A
10/4/2017	1	14.0	9.64	93.6	1.4	Bottom	ND	160	7.63	200	ND	A
10/4/2017	2	14.3	9.44	91.7	1.4	13.0	ND	110	7.74	210	ND	A
10/4/2017	3	14.1	9.43	91.6	1.4	Bottom	ND	110	7.60	210	ND	A
6/22/2018	1	25.3	8.90	108.0	1.4	Bottom	<80	79.0	8.17	200.0	<8	A
6/22/2018	2	24.7	9.20	111.7	1.4	11.0	<80	80.0	8.21	200.0	<8	A
6/22/2018	3	24.8	9.03	109.6	1.0	Bottom	<80	81.0	8.14	200.0	12.0	A
10/2/2018	1	15.8	10.2	103.1	2.1	Bottom	<80	74.0	8.2	200.0	<8	A
10/2/2018	2	15.3	10.0	99.6	2.4	15.0	<80	72.0	7.8	200.0	<8	A
10/2/2018	3	15.1	9.9	98.2	3.8	Bottom	<80	72.0	7.8	200.0	<8	A
5/24/2019	1	15.9	10.5	106.4	1.6	Bottom	<130	69	8.29	190	12.0	B
5/24/2019	2	15.7	10.6	107.2	1.3	8.0	<130	70	8.19	190	16.0	A
5/24/2019	3	15.7	10.6	107.8	1.3	8.5	<130	69	8.17	190	14.0	A
9/30/2019	1	14.5	10.2	101.7	2.4	Bottom	<130	69	8.49	190	<8	B
9/30/2019	2	14.8	10.1	100.0	2.1	12.0	<130	71	8.29	190	<8	B
9/30/2019	3	14.9	10.1	100.5	0.8	Bottom	<130	65	8.29	190	<8	A
9/24/2020	1	16.1	9.9	100.8	2.7	Bottom	<130	78	8.52	94	12	B
9/24/2020	2	16.2	9.9	100.2	2.1	12.0	<130	71	7.91	150	11	A
9/24/2020	3	16.4	10.1	102.7	0.8	Bottom	<130	72	7.82	110	12	A
5/14/2021	1	15.9	11.5	116.7	1.1	Bottom	ND	74.0	8.40	180.0	ND	A
5/14/2021	2	15.5	12.2	123.9	0.3	17.0	ND	74.0	8.25	180.0	18.0	A
5/14/2021	3	15.0	11.8	117.2	0.3	Bottom	140	73.0	8.24	190.0	12.0	A
9/17/2021	1	20.6	9.2	103.4	1.3	Bottom	ND	69.0	8.3	190.0	ND	A
9/17/2021	2	20.8	9.5	106.7	1.4	9.1	ND	66.0	8.1	190.0	ND	A
9/17/2021	3	20.1	9.7	106.9	1.4	8.5	ND	77.0	8.3	190.0	11.0	B

Preserving Our Lakes Today for Our Generations Tomorrow

[www.LakeAndPond.com](http://www.LakeAndPond.com)



3088 Hottis Rd. Hale, MI 48739    Hale: 989.728.2200    Clare: 989.386.0600    Fax: 989.516.5900

## **Parameter Descriptions:**

### **TEMPERATURE AND DISSOLVED OXYGEN**

Temperature exerts a wide variety of influences on most lakes, such as the separation of layers of water (stratification), solubility of gases, and biological activity.

Dissolved oxygen is the parameter most often selected by lake water quality scientists as being important. Besides providing oxygen for aquatic organisms in natural lakes, dissolved oxygen is involved in phenomena such as phosphorus precipitation to, and release from, the lake bottom sediments and decomposition of organic material in the lake.

Low dissolved oxygen concentrations (below 4 milligrams per liter) are generally insufficient to support fish life. In most Michigan lakes, there is no dissolved oxygen below the thermocline in late summer. Some experts like to see some dissolved oxygen in the bottom water of a lake, even if it is almost zero. This is because as long as there is some dissolved oxygen in the water at the bottom of the lake, phosphorus precipitated by iron to the bottom sediments will remain there. Once a lake runs out of dissolved oxygen in the water at the bottom iron comes back into solution. When that happens, it releases the phosphorus back into the water. This can cause additional algae to grow when the lake mixes.

### **DISSOLVED OXYGEN, PERCENT SATURATION**

Because the amount of dissolved oxygen a water can hold is temperature dependent with cold water holding more than warm water, dissolved oxygen saturation is often a better way to determine if oxygen supplies are adequate. The best is between 90 and 110 percent.





3088 Hottis Rd. Hale, MI 48739 Hale: 989.728.2200 Clare: 989.386.0600 Fax: 989.516.5900

## **CHLOROPHYLL $\alpha$**

Chlorophyll  $\alpha$  is used by lake scientists as a measure of the biological productivity of the water. Generally, the lower the chlorophyll  $\alpha$ , the better. High concentrations of chlorophyll  $\alpha$  are indicative of an algal bloom in the lake, an indication of poor lake water quality. The highest surface chlorophyll  $\alpha$  concentration found by Wallace Fusilier (Water Quality Investigators, WQI) in a Michigan lake was 216 micrograms per liter. Best is below one microgram per liter.

## **SECCHI DISK TRANSPARENCY (originally Secchi's disk)**

In 1865, Angelo Secchi, the Pope's astronomer in Rome, Italy devised a 20-centimeter (8 inch) white disk for studying the transparency of the water in the Mediterranean Sea. Later an American limnologist (lake scientist) named Whipple divided the disk into black and white quadrants which many are familiar with today.

The Secchi disk transparency is a lake test widely used and accepted by limnologists. The experts generally felt the greater the Secchi disk depth, the better quality the water. However, one Canadian scientist pointed out acid lakes have very deep Secchi disk readings. (Would you consider a very clear lake a good quality lake, even if it had no fish in it? It would be almost like a swimming pool.) Most lakes in southeast Michigan have Secchi disk transparencies of less than ten feet. On the other hand, Elizabeth Lake in Oakland County had 34 foot Secchi disk readings in summer 1996, evidently caused by a zebra mussel invasion a couple of years earlier.

Most limnology texts recommend the following: to take a Secchi disk transparency reading, lower the disk into the water on the shaded side of an anchored boat to a point where it disappears. Then raise it to a point where it's visible. The average of these two readings is the Secchi disk transparency depth.



3088 Hottis Rd. Hale, MI 48739    Hale: 989.728.2200    Clare: 989.386.0600    Fax: 989.516.5900

Secchi disk measurements should be taken between 10 AM and 4 PM. Rough water will give slightly shallower readings than smooth water. Sunny days will give slightly deeper readings than cloudy days. However, roughness influences the visibility of the disk more than sunny or cloudy days.

### **TOTAL PHOSPHORUS**

Although there are several forms of phosphorus found in lakes, the experts selected total phosphorus as being most important. This is probably because all forms of phosphorus can be converted to the other forms. Currently, most lake scientists feel phosphorus, which is measured in parts per billion (1 part per billion is one second in 31 years) or micrograms per liter ( $\mu\text{g}/\text{L}$ ), is the one nutrient which might be controlled. If its addition to lake water could be limited, the lake might not become covered with the algal communities so often found in eutrophic lakes.

Based on WQI's studies of many Michigan inland lakes, they've found many lakes were phosphorus limited in spring (so don't add phosphorus) and nitrate limited in summer (so don't add nitrogen).

10 parts per billion is considered a low concentration of phosphorus in a lake and 50 parts per billion is considered a high value in a lake by many limnologists.





3088 Hottis Rd. Hale, MI 48739 Hale: 989.728.2200 Clare: 989.386.0600 Fax: 989.516.5900

## **NITRATE NITROGEN**

Nitrate, also measured in the parts per billion range, has traditionally been considered by lake scientists to be a limiting nutrient. The experts felt any concentration below 200 parts per billion was excellent in terms of lake water quality. The highest value found by Fusilier was 48,000 parts per billion in an Ottawa County river which flowed into Lake Macatawa in Holland, Michigan.

On the other hand, WQI has studied hundreds of Michigan inland lakes, and many times they find them nitrate limited (very low nitrate nitrogen concentrations), especially in summer.

WQI was finding many lakes have lower nitrate nitrogen concentrations in summer than in spring. This is probably due to two factors. First, plants and algae growing in lakes as water warms can remove nitrates from the water column. And second, bacterial denitrification (where nitrates are converted to nitrogen gas by bacteria) also occurs at a much faster rate in summer when the water is warmer.

Generally limnologists feel optimal nitrate nitrogen concentrations (which encourage maximum plant and algal growth) are about 10-20 times higher than phosphorus concentrations. The reason more nitrogen than phosphorus is needed is because nitrogen is one of the chemicals used in the production of plant proteins, while phosphorus is used in the transfer of energy, but is not used to create plant material. If the nitrate concentration is less than 10-20 times the phosphorus concentration, the lake is considered nitrogen limited. If the nitrate concentration is higher than 10-20 times the phosphorus concentration, the lake is considered phosphorus limited.



3088 Hottis Rd. Hale, MI 48739 Hale: 989.728.2200 Clare: 989.386.0600 Fax: 989.516.5900

## **TOTAL ALKALINITY**

Alkalinity is a measure of the ability of the water to absorb acids (or bases) without changing the hydrogen ion concentration (pH). It is, in effect, a chemical sponge. In most Michigan lakes, alkalinity is due to the presence of carbonates and bicarbonates which were introduced into the lake from ground water or streams which flow into the lake. In lower Michigan, acidification of most lakes should not be a problem because of the high alkalinity concentrations

## **HYDROGEN ION CONCENTRATION (pH)**

pH has traditionally been a measure of water quality. Today it is an excellent indicator of the effects of acid rain on lakes. About 99% of the rain events in southeastern Michigan are below a pH of 5.6 and are thus considered acid. However, there seems to be no lakes in southern Michigan which are being affected by acid rain. Most lakes have pH values between 7.5 and 9.0.

## **SPECIFIC CONDUCTIVITY**

Conductivity, measured with a meter, detects the capacity of a water to conduct an electric current. More importantly however, it measures the amount of materials dissolved in the water, since only dissolved materials will permit an electric current to flow. Theoretically, pure water will not conduct an electric current. It is the perception of the experts that poor quality water has more dissolved materials than does good quality water