

# INDIAN LAKE PROPERTY OWNERS' ASSOCIATION



## 2022 Annual Report

December 2022

Prepared and presented by



## Background

Over the past ten years, Indian Lake has experienced accelerating problems with harmful algae blooms and organic sediment deposition. In 2017, an engineer's report recommended suction dredging to deepen the southern end of the lake and certain coves. However, concerns were raised about the feasibility and costs of such a project.

To explore alternatives, Clean-Flo / SIS.bio was tasked with undertaking a bathymetric analysis and assessment of the lake in 2019. The purpose of the analysis was to determine the potential for implementing a biotechnology-based solution to reverse ongoing eutrophication of the lake, and to determine the potential to achieve bio-dredging of the organic sediment.

## 2019 Survey

The key findings of the survey and analysis in 2019 were:

- Shallow areas have a hard, consolidated bottom with low organics with a low susceptibility to bio-dredging or mechanical dredging.
- Areas 12 foot deep or deeper contain substantial accumulations of soft organic sediments often 12 to 24 inches thick that are susceptible to bio-dredging but too deep for mechanical dredging. Therefore, mechanical dredging was not an effective option for Indian Lake.
- The lake is severely stratified and deoxygenated below 12 feet, meaning that over 50% of the water volume is anaerobic. The zone that is conducive to fish habitat is limited to about 12 feet deep.
- There are high levels of algae in the lake fueled by recycling of nutrients of bottom sediments covered by hypoxic water.
- The lake is "hypereutrophic" and this is a looming threat to the lake's ecology and by our assessment was at high risk of having cyanobacterial dominance occur resulting in toxic harmful algae blooms (CyanoHABs). This would severely constrain use for recreational purposes and negatively impact property values.

## The Remediation Program

Considering the 2019 survey findings, ILPOA asked Clean-Flo/SIS.BIO to address the problems. Clean-Flo/SIS.BIO designed a program that would provide the following benefits:

- De-stratification and oxygenation of the water column
- Sediment reduction and increase in the average depth and volume of the lake
- Reduction of algae and non-rooted aquatic weeds
- Mitigation of the current risk of toxic CyanoHABs
- A sustainable, healthy lake that will ensure the continuity of recreational activities on the lake and protect property values

The program to prevent cyanobacteria and remediate the lake incorporates

- Our proprietary RADOR dissolved oxygen restoration technology which was installed throughout the lake, in all the coves and in the marina

- Application of our proprietary enzyme formulation to actively digest and eliminate accumulated nutrient-rich organic sediments
- Application of our proprietary micronutrient formulation to promote competition with cyanobacteria and restoration of the food web necessary for nutrient clearance (instead of nutrient recycling)

## Timeline Leading Up to Commissioning the Program

In August 2020 Dave Shackleton visited the lake briefly while on a road trip and noted that there was an obvious *Microcystis* bloom (a strain of cyanobacteria that produces potentially lethal toxins) in Cove 7. ***This indicated that the lake's condition had clearly deteriorated since 2019.***

In about February 2021, a photograph of an algae bloom in the lake was sent to us, and identified by an expert phycologist to be *Dolichospermum*, another strain of cyanobacteria.

At our strong suggestion, from May through August 2021 samples were taken from the lake and sent for phycological analysis to provide us with baseline data on phytoplankton populations, information that is useful for us in developing the dosing regimen of biological products for the lake.

The 2021 data showed that cyanobacteria were dominant in the lake throughout the sampling period, on occasions making up over 90% of the phytoplankton population.

The phenomenon of cyanobacterial succession, whereby cyanobacteria establish their dominance early in the year (*Dolichospermum* in February) and then maintain it as different cyanobacterial species succeed each other as the year progresses through spring, summer and fall has been described in scientific literature. Indian Lake very clearly suffers from this phenomenon.

For this reason, it is important that remediation programs be maintained throughout the year, particularly in the initial stages. Unfortunately, that was not possible in 2021 for a number of reasons.

## Commissioning & Initial Stages

The RADOR system was installed and commissioned in October 2021. To allow baseline data collection by independent consultant Restorative Lake Sciences (RLS), biological dosing was not begun at that time. The RADOR system ran continuously until it was turned off in January 2022 to allow further baseline data collection in the spring.

After the spring data collection by RLS, the full remediation program began in April 2022. The RADOR system resumed operation, algae sampling began, and biological treatments commenced.

The algae samples taken in April and May showed that on average 98% of the phytoplankton was cyanobacteria, with many samples showing 100%.

This was a negative sign. The biological treatment program is designed to actively support competitors to cyanobacteria so that they can outcompete the cyanobacteria. They do so first

by breaking their dominance and then by driving them out of the aquatic ecosystem. When the situation has deteriorated such that only 2% of the population is not cyanobacteria, this becomes more difficult. Since the potential competitors have been all but wiped out, re-establishing their numbers takes more time. However, it is not impossible, and we have been successful in similar situations with even higher cell counts.

### Compromise of System Performance

The biggest single factor affecting system performance this year has been cutting of the airlines that supply compressed air to the diffusers. Between June and October, 17 airlines were cut and one diffuser was destroyed by a propeller strike, as summarized below:

1. On June 20<sup>th</sup> our service and maintenance team visited the site to perform their duties and discovered that three airlines had been cut by propellers north of the beach in water about 5 feet deep. These were repaired.
2. On July 20<sup>th</sup> another cut airline was repaired.
3. On August 26<sup>th</sup> our team repaired 11 cut airlines and replaced one RADOR diffuser that had been destroyed by a propeller.
4. At our final visit on October 11<sup>th</sup> another 3 cut airlines were repaired.

The negative effects of having cut airlines are obvious. Most of the air supplied by the compressor is forced through the cut airlines, and air supply to the RADOR diffusers in the entire system on which a line is cut is drastically diminished. This in turn diminishes the performance of the restoration system as a whole.

In our experience on other lakes, propeller strikes and cut airlines are very uncommon. It was confirmed that according to the rules of the lake, wake boats should not be operating in the area where the airlines were cut, and the Lake Committee were asked to ensure that these rules were brought to the attention of all lake users to prevent any further airlines being cut.

### Phytoplankton (Algae & Cyanobacteria)

Our algae sampling and analysis has shown that although we significantly reduced the overall levels of algae in the lake in late summer, the late start of the treatment program, and the fact that the RADOR system was frequently compromised by cut airlines, meant that results were not as good as we would have expected.

The decrease in the average total phytoplankton cell count is apparent from the data in Table 1, as is the effect of cutting airlines. ***Cut airlines limited oxygenation of the lower water strata, which allowed algae populations to bloom again and compromised the impact of the remediation program.***

Table 1. Average phytoplankton cell counts and percentage cyanobacteria May-October 2022			
Date	Average Total Phytoplankton Cell Count per ml of all samples	% Cyanobacteria	Comment
May 19 <sup>th</sup>	4,051,987	100%	
June 2 <sup>nd</sup>	586,327	98%	
June 16 <sup>th</sup>	8,417	81%	Gradual improvement
June 29 <sup>th</sup>	36,227	99%	3 Airlines cut
July 13 <sup>th</sup>	34,873	85%	
July 27 <sup>th</sup>	21,913	59%	Gradual improvement 1 Airline cut
August 8 <sup>th</sup>	9,780	81%	11 Airlines cut
August 23 <sup>rd</sup>	35,194	66%	
September 16 <sup>th</sup>	96,355	32%	
October 12 <sup>th</sup>	74,279	9%	3 Airlines cut

RLS takes Secchi disk readings at four sites on the lake as part of its data collection protocol. Secchi disk measures the opacity or clarity of the lake visually with a black and white disk which is lowered into the water until it cannot be seen. This depth is then recorded. A shallower depth means a lack of clarity in the water due to suspended matter, primarily phytoplankton cells. Greater depth shows improved clarity and a lower concentration of phytoplankton cells.

Clean-Flo takes Secchi readings at the same sites during our maintenance visits. Data from 2022 is presented in Table 2 below. ***The average Secchi depth approximately doubled as the summer progressed.***

Table 2. Secchi Depths May-August 2022					
Date	Site 1	Site 2	Site 3	Site 4	Average
May 24 <sup>th</sup>	12	33	27	18	23
Jun 21 <sup>st</sup>	24	26	26	26	27
Jul 18 <sup>th</sup>	21	42	44	48	39
Aug 22 <sup>nd</sup>	36	45	35	44	40

## Bio-Dredging

### Bathymetric Scans

Clean-Flo's contract includes annual sonar scans to evaluate changes in the bathymetry of the lake and the program's progress toward achieving reduction of organic nutrient-rich mucky sediments that drive eutrophication, algae blooms, and ultimately toxic cyanobacteria harmful algae blooms (HABs or CyanoHABs).

Comparing scans from year to year helps to understand changes in water body depth and the degree to which it responds to the bio-dredging program. This is first full scan of the lake since the remediation program started and results are compared to results from the scan conducted in 2019.

Scans are done with a Lowrance HDS7 with broadband sounder technology, built-in GPS antenna, and high-definition mapping. The data obtained is uploaded to Biobase GIS, a cloud-based mapping service, to produce contour maps and statistical data on maximum depth, average depth, volume, and vegetation.

The level of the surface of the lake is recorded with every scan. This level is input as an "offset" into the BioBase software so that it can normalize the annual data and allow for "apples-to-apples" comparisons.

The lake this year was 20 inches lower than when the scan was done in 2019. By inputting an offset of 20 inches, BioBase adds back the difference so that the two scans are comparable.

### Scan Results

The initial scan of Indian Lake took place on July 10, 2019. Data from this scan established baseline conditions against which data from subsequent scans during the project would be compared. In 2019, the lake had an average depth of 15.4 feet and maximum depth of 43.8 feet. The volume was 4,619 acre-feet (1.51B gallons, or 7,451,987 cubic yards).

In view of the large amount of biomass in the form of phytoplankton that was produced by the lake in 2020 and 2021, which adds to the bottom organic sediment as it dies and settles, the average depth had probably shrunk between 2019 and April 2022 when the remediation program began.

The 2022 scan took place on October 11. The lake currently has an average depth of 15.7 feet and maximum depth of 42.5 feet. The volume is 4,880 acre-feet (1.59B gallons, or 7,873,067 cubic yards).

***The changes between 2019 and 2022 reflect an increase in average depth of the whole lake of 0.3 feet (4 inches), a decrease of maximum depth of 1.3 feet (16 inches), and an increase in volume of 261 acre-feet (85M gallons or 421,080 cubic yards). The increase in water volume is due to the digestion of nutrient-rich organic sediment that fuels phytoplankton blooms, equivalent to the removal by dredging of 421,080 cubic yards. This quantity is equal to 28,000 tri-axle dump truck loads.***

Table 3 illustrates changes in the lake's depth and volume since 2019.

<b>Table 3. Depth and Volume Change in Indian Lake</b>			
<b>Category</b>	<b>2019</b>	<b>2022</b>	<b>Change</b>
Volume (ac-ft)	4619	4880	261
Volume (gal)	1,505,003,227	1,590,044,544	85,041,317
Volume (cubic yards)	7,451,987	7,873,067	421,080
Avg Depth (ft)	15.4	15.7	0.3
Max Depth (ft)	43.8	42.5	(1.3)

The decrease in maximum depth is likely due to sediment deposition since 2019 in a small area of the deepest part of the lake (in the northwest corner) because mucky organic sediment tends to accumulate in the deepest parts of a lake. Despite this, consistent increases in depth have been achieved on average throughout the lake, as evidenced by the 4-inch increase in average depth overall.

## Bathymetric Maps

Changes in depth may be seen visually by comparing maps generated with the sonar data. Because the lake is large, when you zoom out to obtain a view of the depth contours of the whole lake, the BioBase software reduces the resolution of the contours to 5-foot intervals (i.e., it shows 5-foot, 10-foot, 15-foot, 20-foot, etc. contours).

To examine the details more closely, one must zoom-in on the computer screen. Below we have presented comparative views of the whole lake and magnified three smaller sections (two at the north end of the lake and one in the beach area) to show what has been achieved in more detail.

Figure 1 shows side-by-side comparisons of maps of the entire lake in 2019 and 2022. The contour interval on these maps is five feet, thus the comparison is relatively coarse. Figures 2, 3, and 4 provide a more granular view of changes in the areas outlined with red boxes in Figure 1.

It is important to realize that the depths indicated in the 2022 maps do not reflect the lake's actual depth at the time of the scan. As explained in describing the offset, the depths instead indicate the depth that the water would be with the surface elevation equal to the surface elevation at the time of the original scan in 2019. ***Because there was little rain in the latter half of the summer this year, the water level when the 2022 scan was done was 20 inches lower than at the time of the 2019 scan.***

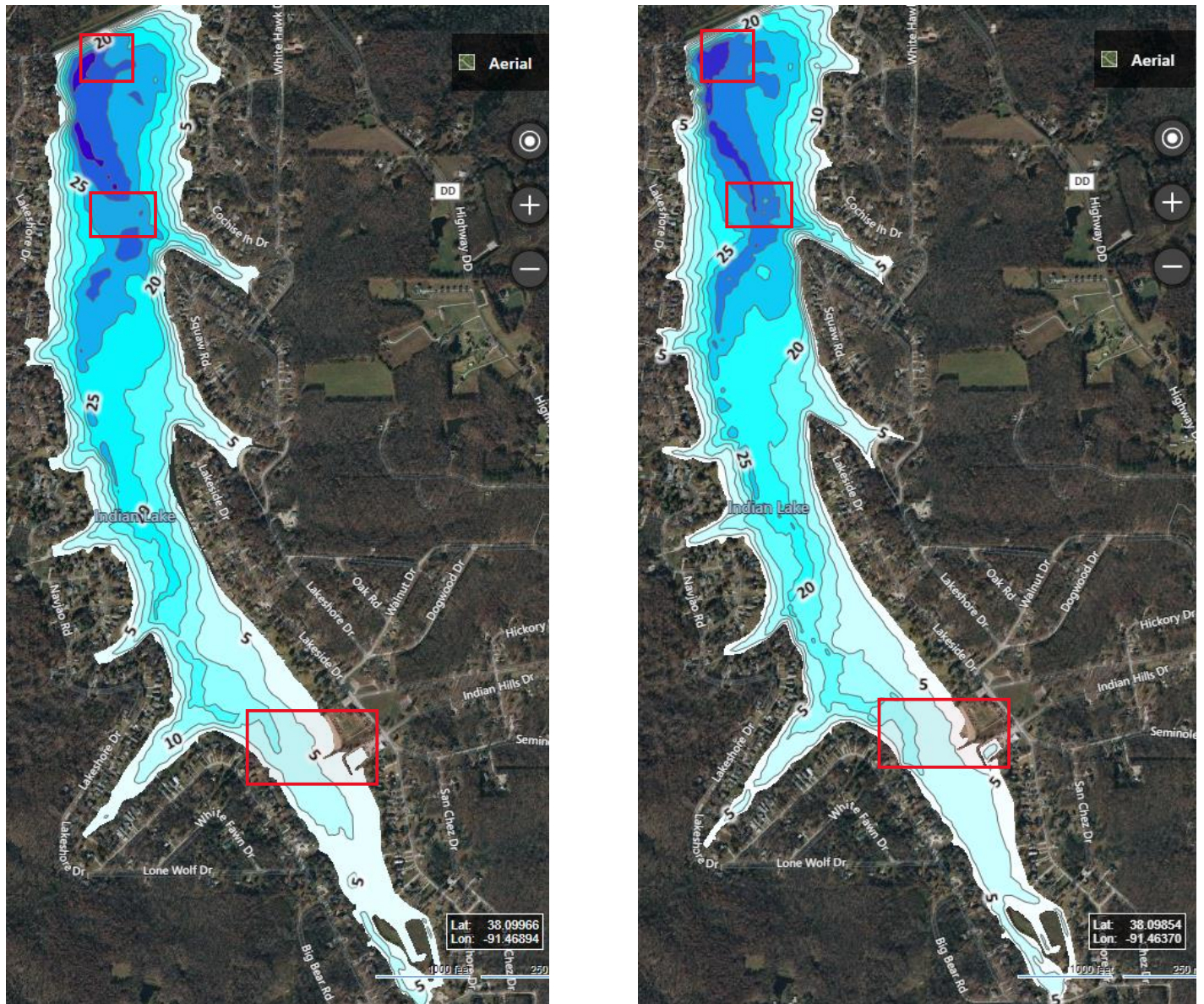
Because of the low water level, readers of this report may therefore observe that the contours on these maps – particularly in shallower areas – appear deeper than they would have perceived them to be in the lake this summer. This is because an offset adjustment of 20 inches has been added to make the two scans comparable.

It is very likely that additional sediment accumulation occurred between the original survey in 2019 and the start of the project. Although a complete scan was not performed in 2021, spot checking of depths suggested that this was in fact the case. The implication of this is that the quantity of sediment removed to achieve the gains in average depth and enlargement of

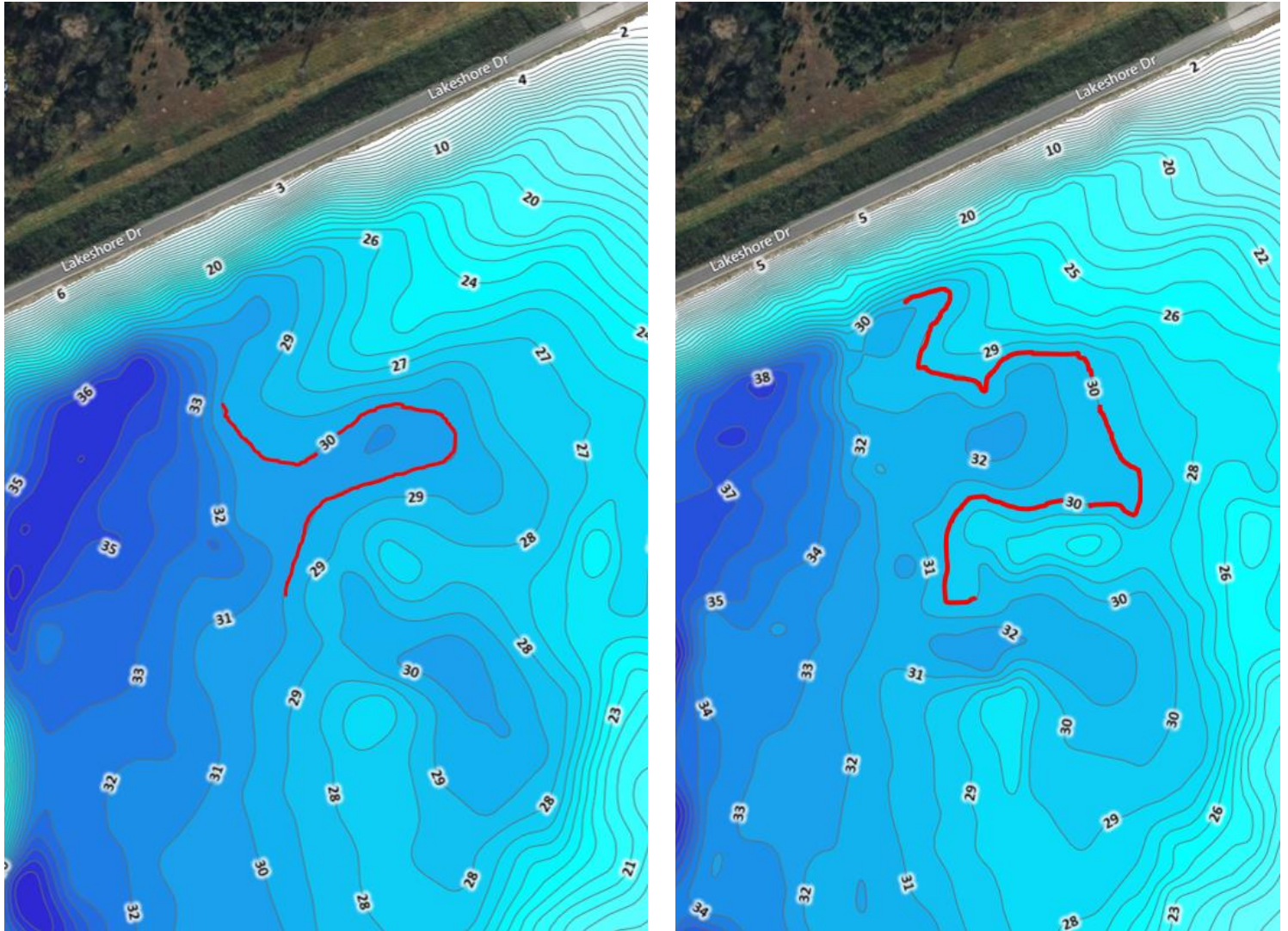
contours since 2019 is understated here, since the starting point had another two years of sediment accumulation added to it.

Annual scans in subsequent years will provide further year-over-year quantification of sediment reduction and increase in depth attained by Clean-Flo's remediation program.

***Finally, it is worth noting that the original proposal to physically dredge the lake stated that the objective was to remove 460,250 cubic yards of sediment. The BioBase bathymetric scans show that despite the setbacks of starting the remediation program late, and having suffered repeated cutting of airlines, 421,080 cubic yards of sediment have already been bio-dredged from the lake, when compared to 2019.***



**Figure 1.** 2019 (left) and 2022 (right) bathymetric maps of entire lake. Red boxes indicate areas of focus in the following figures.



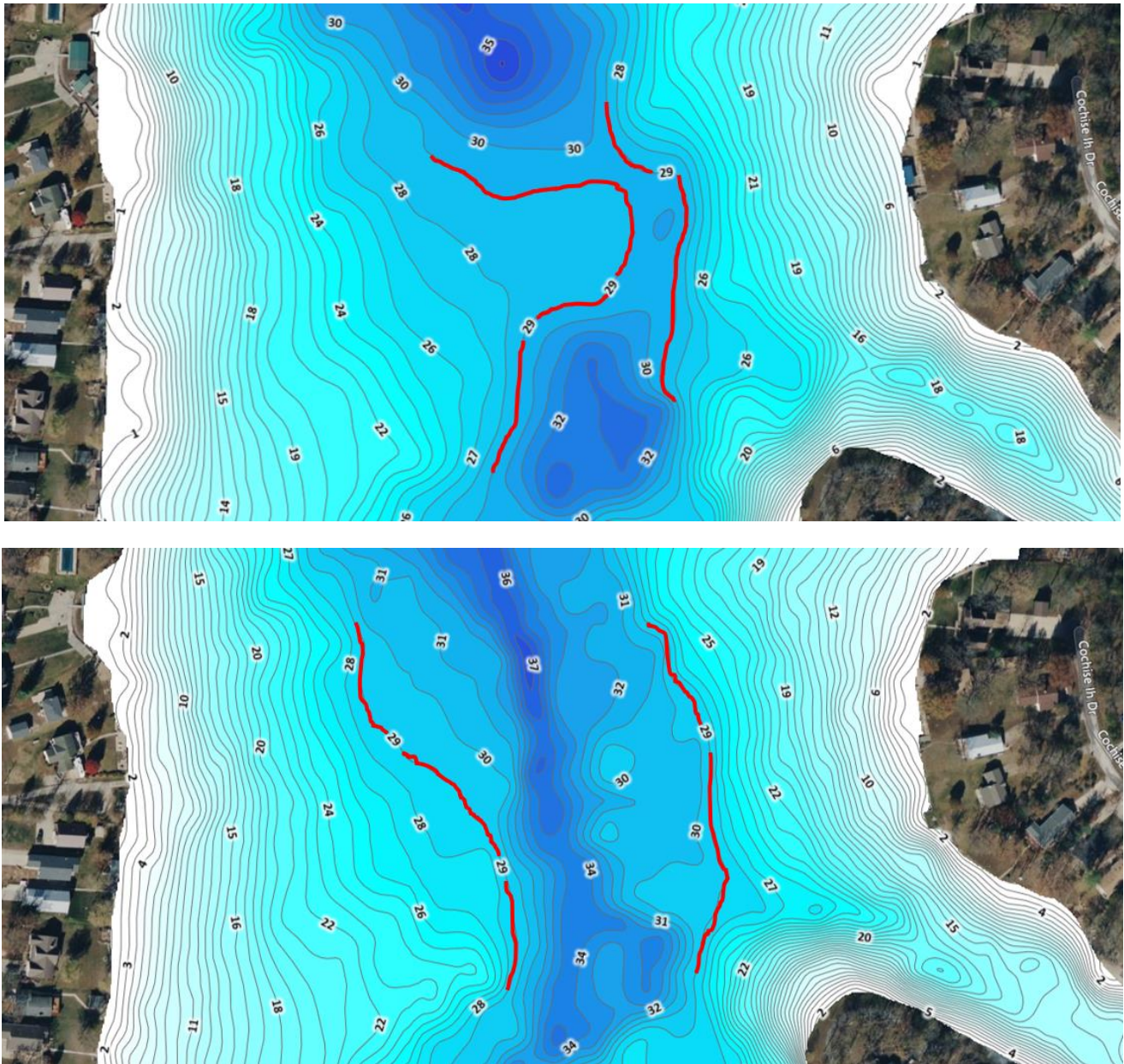
**Figure 2.** This is at the far north end of the lake, near the dam wall. 2019 (left) shows the 30-foot contour, with a small 31-foot contour inside of it. 2022 (right) shows enlargement of the 30-foot and 31-foot contours. Within the 31-foot contour there is now a 32 foot contour. Enlargements of other contours and the appearance of new, deeper contours can also be seen.

As stated in the initial report in 2019, below a depth of 12 feet our sampling showed up to 24 inches of organic rich sediment to be present. It is natural that more of this matter accumulates in deeper parts of the lake because there is a greater volume of suspended organic material that can settle out above the deepest parts, and because it is mucky and mobile, it can slowly flow and gravitate to deeper areas.

For this reason, the organic sediments at the deepest parts of the lake can build up to be many feet thick over time.

This has a number of possible consequences

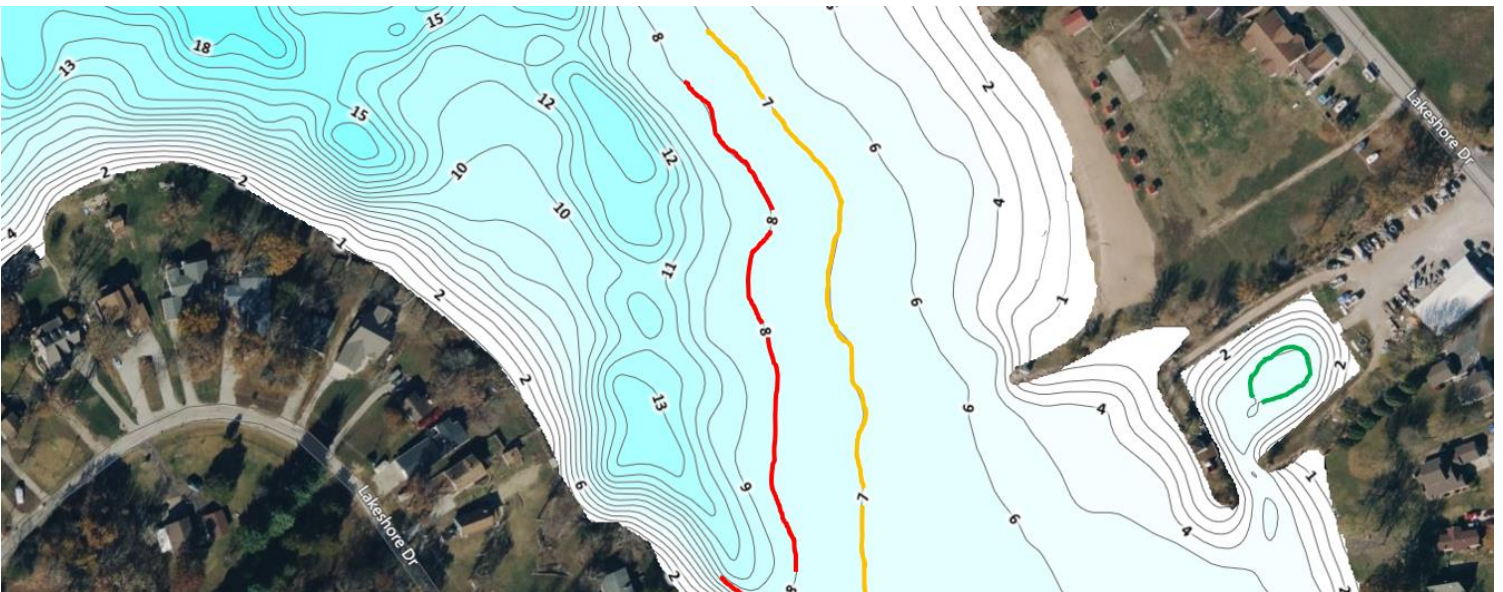
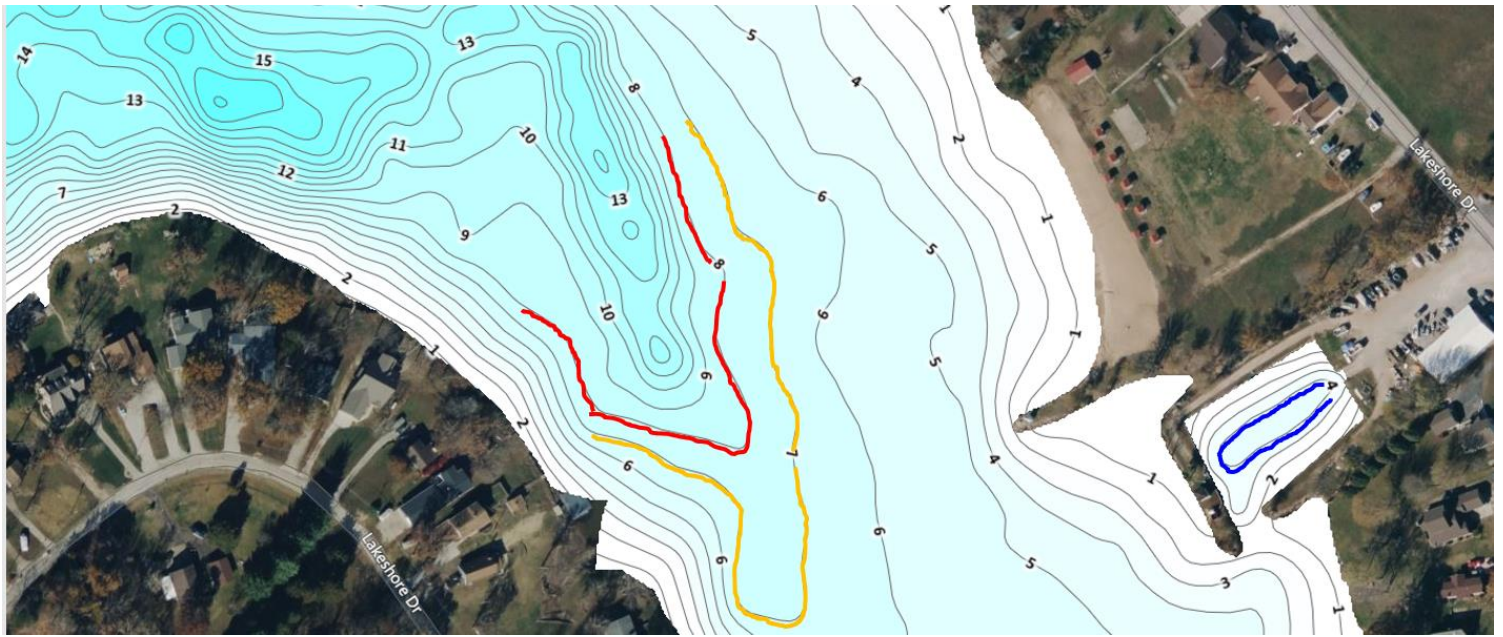
- The very deepest parts become shallower at a faster rate than shallow areas
- In some lakes we have seen over 20 feet of accumulated sediment
- Bio-dredging can continue to deliver results for many years as this organic material is gradually worked off.



**Figure 3.** 2019 (top) shows the 29-foot contours either side of the original course of the river opposite Cove 2. At the narrowest point, there is a small circular 30-foot contour, showing a small “hole” in the sediment there.

2022 (bottom) bathymetric maps shows how deepening of the lake has widened the gap between the 29 foot contours on either side of the lake and created much more depth as the sediment has been reduced here.

Close examination of the two charts above shows that in this section there are parts of the lake in the deepest center channel that have increased in depth by 3 or 4 feet. Although inaccessible to conventional suction dredging, biodredging can deliver results at such depth, and potentially do so for several years to come.



**Figure 4.** 2019 (top). The 8-foot contour is shown in red and the 7-foot contour is shown in orange. 2022 (bottom) shows how these contours have shifted into the lake as it has deepened. For the marina area the blue line (top) shows the 4-foot contour, whereas the green line (bottom) shows a new 6-foot contour.

These shallower areas accumulate less muck, and what does accumulate is readily mobilized by stormwater inflows and the action of wake boats, allowing it to gradually migrate to deeper waters. We would not expect to see as dramatic improvements here as in deeper sections shown above, and the rate of sediment digestion is likely to reduce faster here than in deeper parts.

## Vegetative Biovolume

As described in the 2019 survey results, aquatic vegetation in Indian Lake is not excessive, and therefore mapping of the vegetation does not provide useful insight into its concentration or geographical location. However, sonar data collected in this year's scan do reveal a statistical decline in area coverage and concentration and are worth noting. Table 4 illustrates the statistical results. PAC is defined as the percentage of the lake's area occupied by vegetation. BVw is defined as the average volume of the water column occupied by vegetation. Avg BVp indicates how concentrated vegetation is in those areas where it is present. You can see that by these metrics, Indian Lake has improved since the beginning of the project.

Table 4. Vegetation Changes in Indian Lake 2022			
Category	2019	2022	Change
PAC - Percent Area Covered	4.8%	1.5%	-3.3%
BVw - Average Biovolume Concentration overall	0.4%	0.1%	-0.3%
BVp - Average Biovolume where Vegetation Present	8.0%	7.5%	-0.5%

## Conclusions

*The late commencement date of the remediation program and the repeated cutting of airlines, at an average cost of \$2,000.00 per cut airline, have without doubt compromised the performance and achievements of the program this year. Despite these challenges, there have been many quantifiable improvements in the lake's physical and ecological qualities.*

*To summarize:*

- 1. The total phytoplankton cell count on average was reduced throughout the summer, but there was no statistical consistency because the repeated cutting of airlines allowed the situation to repeatedly regress.*
- 2. The proportion of total phytoplankton consisting of HABs cells was steadily reduced but the repeated disruptions caused by the cutting of airlines makes objective quantitative assessment of this difficult.*
- 3. Increasing Secchi depth showed steadily improving water clarity and confirms the reduction of phytoplankton.*
- 4. Bio-dredging deepened the entire lake by an average of four inches. Many specific areas – particularly in deeper water – saw more substantial increases in depth, by 36 inches or more.*
- 5. Deepening of the lake resulted from the digestion of 421,080 cubic yards of organic sediment, which in turn increased the volume of the lake by 85M gallons.*
- 6. The area covered by and concentration of vegetation in the lake was reduced.*

*The statistical and sampling data presented in this report show the measurable changes to the lake. Apart from the data, residents have told us how great the visual and aesthetic improvements to the lake have been. We have heard many anecdotal reports describing the lake's improved quality, including scud hatches, hellgrammite hatches, increasing resident wood duck populations, and most recently, visiting pelicans. These are macro-indications of a damaged ecosystem that is returning to life.*