KIESER & ASSOCIATES
ENVIRONMENTAL SCIENCE & ENGINEERING

Technical Memorandum

To:	Lauren Koloski, Environmental Supervisor Washtenaw County Water Resources Commissioner's Office	**Date:**	December 30, 2022
From:	Zach Harrison, Project Scientist Mike Foster, Environmental Engineer Mark Kieser, Senior Scientist Kieser & Associates, LLC	**cc:**	Project Files
RE:	North Lake 2022 Phoslock Pilot Study Results		

Contents

1. Introduction

Phoslock® is a lanthanum modified bentonite clay product that works to bind water column and sediment phosphorus to limit available phosphorus for plant and algal growth. The use of Phoslock was proposed by Kieser & Associates, LLC (K&A) as a means to potentially lower the amount of available spring-time phosphorus levels in select shallow areas of North Lake to mitigate what have been recurrent nuisance, filamentous benthic green algal blooms. K&A conducted a 2022 pilot study to apply Phoslock to an area at the westernmost end of the lake to

analyze such impacts. Phoslock was applied to a pre-determined area following ice-out conditions by the North Lake herbicide contractor. K&A sampling events were implemented to analyze total phosphorus in the sediments and water quality before, during, and after Phoslock applications at the treatment location, as well as at two control (non-Phoslock treated) areas (pre-treatment sampling only) to objectively determine treatment effectiveness. Sampling was supplemented with K&A visual observations throughout the spring and summer periods. Phoslock application in shallow areas for benthic algal control is considered experimental at this time.

2. Methods

The pilot study discussed herein included one treatment area (Site 1; 5 acres – see Figure 1) that received a one-time treatment in early April of 2022, and two control areas (S2; 1-acre and S3; 1-acre). Water quality monitoring was conducted at the treatment site before, during, and after treatment with control areas being monitored only prior to treatment. GPS coordinates, maximum depths and the field and laboratory water quality parameters assessed during each 2022 Phoslock sampling event are compiled in Table 1.

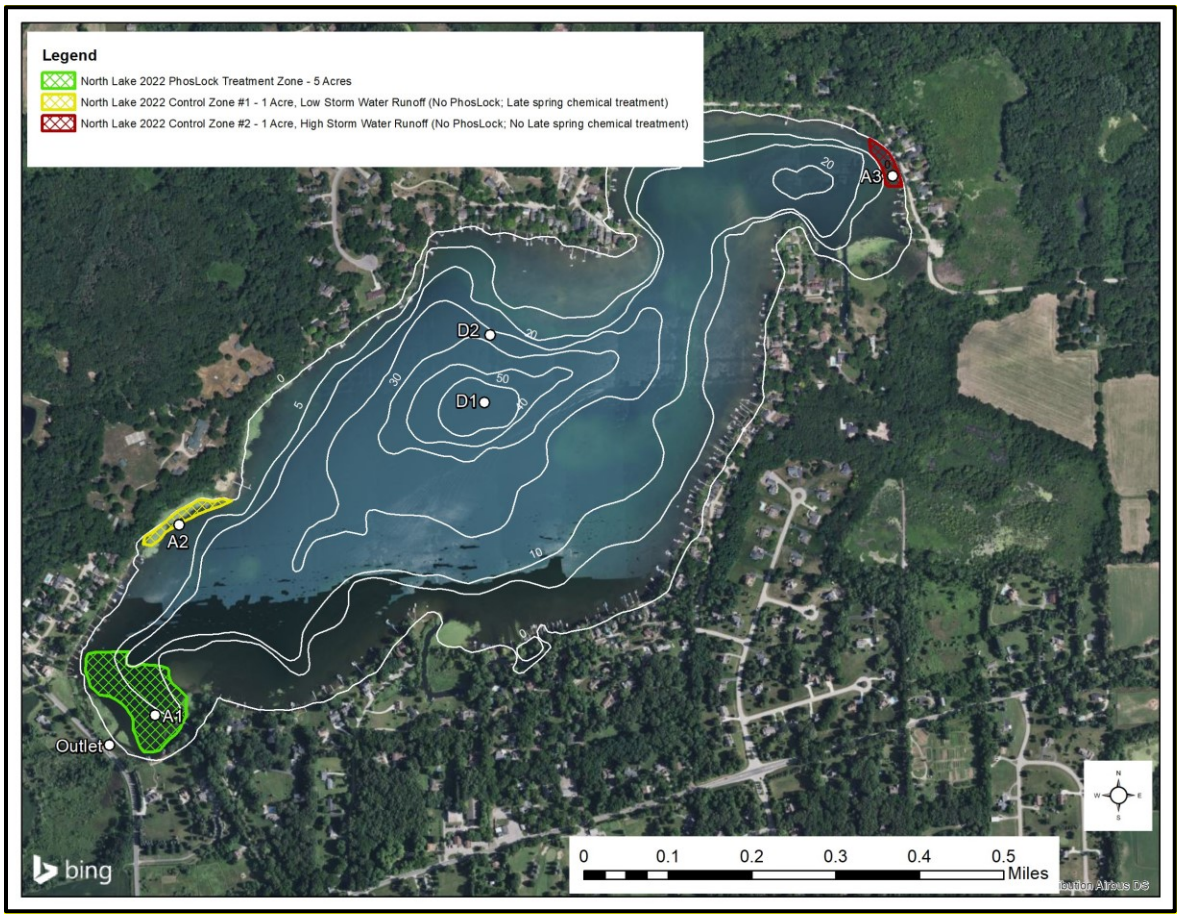


Figure 1 – North Lake Phoslock pilot study treatment area (A1, or Site 1) and control areas (A2-Site 2 and A3-Site 3). (Mid-lake stations D1 and D2 are also shown here that were examined in the parallel phosphorus mass balance study in 2022).

Table 1 – North Lake Phoslock sampling site locations, depths, and field and laboratory analytical parameters.

Site ID	GPS Coordinates	Max Depth (ft)	Field Parameters	Lab Parameters
S1 (Treatment)	42.38887, -84.015174	6.9	Temperature, Dissolved Oxygen, Specific Conductance, pH, Secchi Disk Depth	Total Phosphorus, Soluble Reactive Phosphorus, Total Suspended Solids, Total Alkalinity, Chlorophyll *a*, Total Lanthanum (Site 1 only), Sediment Phosphorus/Iron, Algae Taxonomy Count (1 sample)
S2 (Control)	42.39159, -84.014393	7.1		
S3 (Control)	42.39753, -83.997603	10.2		

Field parameters of temperature, dissolved oxygen (DO), specific conductance (conductivity), pH, and Secchi disk transparency were measured *in situ* at Sites 1-3 by K&A staff on April 1, 2022 prior to Phoslock application. Conductivity was measured using a YSI Pro30 conductivity meter. In this study, conductivity is reported as specific conductance, the temperature-compensated conductivity measurement reported by the YSI meter. For measuring pH, K&A field staff used an Oakton pH Tester 30 probe, calibrated using appropriate standard solutions prior to use. Immediately following Phoslock application on April 5, 2022, these same field parameters were collected again at Site 1. A late-season sampling event was conducted on July 29, 2022 at Site 1. During each sampling event, DO, temperature, and conductivity profiles were measured from the surface to just above the lake bottom, then rested in the lake substrate of each sampling site. pH was measured at the middle depth of each sampling site during each event. Secchi disk transparency was measured from the surface of each sampling station location.

Samples for laboratory analysis were collected from the mid-depths at Sites 1-3 prior to Phoslock application and were analyzed for total phosphorus (TP), soluble reactive phosphorus (SRP), total suspended solids (TSS), and total alkalinity. Additional samples were taken at Site 1 immediately following treatment (4/5/2022) and during the late summer (7/29/2022). Chlorophyll *a* samples were collected using a depth-integrated composite sampler lowered to depths of two-times the measured Secchi disk depth, or from the lake bottom where applicable, at each sampling site per EGLE sampling protocol. Total lanthanum content was measured at Site 1 immediately following Phoslock application and later during the July sampling event. Lake sediment samples were collected prior to Phoslock application and analyzed for sediment iron and total phosphorus concentrations at Sites 1-3 with additional samples collected at Site 1 immediately following treatment and then again during the late-summer.

Laboratory analysis of total alkalinity was conducted at Merit Laboratories, Inc. of Lansing, Michigan. Chlorophyll *a* analysis was conducted by Great Lakes Environmental Center of Traverse City, MI. Total lanthanum analysis was performed by Conti Testing Laboratories of Bethel Park, PA., and the taxonomic algal assessment was performed by LimnoPro of St. Cloud,

MN. The full dataset is presented with compiled historic data as well as copies of the analytical laboratory reports as an attachment to this memorandum.

The following sections describe the findings and implications of these data for North Lake. A discussion on the relevance of each water quality parameter examined in this study precedes each parameter discussion in order to illustrate the value of these measures with respect to water quality characterization.

3. Water Quality Monitoring Results

Phoslock monitoring water quality data are summarized in Table 2. Corresponding laboratory reports are included in the Attachment to this memorandum (including a comprehensive data table of all 2022 Phoslock pilot results.)

Table 2 – Summary of water quality results from 2022 Phoslock sampling activities on North Lake.

Date	Site ID	Secchi Depth	Collection Depth	Temp	D.O.	Conductivity	pH	TP	SRP	Chlorophyll *a*	Total Lanthanum
		(ft)	*(ft)*	*(°C)*	*(mg/L)*	*(umhos/cm)*	*(SU)*	*(mg/L)*	*(mg/L)*	*(ug/L)*	*(µg/L)*
4/1/2022 (pre-treatment)	1	5.8	4	5.8	11.94	242.5	7.83	0.0129	<0.00213	0.00205	-
			5.8	6	5.95	255.7	-	-	-	-	-
	2	5.5	5	5.9	11.95	243.3	7.95	0.0109	<0.00213	0.00673	-
			5.1	6.2	10.88	253.5	-	-	-	-	-
	3	5.7	4	5.6	11.90	238.2	8.13	0.0052	<0.00213	0.00815	-
			6.4	5.6	11.81	241.0	-	-	-	-	-
4/5/2022 (post-treatment)	1	5.8	5	6.2	11.6	248.3	8.43	0.0041	<0.00213	0.01183	10.98
7/29/2022	1	6.7	3	25.7	8.1	337.7	8.1	0.0313	0.0023	0.00158	<0.10

3.1. Total Phosphorus (TP) and Soluble Reactive Phosphorus (SRP)

Prior to Phoslock application, TP concentrations were highest at Site 1 (0.129mg/L). Immediately following Phoslock application, the phosphorus concentration in the water column at Site 1 fell to 0.004 mg/L. By the July 29 sampling event, TP had increased to 0.031 mg/L at Site 1. Soluble reactive phosphorus (SRP) was below detection limits (<0.002 mg/L) prior to Phoslock treatment at all monitoring sites. Following application, Site 1 SRP remained below the detection limit and was only detected during the late-summer sampling event at 0.0023 mg/L.

These are very low level detection limits, and thus, very low SRP levels in the water column. Total phosphorus water quality data collected from the Phoslock-related sampling events are illustrated in Figure 2.

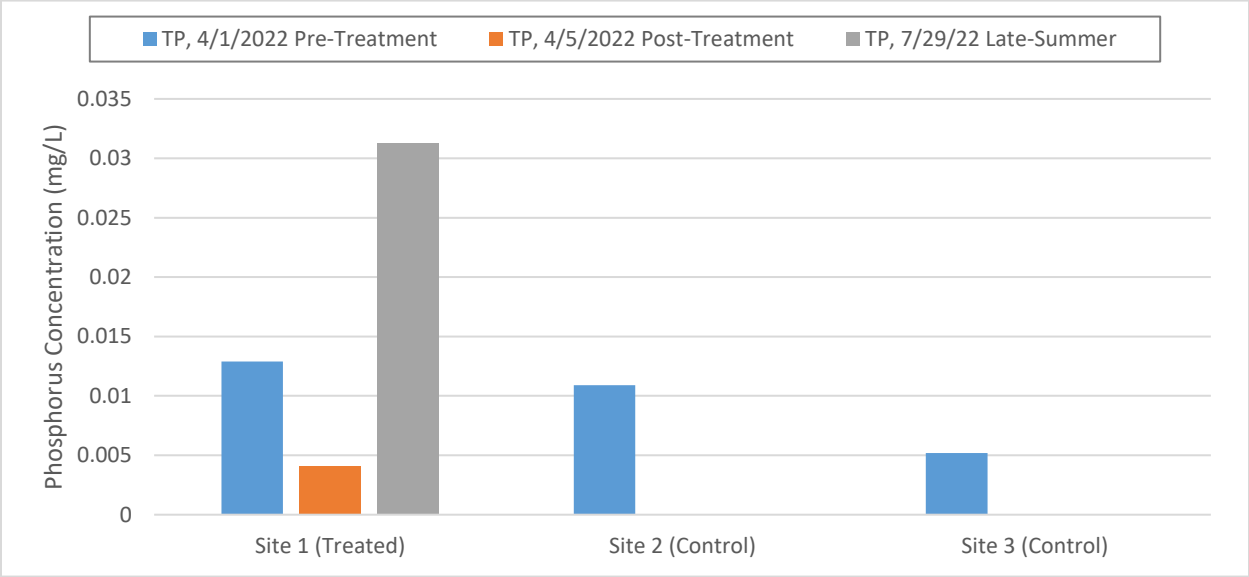


Figure 2 – Total Phosphorus data collected prior to and following Phoslock application.

3.2. Secchi Disk Transparency

Secchi disk transparency is the depth at which a Secchi disk (a flat white or black and white platter, approximately 8 inches in diameter) suspended into a lake disappears from the investigator's sight. In general, the greater depth at which the Secchi disk can be viewed, the lower the productivity of the water body.

Secchi disk depths measured during the 2022 sampling events were generally consistent across all sites and sampling events. Prior to Phoslock application, visibility reached to the lake bottom at Sites 1 and 2. Site 3 Secchi depth was 5.7 ft, nearly reaching the lake bottom at 6.4 ft. These depths confirm ample light for benthic algal growth is present in springtime conditions.

Measured Secchi disk depths following Phoslock treatment and during the late-summer sampling event also reached the lake bottom in the treatment and control areas. Given the shallow bathymetry present at Site 1, the extent of improvements in water clarity following Phoslock application is uncertain. Figure 3 illustrates Secchi disk transparency data for the 2022 monitoring events.

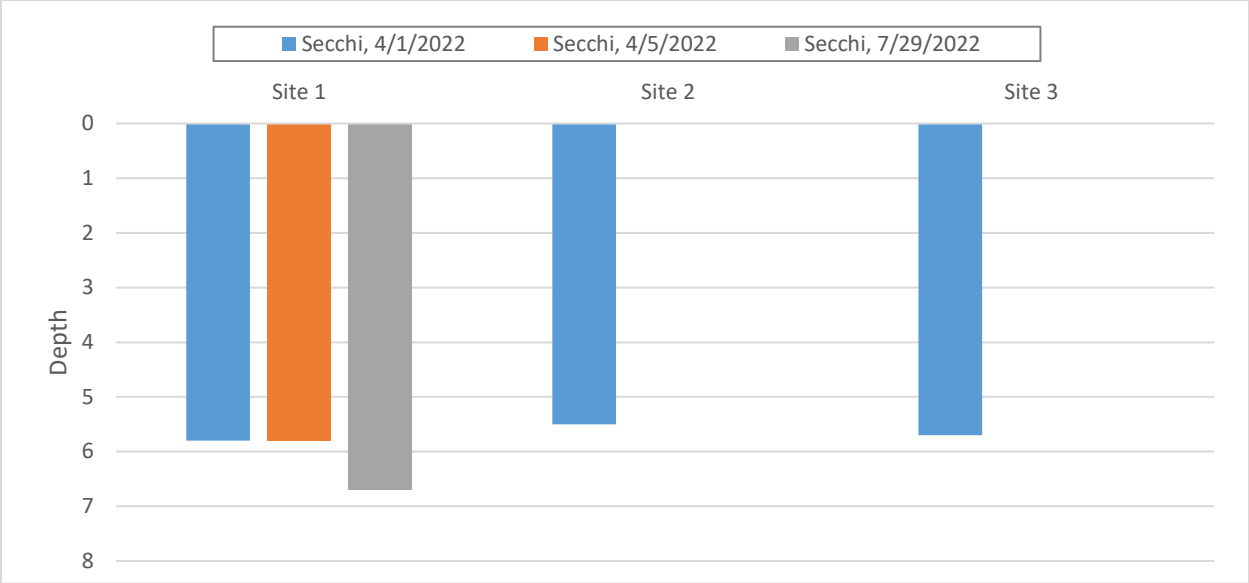


Figure 3.– North Lake Phoslock water quality data for Phoslock monitoring sites.

3.3. Chlorophyll *a* and Filamentous Algal Bloom Observations

Chlorophyll *a* is a measure of the active green pigment in algae suspended in the water column that allows them to photosynthesize. Chlorophyll *a* monitoring is a way to indirectly measure the amount of algae or phytoplankton in surface waters. Such suspended algae depend on soluble phosphorus for growth, which can be stimulated by excess nutrients (typically phosphorus) in the water column. While some algae are necessary and desirable for a healthy lake ecosystem, nuisance algal blooms can create conditions that inhibit recreation and aesthetics. Blue-green algae (cyanobacteria) can create potentially harmful conditions for humans and pets. Chlorophyll *a* levels of less than 2.2 µg/L are representative of lakes with oligotrophic (low productivity) conditions in Michigan.[1]

Chlorophyll *a* measured before Phoslock application at Site 1 was indicative of low production conditions at 2.0 µg/L, while Sites 2 and 3 had higher Chlorophyll *a* values. Immediately following Phoslock application, the concentration of Chlorophyll *a* increased to nearly 12 µg/L. An increase in productivity despite Phoslock binding water column phosphorus suggests other factors also strongly influence productivity in North Lake. One explanation may be the approximately 15°F increase in daily average temperature at Site 1 between the pre-treatment and post-treatment sampling events, as warm temperatures and sunlight promote higher productivity. By the late-summer sampling event, Chlorophyll *a* had fallen below the pre-treatment baseline to 1.58 µg/L. Chlorophyll *a* data for 2022 North Lake sampling events and stations are illustrated in Figure 4.

[1] US Geological Survey. (2012). "Water Quality Characteristics of Michigan's Inland Lakes, 2001-10." *Scientific Investigations Report* 2011–5233.

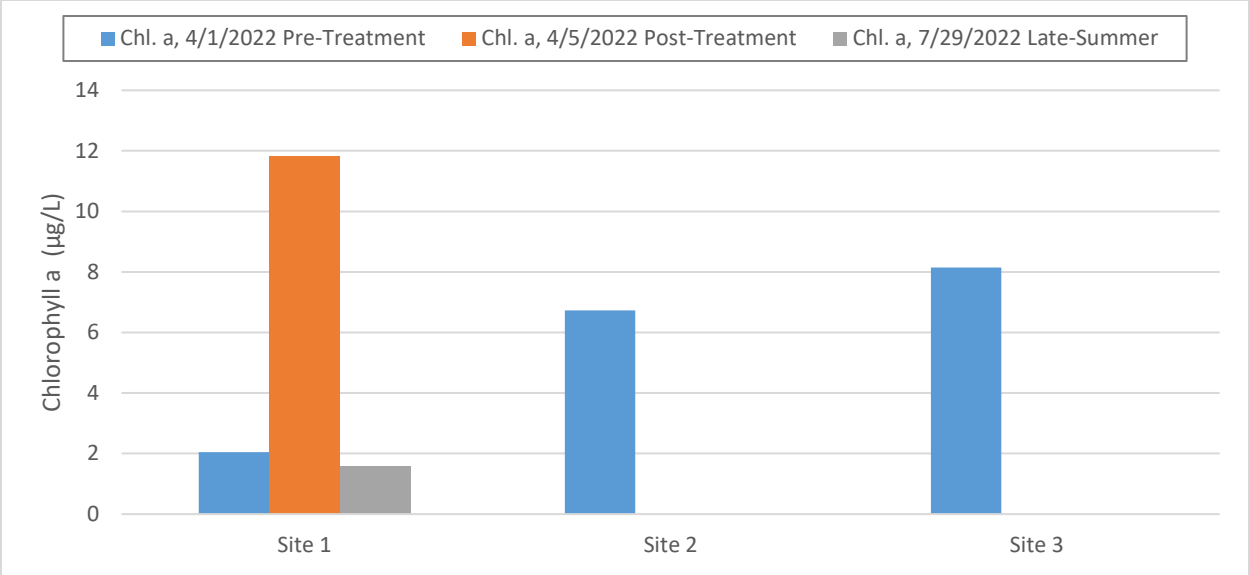


Figure 4 – North Lake 2022 Chlorophyll a concentrations measured prior to and following Phoslock application.

It is uncertain whether the post-treatment spike in suspended algae was a ubiquitous condition at both treatment and control sites as the scope only had post-treatment Chlorophyll *a* sampling for treatment Site 1. Pre-treatment measurements show Chlorophyll *a* at levels three to four times higher at control sites than at the treatment site suggesting suspended algal growth was substantially higher following ice-out conditions at other nearshore locations in North Lake.

Notably, no filamentous benthic algal production was observed across bottom areas of the three pilot locations at the time of pre-treatment sampling. This suggested that the early April treatment site application was appropriately timed; i.e., before there might be benthic algal productivity. Besides Phoslock, the pilot treatment area received no other chemical treatments in 2022; control areas also received no treatments. No nuisance algal blooms were otherwise noted anywhere on the lake until early June, and these were largely confined to a canal area (AROS 621 and 622) along the southern shoreline of the lake.

As no benthic filamentous algae were noted in 2022 at the 5-acre treatment or control areas in the spring (or even throughout the growing season), no algal composition samples were collected from these sites. This despite multiple nearshore locations with filamentous algal blooms causing recreational nuisance conditions observed in the spring and early summer of 2020 and 2021, especially the treatment area. The limited 2022 filamentous algal blooms observed in 2022 did not cause nuisance conditions except as noted above in a canal.

During a June visit, K&A did observe benthic filamentous algal growth near the lake outlet, outside of the Site 1 Phoslock treatment area. A sample was collected of the observed benthic algae here, with this composite sample being comprised primarily of *Cladophora sp.,* an attached green macroalgae commonly observed in the spring and early summer when there is ample sunlight (i.e., no other plant competition), cool water temperatures and dissolved phosphorus available in the water column (even very low phosphorus levels can trigger its growth). *Cladophora* often proliferates to nuisance levels in nearshore zones of inland lakes,

even the Great Lakes, at low SRP concentrations following ice-off conditions. As water temperatures warm, *Cladophora* dies off and biomass sloughs off of the lake bottom creating decaying mats of rotting algae floating at the water's surface. In total, 24 genera were identified within the 2022 algal sample. Four of the genera were identified as blue-green algal species (*Coelosphaerium sp., Merimopedia sp. Oscillatoria sp., and Microcystis sp.*), which were 8.7% of the total.

3.4. Dissolved Oxygen and Temperature

A sufficient supply of dissolved oxygen (DO) in lake water is necessary for most forms of desirable aquatic life. Colder waters contain more dissolved oxygen than warmer waters. Increased algal and plant growth associated with additional nutrients in the lake can lead to supersaturated oxygen conditions in shallow surface waters associated with increased photosynthesis.

DO depletion is the most common dissolved oxygen problem in productive lakes, primarily observed in bottom waters during periods of temperature stratification in warmer summer months in deeper lakes, and to a lesser degree under winter ice cover conditions. This is common in most Michigan lakes that thermally stratify in the summer and winter. Low DO levels in bottom waters can lead to increased release and recirculation of accumulated phosphorus from sediments thus serving as an "internal" source of TP that can contribute to poor water quality conditions. Michigan water quality standards for rivers and lakes designated for warm water fish and aquatic life are 5 mg/L[2].

Prior to the 2022 Phoslock pilot application on North Lake, the temperature at each pilot site was uniform throughout the water column at about 6°C. Dissolved oxygen was also mixed at all sampling Sites, but did fall to below 6 mg/L just above the sediment surface at Site 1. This suggests the presence of organic sediments where bacterial respiration associated with active decomposition is consuming oxygen at the sediment-water interface. DO/temperature profiles were not measured during the post-treatment event, but one reading measured at Site 1, 5 ft below the water's surface suggested the Phoslock application had no impact on DO.

By the July 29 sampling event, temperature and DO were still mixed throughout the water column at Site 1. Dissolved oxygen was measured at 2.45 mg/L just above the sediment surface during this sampling event. The shallow lake bathymetry at Site 1 promotes even heating of the water column and limits the degree of thermal and DO stratification throughout the warm summer months. No supersaturated oxygen conditions were noted at these sites which would suggest elevated phosphorus levels causing luxuriant plant or algae growth. Temperature and DO profiles for the pre-treatment sampling event and late-summer event are illustrated in Figures 5-8.

[2] Michigan Department of Environmental Quality. (2006). "Part 4-Water Quality Standards." *Water Bureau, Water Resources Protection*.

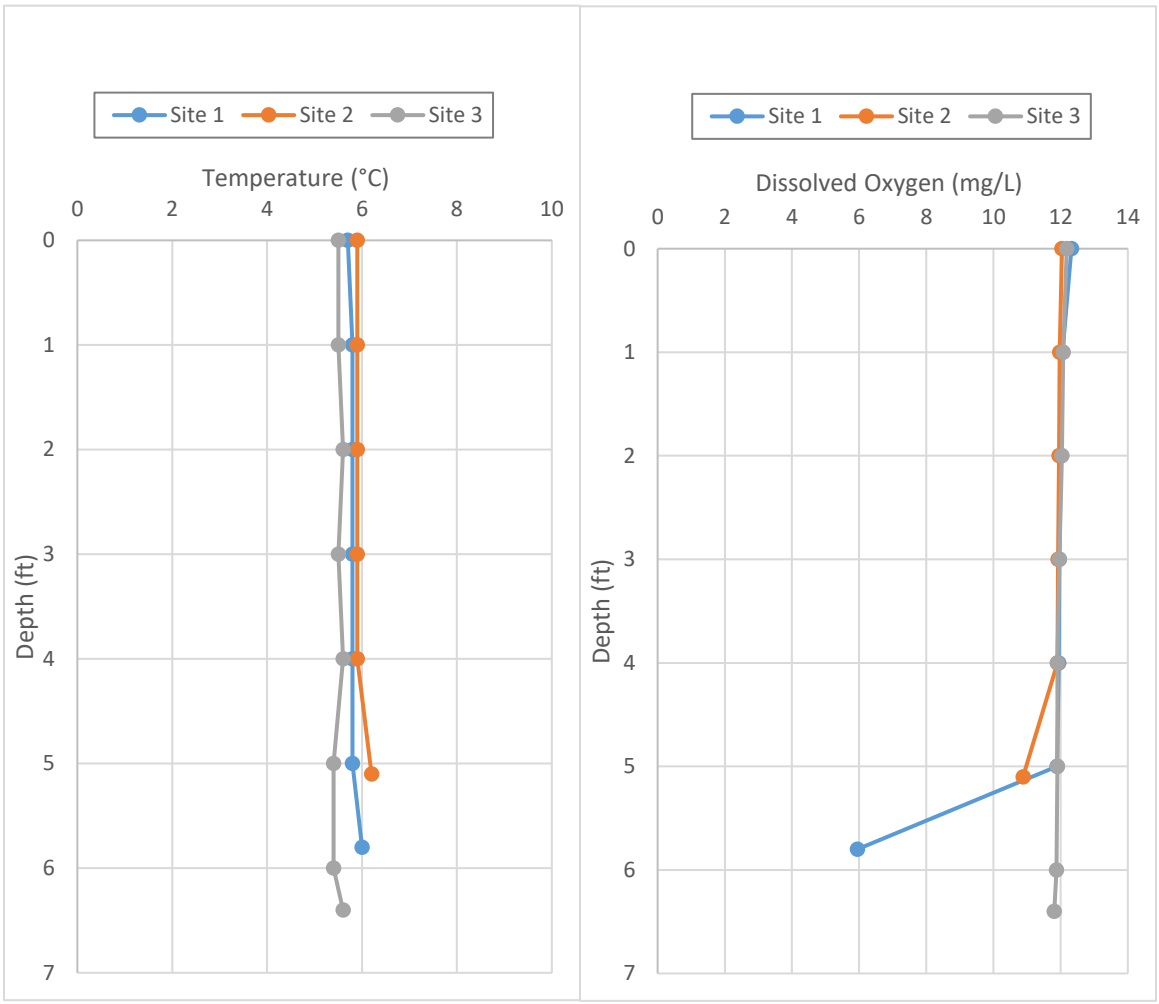


Figure 5 – (left): North Lake, April 1, 2022, all sampling sites: Temperature profiles.
Figure 6 – (right): North Lake, April 1, 2022, all sampling sites: DO profiles.

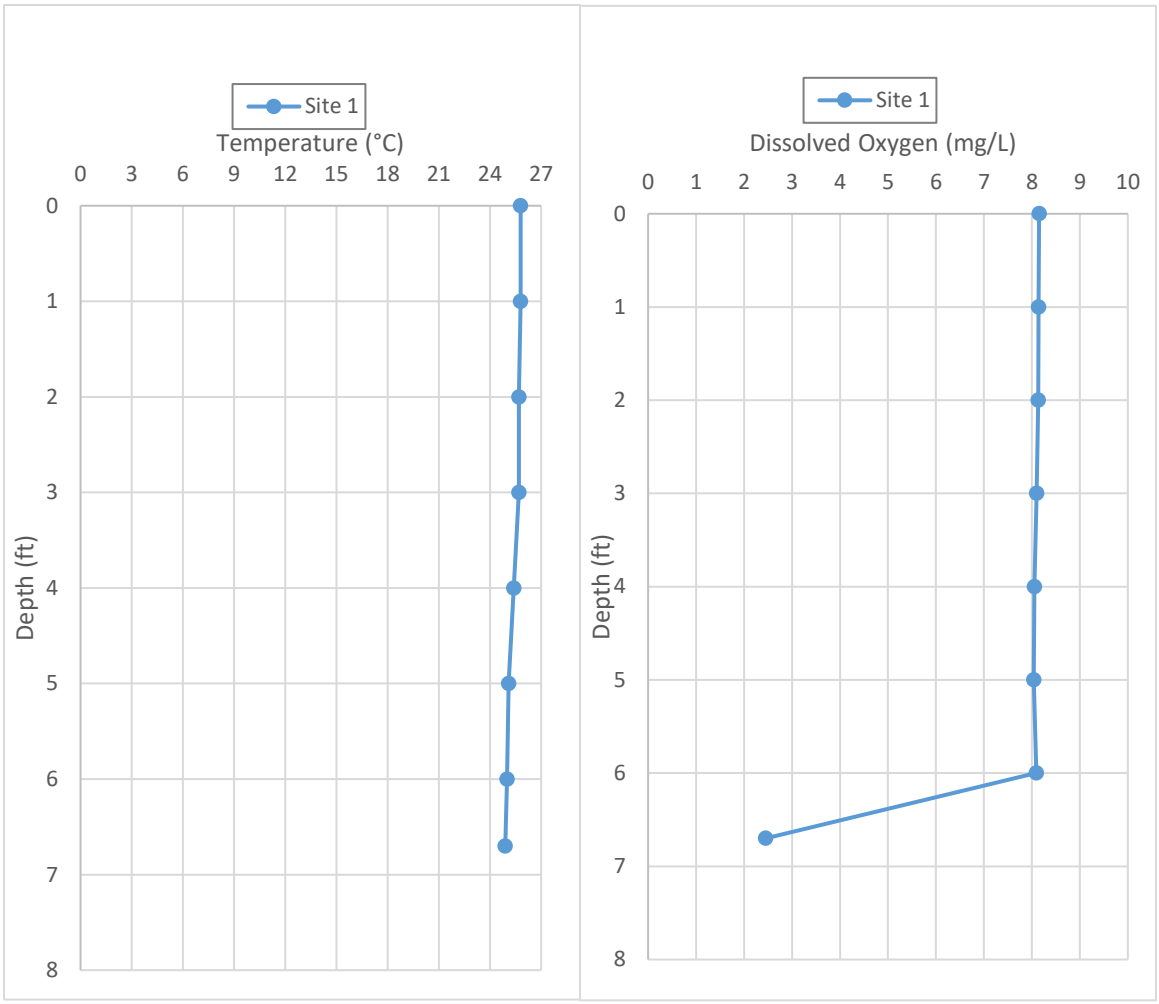


Figure 7 (left) – North Lake, July 29, 2022, Site 1 temperature profile.
Figure 8 (right) – North Lake, July 29, 2022, Site 1 D.O. profile.

3.5. Conductivity

Conductivity, or specific conductance, is the measure of the flow of electrons through water. This value relates to the total dissolved ion level, which essentially is a measure of dissolved salts present in a solution. Conductivity can serve as an indicator of chemical presence, septic system or road salt inputs with higher conductivity indicating the presence of dissolved materials. Studies of inland freshwaters indicate that water bodies supporting healthy fish communities have a range between 150 and 500 µmhos/cm[3].

Conductivity profiles measured during the pre-treatment sampling event were generally uniform throughout the water column between 220 µmhos/cm and 260 µmhos/cm. A grab

[3] US Environmental Protection Agency. (2015). "Water: Monitoring and Assessment, 5.9 Conductivity." http://water.epa.gov/type/rsl/monitoring/vms59.cfm

sample at Site 1 following Phoslock application revealed a conductivity of 248.3 µmhos/cm, suggesting the treatment had no immediate impact on conductivity. Late-season conductivity measurements at Site 1 had increased by approximately 100 µmhos/cm relative to pre-treatment values but were still within the range of acceptable conditions (150-500 µmhos/cm). Conductivity water column profiles were monitored during each sampling event and are illustrated in Figures 9 and 10.

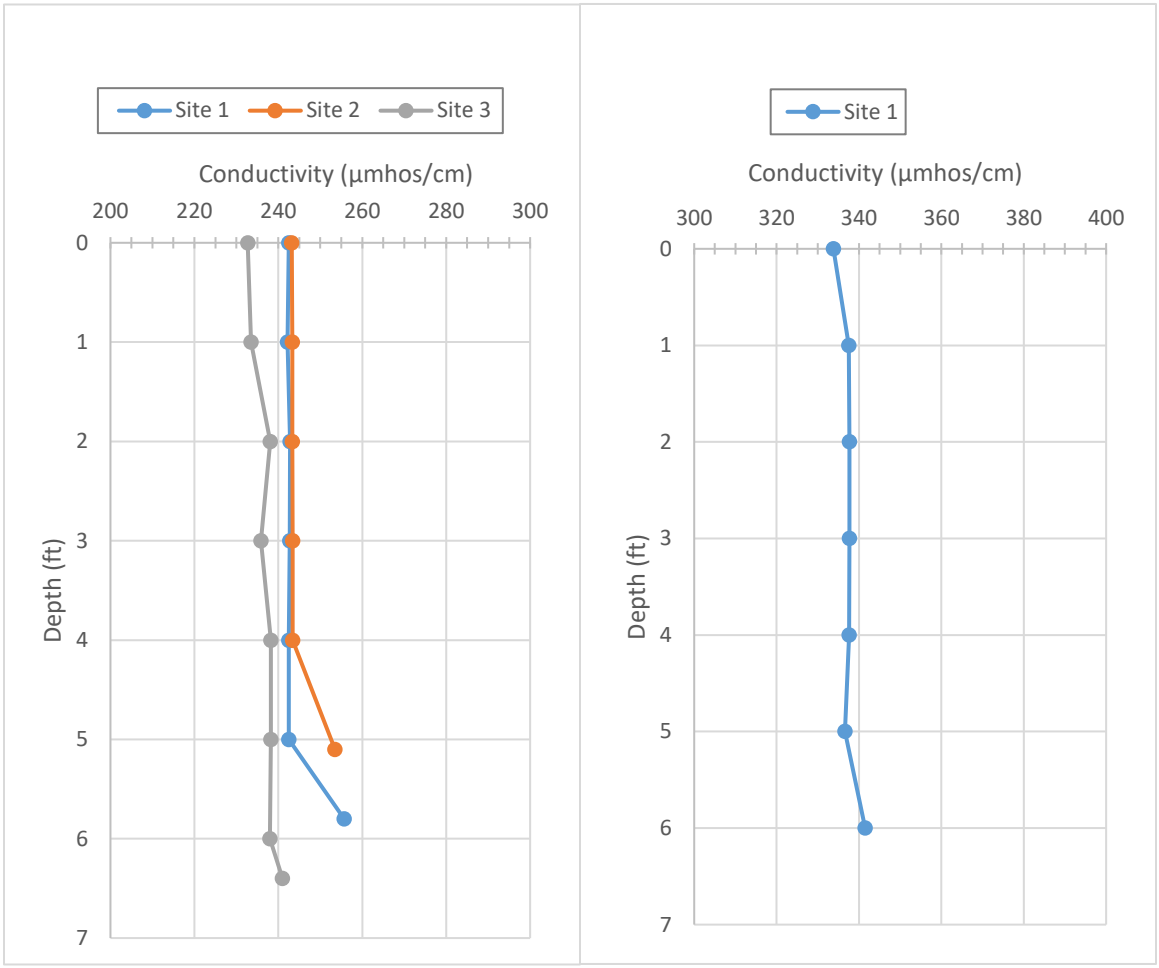


Figure 9 (left) – North Lake, April 1, 2022, conductivity profiles at all sampling Sites.
Figure 10 (right) – North Lake, July 29, 2022, Site 1 conductivity profile.

3.6. pH

The measure of hydrogen ion activity in water is expressed as the pH value. Generally, waters with a pH value below 7.0 are considered acidic while values greater than 7.0 are described as basic or alkaline. Lakes typically experience a fluctuation in pH levels during the course of a day as photosynthetic processes occur in rooted plants and algae during the daylight hours. These processes raise the pH (by removing CO_2). Respiration processes occurring in the evening hours then lower pH (by producing CO_2). Organic matter decomposition can also lower pH. Since pH is measured on a logarithmic scale, a change of one pH unit corresponds with a ten-fold change in

hydrogen ion concentration. In addition to direct effects on biota, low pH values also can mobilize toxic metals that are otherwise bound to sediments under higher pH conditions. Michigan Water Quality Standards state that pH shall be maintained within the range of 6.5 to 9.0 in all waters of the state[4].

Pre-treatment pH values were consistent across each monitoring Site at approximately 8.0. Immediately following Phoslock application, pH at Site 1 was 8.43, an increase of 0.60 relative to the pre-treatment sampling. All pH data reported during 2022 sampling fell well within the accepted range for surface waters of the state. Figure 11 illustrates the 2022 results for pH in North Lake.

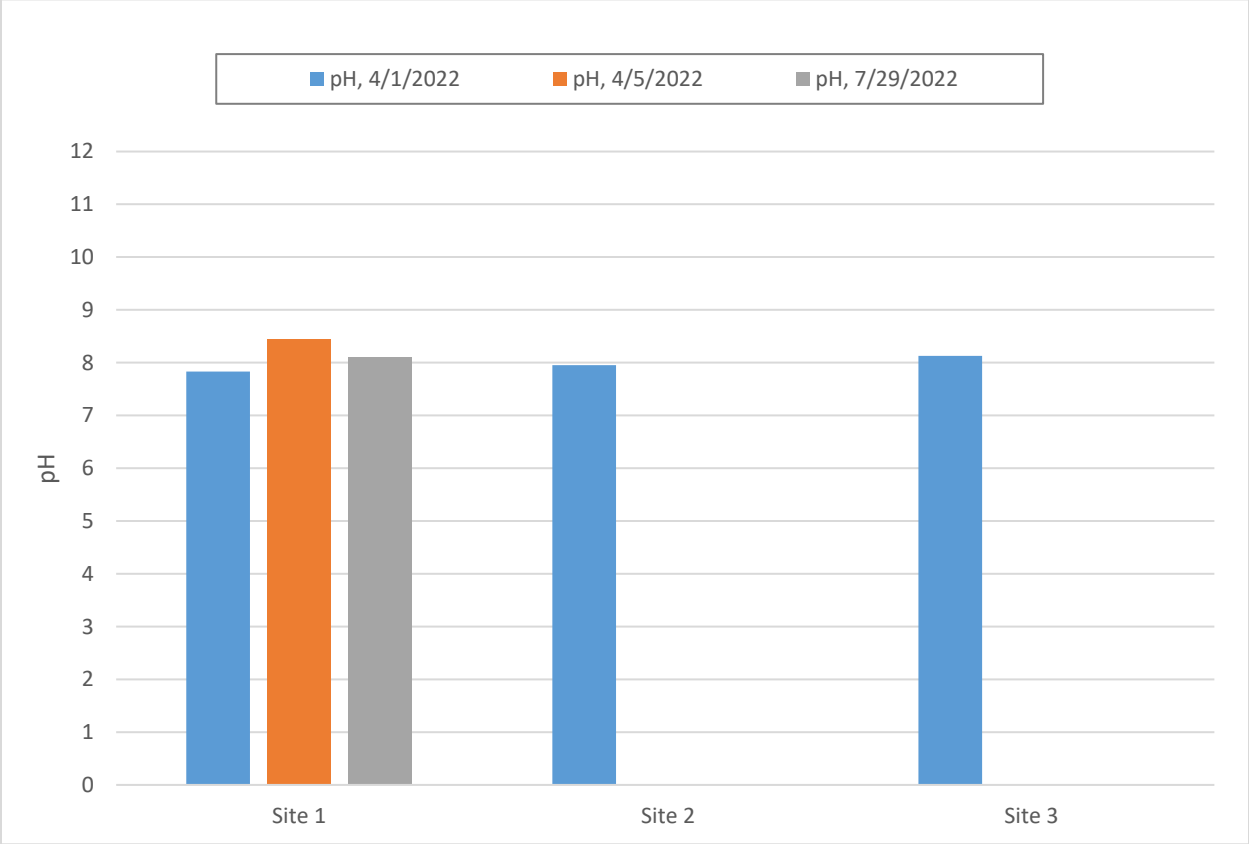


Figure 11 – North water quality data for all sites and events: pH.

3.7. Alkalinity

Alkalinity is a measure of the acid-neutralizing or "buffering" capacity of water. The higher the alkalinity, the greater the resistance to a change in pH. Alkalinity is influenced by carbonates

[4] Michigan Department of Environmental Quality. (2006). "Part 4-Water Quality Standards." *Water Bureau, Water Resources Protection*.

(CO_3^{2-}) and bicarbonates (HCO_3^-). Michigan inland lakes have a wide range of recorded alkalinity values ranging from <20 to 323 mg/L, as calcium carbonate ($CaCO_3$)[5].

Total alkalinity collected prior to Phoslock application was consistent across all monitoring locations between 115-120 mg/L. Following treatment at Site 1 the total alkalinity increased marginally to 118 mg/L; late-season alkalinity at Site 1 had fallen considerably to 92 mg/L. All reported alkalinity data for 2022 in fall within the standard range of <20-323 mg/L of Michigan inland lakes. Figure 12 illustrates the 2022 total alkalinity results for each sampling location.

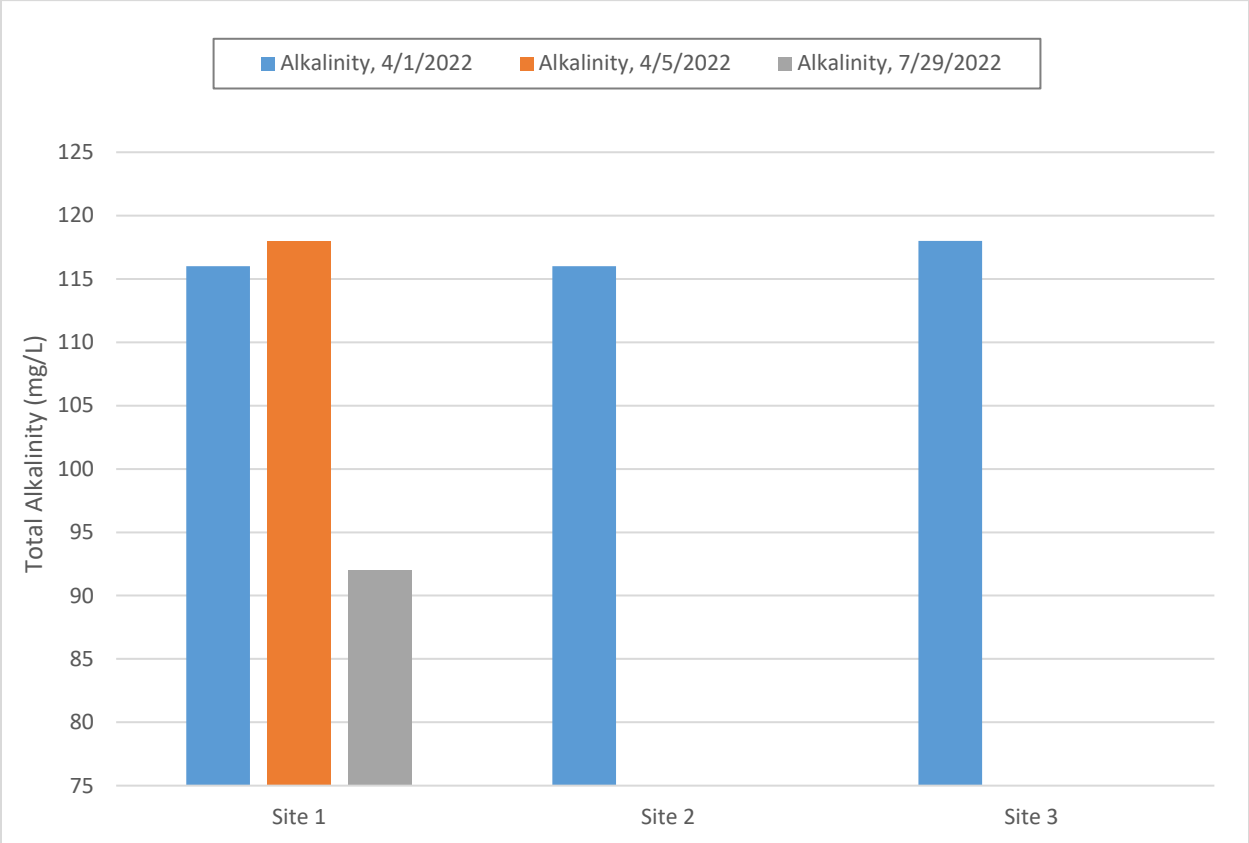


Figure 12 – North Lake 2022 water quality data for all sites and events: Alkalinity.

3.8. Total Lanthanum

Lanthanum is a rare earth metal and a component of the Phoslock compound that has potential for harmful accumulation in lake systems.[6] As such, lanthanum concentrations were monitored

[5] US Geological Survey. (2012). "Water Quality Characteristics of Michigan's Inland Lakes, 2001-10." *Scientific Investigations Report* 2011–5233.

[6] (Oosterhout, et al. (2020). "Lanthanum in Water, Sediment, Macrophytes and chironomid larvae following application of a Lanthanum modified bentonite in lake Rauwbraken (The Netherlands)." *Science of the Total Environment* 2020-706.

immediately following application as well as three months later to understand whether lanthanum would remain suspended in the water column for an extended time period. Following application on April 5, 2022 at Site 1, the lanthanum concentration was reported as 10.98 µg/L. By the July 29, 2022 sampling date, the lanthanum concentration had fallen below the detection limit of 0.10 µg/L. Samples collected during the 2022 monitoring period did not exceed the water quality criterion (WQC) for lanthanum of 14 µg/L.[7]

3.9. Sediment Iron, Total Phosphorus, and Sediment Mobile-phosphorus Fractions

For the purpose of this pilot study, mobile-phosphorus is defined as the sum of iron bound phosphorus and loosely bound phosphorus within the lake sediment. Mobile phosphorus is the primary analyte of concern as anoxic conditions mobilize iron bound phosphorus and loosely bound phosphorus as SRP into the water column. As such, high SRP values in the hypolimnion of lakes are often evidence of internal phosphorus loading from the lake bottom. In shallow nearshore waters, these measures provide an indication available phosphorus at the sediment-water interface that could stimulate benthic filamentous algal production. Sediment phosphorus and iron results for 2022 at each monitoring location are tabulated in Table 3.

Table 3 – North Lake sediment phosphorus and iron ratios (DW refers to concentrations reported as dry weight of the sample; dual results represent lab duplicates run as part of their standard QA/QC procedures).

Date	Location	Sediment Iron (mg/kg DW)	Sediment TP (mg/kg DW)	Fe:P Ratio	Sediment Fe-Bound P (mg/kg DW)	Sediment Loosely Sorbed P (mg/kg DW)	Mobile P Fraction (%)
4/1/22	Site 1	13,000	131	99.2	49.08 / 40.02	3.42 / 3.38	36.6
	Site 2	13,000	149	87.2	130.58	6.45	92.0
	Site 3	6,300	199	31.7	53.37	3.14	28.4
4/5/22	Site 1	9,500	135	70.4	29.84	1.52	23.2

At Site 1 prior to Phoslock application, the mobile phosphorus concentration was 47.95 mg/kg dry weight (DW) representing 36.6% of total sediment phosphorus content of the sample. Post-treatment sampling at Site 1 revealed a reduction in the mobile phosphorus to 31.36 mg/kg DW, a fractional reduction by 23.2%. This suggests a decrease in the available phosphorus that could be utilized by benthic filamentous algae. The Site 2 control location had the highest mobile phosphorus fraction with approximately 92% of the total phosphorus being mobile. Lacking a spring-time benthic algal bloom at this control location suggests that available phosphorus at the sediment-water interface may not be the sole driver of blooms. Such results may indicate

[7] (Liu, et al. (2022). "Water quality criteria for lanthanum for freshwater aquatic organisms derived via species sensitivity distributions and interspecies correlation estimation models." *Ecotoxicology* 2022-31.

the need for additional monitoring at Site 2 with recommended continued pilot efforts. These also suggest that a more finite sampling approach specifically targeting the sediment-water interface may be an appropriate refinement vs. the use of a petite ponar sampler used to collect three subsamples for a composite sample at each site that also captures sediment below the sediment-water interface.

4. Phoslock Application Vegetation Impacts

A full assessment of the vegetation impacts of the Phoslock application will require further data to be collected in 2023. Interim findings reported here primarily focus on changes to the aquatic vegetation community throughout the 2022 growing season. Impacts on the production of benthic algal suppression are not fully discernable as algal bloom activity was limited on the lake in 2022, and no blooms were observed in the Phoslock treatment area or two control areas either prior to or after application. The southern canal (AROS 621 and 622 – see Figure 1 of 2022 LakeScan™ final report for details) did show signs of a nuisance algal bloom from June 16, 2022 K&A observations.

Phoslock binds and removes phosphorus from the water column as it is applied. It also binds phosphorus into unavailable forms in the top layer of lake sediment. As non-vascular plants (i.e., phytoplankton and macroalgae including *Chara* and Starry stonewort) rely on water column nutrients for growth, the project team hypothesized that these algae might see limited growth in the Phoslock treatment area relative to the rest of the lake. It was also thought that rooted aquatic plants might take advantage of reduced macroalgae coverage.

For the purposes of statistical analysis of these possible outcomes, North Lake AROS' were split into three groups: Untreated areas (except Tier 2 and 6 AROS'), the Phoslock-treated area, and Chemical-treated areas with the latter two being those areas that received 2022 Phoslock or herbicide/algaecide treatments, respectively. Starry stonewort coverage decreased in all three groups between the June 16th and August 18th LakeScan^{TM} vegetation surveys, while *Chara* and vascular plant coverage increased in all three groups. Population changes from early to late season were statistically significant ($p < .01$) for vascular plants in all three groups, while for Starry stonewort and *Chara* changes were only significant for the Phoslock group. Macroalgae coverage is illustrated in Figure 13, while vascular plant coverage is illustrated in Figure 14.

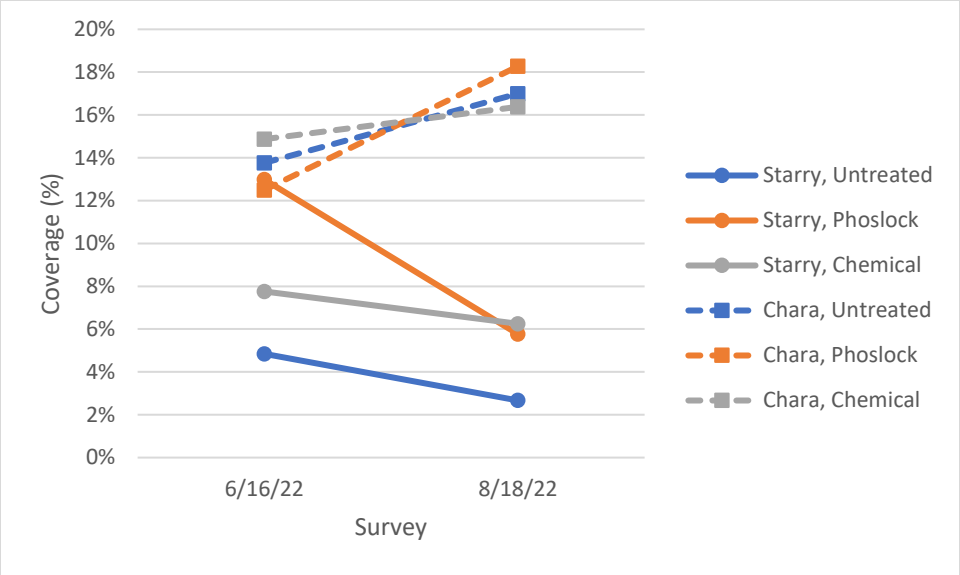


Figure 13 – North Lake 2022 changes in non-vascular plant coverage.

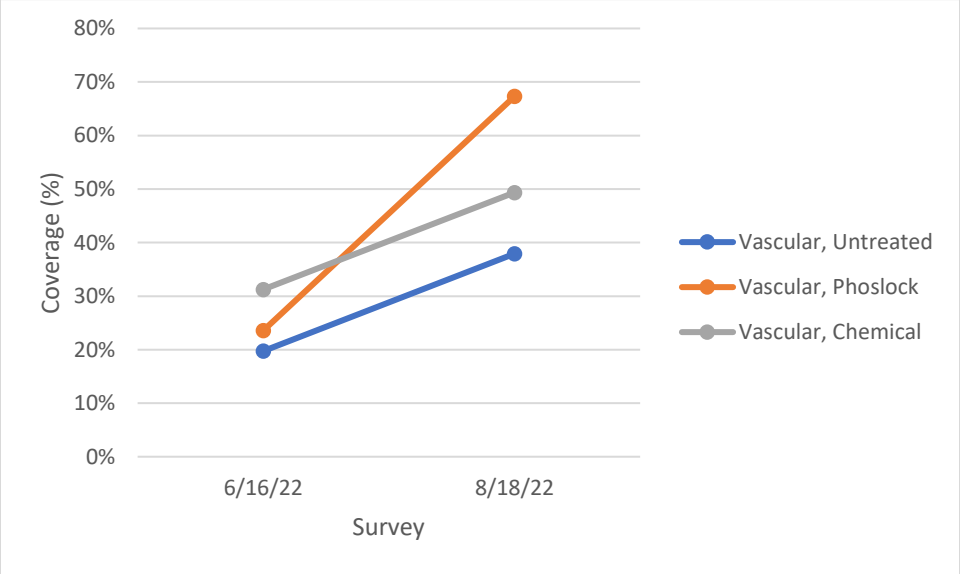


Figure 14 – North Lake 2022 changes in submerged vascular plant coverage.

These findings would suggest that Phoslock is not impacting macroalgae in the same way. Starry stonewort coverage *decreased* significantly in the Phoslock treatment area, while *Chara* coverage *increased*. Coverage changes for these two species in the other AROS groups (untreated, chemical) were not significant, suggesting that the Phoslock application may be driving the observed coverage shifts. While vascular plant (non-emergents only) coverage changes were significant in all three AROS groups, the shift was most dramatic for the Phoslock group (44% increase) than the untreated (18% increase) or chemically-treated (18% increase) groups. Data for 2021 and 2022 in all three AROS groups shows a weak negative correlation between starry stonewort coverage and vascular plant coverage, indicating that vascular plants

may be taking advantage of reduced starry stonewort competition. Changes to the plant community can also be assessed by analyzing the Floristic Quality Index (FQI – see Section 3.4) for each AROS group. FQI increased for all three groups in 2022, but did so more dramatically for the Phoslock group than for the other two (Figure 15).

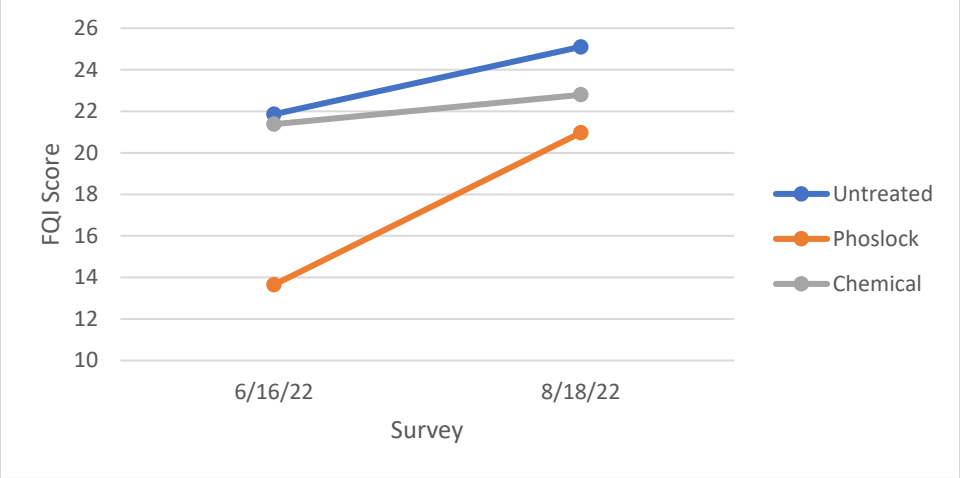


Figure 15 – North Lake 2022 changes in floristic quality index (FQI).

5. Summary Findings and Next Steps

This section summaries findings of the 2022 Phoslock pilot and identifies K&A follow-up recommendations for next step considerations of Phoslock treatments on North Lake. Summary findings include the following:

- The Phoslock pilot study work plan to assess potential alternative controls of benthic filamentous algal blooms on North Lake following ice-off conditions was successfully completed in 2022. The lack of recurrent and substantial 2022 spring blooms in areas suffering nuisance bloom conditions in 2021 and 2020 was a noted possibility in 2021 discussions and LakeScan™ reporting when this pilot was being contemplated. This is attributed to the unpredictability of a range of conditions driving nuisance algal blooms. That said, a host of relevant discoveries about the lake and potential Phoslock treatment benefits is an outcome of 2022 efforts.
- Dissolved phosphorus (represented by SRP measurements) was quite low in nearshore areas of North Lake following ice-out conditions in 2022 and before Phoslock treatment application. This is a good water quality attribute, separate from any discussion of Phoslock treatments. Specifically for treatment considerations, Phoslock no doubt bound up what little soluble phosphorus was in the water column at the time of treatment, albeit likely only temporarily at the treatment site given the suspended algal growth measured by increased water column Chlorophyll *a* levels within days of treatment. Important to note here is that these Chlorophyll *a* measurements represent planktonic (suspended) algae and not the obvious filamentous algae observed growing on the lake bottom or as decaying, floating mats in recent years along select shoreline areas.
- Available phosphorus in nearshore sediments was clearly reduced based on pre- and post-treatment sampling. This would most particularly be relevant at the sediment-water interface for diminishing potential benthic filamentous algal growth. This

potential suppression was anecdotally confirmed with no observed growths in the treatment area through the spring and summer of 2022, while such growth was observed outside of the treatment area on the lake bottom near the outlet. Confounding a clear assertion of benthic algal suppression by the Phoslock treatment, is the lack of benthic algal blooms at control sites.

- Statistically significant shifts from invasive starry stonewort coverage to increases in desirable *Chara* and vascular plant coverage, as well as improved FQI scores in the treatment area portends interesting secondary benefits in the battle against starry stonework proliferation and managing for a desired, ecologically-balanced plant community on the lake.
- No adverse water quality impacts were noted with Phoslock treatment suggesting that application rates specified in the related ANC permit and considered appropriate for the pilot application, open the possibility for extending pilot treatments into 2023 with limited environmental concern.
- K&A has initiated preliminary discussions with Phoslock technical staff in the UK that are conducting similar research efforts on the ecological outcomes of Phoslock treatment applications in Europe. These conversations have revealed that North Lake observations are consistent with those being identified in other settings, particularly for those lakes with multi-year Phoslock applications. Given the novel nature of the North Lake pilot efforts, this feedback is affirming the merits of further treatments with monitored outcomes.

Going forward, it is important to recognize both aquatic vegetation and algal bloom conditions are influenced by a wide variety of factors that can vary greatly from year-to-year. As such, a single season's worth of data make it difficult to fully analyze the North Lake system response to the pilot Phoslock treatment. Limited algal bloom activity on North Lake in 2022 was clearly a highly desirable condition for recreational and aesthetic uses. Whether 2023 will yield conditions like those in 2022, or return to those of 2021 and 2020 is uncertain. What is known is that water quality data, sediment data, plant survey data and field observations revealed that the treatment area experienced anecdotal and statistically significant benefits over untreated or other chemically-treated areas of the lake. For K&A, this suggests that a follow-up application in 2023 would provide a more robust dataset to determine how and if expansion of the Phoslock treatment alternative will bring improved and sustainable conditions towards achieving and maintaining lake management goals. This is relevant in the context of increasing EGLE restrictions on the use of copper-based algaecides to combat nuisance algal blooms.

As such, K&A is recommending Phoslock applications and water quality monitoring consistent with 2022 (though with some adaptation) for 2023. This would include 2023 treatment of Site 1, and maintaining Sites 2 and 3 as controls (no treatment). This will provide information necessary to more fully analyze the benefits and cost-effectiveness of this treatment method in future years. Other detailed management recommendations for the lake are laid out in the 2022 North Lake LakeScan™ final report. The combination of these other treatment approaches will keep an extended Phoslock pilot effort in context with overall lake management needs.

ATTACHMENT

K&A North Lake Phoslock Pilot Study

- Data Summary Table
- Laboratory Reports

Date	Sample ID	Secchi Depth	Collection Depth	Temp	DO	COND	pH	Turbidity	SPC. COND	Alkalinity	TSS	TP	SRP	Chlorophyll a	Sediment Iron	Sediment TP	Sediment Fe Bound P	Sediment Loosely Sorbed P	Total Lanthanum	% Solids	Lab
		(ft)	*(ft)*	*(°C)*	*(mg/L)*	*(umhos/cm)*	*(SU)*	*(NTU)*	*(umhos/cm)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(ug/L)*	*(mg/kg) DW*	*(mg/kg) DW*	*(mg/kg) DW*	*(mg/kg) DW*	*ppb*	*%*	
4/1/2022	AS-1	5.8	0	5.7	12.32	242.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/1/2022	AS-1	5.8	1	5.8	12.06	242.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/1/2022	AS-1	5.8	2	5.8	12.01	242.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/1/2022	AS-1	5.8	3	5.8	11.96	242.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/1/2022	AS-1	5.8	4	5.8	11.94	242.5	7.83	13.95	280	116	<3	0.0129	<0.00213	0.00205	-	-	-	-	-	-	GLEC / MERIT
4/1/2022	AS-1	5.8	5	5.8	11.89	242.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
4/1/2022	AS-1	5.8	5.8	6	5.95	255.7	-	-	-	-	-	-	-	-	13,000	131	49.08 / 40.02	3.42 / 3.38	-	8.96 / 8.97	GLEC
4/1/2022	AS-2	5.1	0	5.9	12.04	243.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
4/1/2022	AS-2	5.1	1	5.9	11.97	243.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
4/1/2022	AS-2	5.1	2	5.9	11.95	243.3	7.95	14.9	280	116	<3	0.0109	<0.00213	0.00673	-	-	-	-	-	-	GLEC / MERIT
4/1/2022	AS-2	5.1	3	5.9	11.92	243.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/1/2022	AS-2	5.1	4	5.9	11.9	243.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/1/2022	AS-2	5.1	5.1	6.2	10.88	253.5	-	-	-	-	-	-	-	-	13,000	149	130.58	6.45	-	4.28	GLEC
4/1/2022	AS-3	5.7	0	5.5	12.18	232.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/1/2022	AS-3	5.7	1	5.5	12.08	233.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/1/2022	AS-3	5.7	2	5.6	12.04	238.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/1/2022	AS-3	5.7	3	5.5	11.96	235.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/1/2022	AS-3	5.7	4	5.6	11.9	238.2	8.13	23	290	118	<3	0.0052	<0.00213	0.00815	-	-	-	-	-	-	GLEC / MERIT
4/1/2022	AS-3	5.7	5	5.4	11.9	238.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/1/2022	AS-3	5.7	6	5.4	11.88	238	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/1/2022	AS-3	5.7	6.4	5.6	11.81	241	-	-	-	-	-	-	-	-	6,300	199	53.37	3.14	-	10.09	GLEC
4/5/2022	AS-1	5.8	5	6.2	11.6	248.3	8.43	-	-	118	<3	0.0041	<0.00213	0.01183	9,500	135	29.84	1.52	10.98	9.96	GLEC / MERIT
7/29/2022	AS-1	6.7	0	25.8	8.15	333.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7/29/2022	AS-1	6.7	1	25.8	8.14	337.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7/29/2022	AS-1	6.7	2	25.7	8.13	337.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7/29/2022	AS-1	6.7	3	25.7	8.1	337.7	8.1	-	-	92	13	0.0313	0.0023	0.00158	-	188	-	-	<0.10		GLEC / MERIT
7/29/2022	AS-1	6.7	4	25.4	8.05	337.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7/29/2022	AS-1	6.7	5	25.1	8.04	336.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7/29/2022	AS-1	6.7	6	25	8.09	341.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7/29/2022	AS-1	6.7	6.7	24.9	2.45	479	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Great Lakes Environmental Center

Project Number: 2592-B09

May 12, 2022

Kieser & Associates-North Lake
536 E. Michigan Ave., Suite 300
Kalamazoo, MI 49007

Attention: Josh Kieser

Project Description: Water Quality Sampling

Dear Client,

Enclosed is a copy of your laboratory report relating to samples, as they were received. All tests were performed within the maximum holding times and have met or exceeded QC criteria. Test results are in compliance with The NELAC Institute Standards. Visit our web site for a full list of tests for which GLEC (Lab 2059) is accredited through the New Hampshire Environmental Laboratory Accreditation Program (NH ELAP).

Please don't hesitate to call if you have questions or require further information.

Data Qualifiers:

U = Analyte not detected
IST = Received above temp

Sincerely,

Michelle A. Moore
Laboratory Coordinator and Research Scientist/Nutrient Chemistry

Great Lakes Environmental Center

739 Hastings St., Traverse City MI 49686 - (231) 941-2230 - FAX: (231) 941-2240

Client ID:

Kieser-North Lake

REPORT OF ANALYSIS

Total Phosphorus

LabSampleID	SampleDescription	Sample Date	Result	Units	Rep Limit	MDL	Lab Qualifie	AnalysisDate	Comments	Initials
2K04010004	A1-S	4/1/2022	131	mg/kg dr	24.78	12.3915		4/26/2022		BSC
2K04010005	A2-S	4/1/2022	149	mg/kg dr	23.05	11.5245		4/26/2022		BSC
2K04010006	A3-S	4/1/2022	199	mg/kg dr	24.27	12.1335		4/26/2022		BSC
2K04050007	A1-S	4/5/2022	135	mg/kg dr	22.40	11.202		4/26/2022		BSC

LabQualifiers:

U - Analyte not detected.

J - Result between MDL and RL should be considered estimated.

Method: SM 4500-P F

Friday, May 13, 2022

Great Lakes Environmental Center

739 Hastings St., Traverse City MI 49686 - (231) 941-2230 - FAX: (231) 941-2240

Client ID:

Kieser-North Lake

REPORT OF ANALYSIS

Total Phosphorus

LabSampleID	SampleDescription	Sample Date	Result	Units	Rep Limit	MDL	Lab Qualifie	AnalysisDate	Comments	Initials
2K04010001	A1-WQ	4/1/2022	0.0129	mg/L	0.003	0.0015	IST	4/14/2022	Over Temp	BSC
2K04010002	A2-WQ	4/1/2022	0.0109	mg/L	0.003	0.0015	IST	4/14/2022	Over Temp	BSC
2K04010003	A3-WQ	4/1/2022	0.0052	mg/L	0.003	0.0015	IST	4/14/2022	Over Temp	BSC
2K04050008	A1-WQ	4/5/2022	0.0041	mg/L	0.003	0.0015	IST	4/14/2022	Over Temp	BSC

LabQualifiers:

U - Analyte not detected.

J - Result between MDL and RL should be considered estimated.

Method: SM 4500-P F

Great Lakes Environmental Center

739 Hastings St., Traverse City MI 49686 - (231) 941-2230 - FAX: (231) 941-2240

Client ID:

Kieser-North Lake

REPORT OF ANALYSIS

Soluble Reactive Phosphorus

LabSampleID	SampleDescription	Sample Date	Result	Units	Rep Limit	MDL	Lab Qualifie	AnalysisDate	Comments	Initials
2K04010001	A1-WQ	4/1/2022	<0.00213	mg/L	0.003	0.00213	U	4/19/2022		BSC
2K04010002	A2-WQ	4/1/2022	<0.00213	mg/L	0.003	0.00213	U	4/19/2022		BSC
2K04010003	A3-WQ	4/1/2022	<0.00213	mg/L	0.003	0.00213	U	4/19/2022		BSC
2K04050008	A1-WQ	4/5/2022	<0.00213	mg/L	0.003	0.00213	U	4/19/2022		BSC

LabQualifiers:

U - Analyte not detected.

J - Result between MDL and RL should be considered estimated.

Method: SM 4500-P F

Great Lakes Environmental Center

739 Hastings St., Traverse City MI 49686 - (231) 941-2230 - FAX: (231) 941-2240

Client ID:

Kieser-North Lake

REPORT OF ANALYSIS

Loosely Sorbed P

LabSampleID	SampleDescription	Sample Date	Result	Units	Rep Limit	MDL	Lab Qualifie	AnalysisDate	Comments	Initials
2K04010004A	A1-S	4/1/2022	3.42	mg/kg dr	1.128	0.564		4/27/2022		BC
2K04010004B	A1-S	4/1/2022	3.38	mg/kg dr	1.128	0.564		4/27/2022		BC
2K04010005	A2-S	4/1/2022	6.45	mg/kg dr	2.331	1.1655		4/27/2022		BC
2K04010006	A3-S	4/1/2022	3.14	mg/kg dr	0.915	0.4575		4/27/2022		BC
2K04050007	A1-S	4/5/2022	1.52	mg/kg dr	1.086	0.543		4/27/2022		BC

LabQualifiers:

U - Analyte not detected.

J - Result between MDL and RL should be considered estimated.

Method: SM 4500-P F

Friday, May 13, 2022

Great Lakes Environmental Center

739 Hastings St., Traverse City MI 49686 - (231) 941-2230 - FAX: (231) 941-2240

Client ID:

Kieser-North Lake

REPORT OF ANALYSIS

Iron Bound P

LabSampleID	SampleDescription	Sample Date	Result	Units	Rep Limit	MDL	Lab Qualifie	AnalysisDate	Comments	Initials
2K04010004A	A1-S	4/1/2022	49.08	mg/kg dr	5.64	2.82		4/27/2022		BC
2K04010004B	A1-S	4/1/2022	40.02	mg/kg dr	5.637	2.8185		4/27/2022		BC
2K04010005	A2-S	4/1/2022	130.58	mg/kg dr	11.66	5.829		4/27/2022		BC
2K04010006	A3-S	4/1/2022	53.37	mg/kg dr	4.575	2.2875		4/27/2022		BC
2K04050007	A1-S	4/5/2022	29.84	mg/kg dr	5.424	2.712		4/27/2022		BC

LabQualifiers:

U - Analyte not detected.

J - Result between MDL and RL should be considered estimated.

Method: SM 4500-P F

Friday, May 13, 2022

Great Lakes Environmental Center

739 Hastings St., Traverse City MI 49686 - (231) 941-2230 - FAX: (231) 941-2240

Client ID:

Kieser-North Lake

REPORT OF ANALYSIS

chla

LabSampleID	SampleDescription	Sample Date	Result	Units	Rep Limit	MDL	Lab Qualifie	AnalysisDate	Comments	Initials
2K04010009	A1-WQ	4/1/2022	0.00205	mg/L	0.0002	0.000059	IST	4/15/2022	Over Temp	BSC
2K04010010	A2-WQ	4/1/2022	0.00673	mg/L	0.0002	0.000059	IST	4/15/2022	Over Temp	BSC
2K04010011	A3-WQ	4/1/2022	0.00815	mg/L	0.0002	0.000059	IST	4/15/2022	Over Temp	BSC
2K04050012	A1-WQ	4/5/2022	0.01183	mg/L	0.0002	0.000059	IST	4/15/2022	Over Temp	BSC

LabQualifiers:

U - Analyte not detected.

J - Result between MDL and RL should be considered estimated.

Method: SM 10200 H

Friday, May 13, 2022

Great Lakes Environmental Center

739 Hastings St., Traverse City MI 49686 - (231) 941-2230 - FAX: (231) 941-2240

Client ID:

Kieser-North Lake

REPORT OF ANALYSIS

Percent Solids

LabSampleID	SampleDescription	Sample Date	Result	Units	Rep Limit	MDL	Lab Qualifie	AnalysisDate	Comments	Initials
2K04010004A	A1-S	4/1/2022	8.96	%	0.05	0.05		4/11/2022		BSC
2K04010004B	A1-S	4/1/2022	8.97	%	0.05	0.05		4/11/2022		BSC
2K04010005	A2-S	4/1/2022	4.28	%	0.05	0.05		4/11/2022		BSC
2K04010006	A3-S	4/1/2022	10.09	%	0.05	0.05		4/11/2022		BSC
2K04050007	A1-S	4/5/2022	9.96	%	0.05	0.05		4/11/2022		BSC

LabQualifiers:

U - Analyte not detected.

J - Result between MDL and RL should be considered estimated.

Method: SM 2540 G

Friday, May 13, 2022

GREAT LAKES ENVIRONMENTAL CENTER, INC.

Great Lakes Environmental Center

CHAIN OF CUSTODY RECORD

Traverse City, MI - Laboratory
739 Hastings Street
Traverse City, MI 49686

www.glec.com
Phone (231)941-2230
Fax (231)941-2240

Section I.

Submitting Company: Kieser & Associates

Report Results To: Zachary Harrison

Address: 536 E. Michigan Ave. Kalamazoo, MI 49007

Phone: (269) 344-7117 E-mail: ZHarrison@Kieser-associates.com

Section II.

Project Name: North Lake

Project Number:

P.O.#:

Sampled by: (initials) GLEC ____ ☒ Client ZH

Section III. Sample Information at Collection

#	GLEC No.	Sample Identification	Sample Information: Date	Time	Matrix	Grab or Composite	Preservative	Filtered Y or N	Sample Containers: Type	Size	No.	TP	SRP	Sediment Total phosphorus	Sediment total Iron					pH of Sample Upon Receipt
1		A1-WQ	4-1-22	12:15 pm	SW	Grab	Y-TP(H_2SO_4)	Y(SRP)	Glass	250ml	2	X	X							≤2
2		A2-WQ	4-1-22	11:50 Am	SW	Grab					2	X	X							≤2
3		A3-WQ	4-1-22	10:45 Am	SW	Grab					2	X	X							≤2
4		A1-S	4-1-22	1:15pm	S	Composite		-		500ml	1			X	X					
5		A2-S	4-1-22	1:30pm	S	Composite		-		500ml	1			X	X					
6		A3-S	4-1-22	1:45pm	S	Composite		-		500ml	1			X	X					
7		A1-WQ	4-5-22	1:31pm	SW	Grab		Y(SRP)		250ml	2	X	X							≤2
8		A1-S	4-5-22	1:37pm	S	Composite		-		500ml	1			X	X					

Client Notes: ☆ A1-WQ 4-5-22 Sample Broken glass - replaced in Acid washed Mason JAR

* TP samples received above temp. 5-12-4

RELEASED BY / ORGANIZATION	DATE	TIME	RECEIVED BY / ORGANIZATION	DATE	TIME
Print Name & Organization: Mark S. Kieser K:A	4/8/22	16:00	Print Name & Organization: Angie Bought GLEC	4/8/22	16:04
Signature: Mark S. K			Signature: Angie Bought		
Print Name & Organization			Print Name & Organization		
Signature			Signature		

FOR LAB USE ONLY

Temperature of Samples: 6.7 °C Initials: ____ Bottle ID #, if applicable ____ ☐ Received on Wet Ice

Notes/Anomalies/Discrepancies: ____

GLEC may subcontract out analyses that we do not perform.

MATRIX CODES: S = SEDIMENT; SW = SURFACE WATER; E = EFFLUENT; GW = GROUNDWATER; SL = SLUDGE; AO = AQUATIC ORGANISM

GLEC
Great Lakes Environmental Center

GREAT LAKES ENVIRONMENTAL CENTER, INC.

CHAIN OF CUSTODY RECORD

Traverse City, MI - Laboratory
739 Hastings Street
Traverse City, MI 49686

www.glec.com
Phone (231)941-2230
Fax (231)941-2240

Section I.

Submitting Company: Kieser & Associates
Report Results To: Zach Harrison
Address: 536 E. Michigan Ave. Kalamazoo, MI 49007
Phone: (269) 344-7117 E-mail: Zharrison@kieser-associates.com

Section II.

Project Name: North Lake
Project Number:
P.O.#:
Sampled by: (initials)
☐ GLEC _____ ☐ Client _____

Section III. **Sample Information at Collection**

#	GLEC No.	Sample Identification	Sample Information: Date	Time	Matrix	Grab or Composite	Preservative	Filtered Y or N	Sample Containers: Type	Size	No.
1		A1 - WQ	4-1-22	4:01 pm	SW	C	–	Y	Plastic	250	1
2		A2 - WQ	4-1-22	4:05 pm	SW	↓	↓	↓	↓	↓	↓
3		A3 - WQ	4-1-22	4:10 pm	SW	↓	↓	↓	↓	↓	↓
4		A1 - WQ	4-5-22	2:45 pm	SW	↓	↓	↓	↓	↓	↓
5											
6											
7											
8											

Section IV. Requested Analysis

Chlorophyll a								pH of Sample Upon Receipt
X								
X								
X								
X								

Client Notes: All Chl a Samples 150 mL filtered Chlorophyll sampler received above temp 5-12-22

RELEASED BY / ORGANIZATION	DATE	TIME	RECEIVED BY / ORGANIZATION	DATE	TIME
Print Name & Organization: Mark S. Kieser K:A	4/8/22	16:00	Print Name & Organization: Angie Bought GLEC	4/8/22	16:04
Signature: Mark S. Kieser			Signature: Angie Bought		
Print Name & Organization			Print Name & Organization		
Signature			Signature		

FOR LAB USE ONLY

Temperature of Samples: 6.7 °C Initials: _____ Bottle ID #, if applicable _____ ☐ Received on Wet Ice

Notes/Anomalies/Discrepancies: _____

GLEC may subcontract out analyses that we do not perform.

MATRIX CODES: S = SEDIMENT; SW = SURFACE WATER; E = EFFLUENT; GW = GROUNDWATER; SL = SLUDGE; AO = AQUATIC ORGANISM

26-May-2022

Ben Cook
Great Lakes Environmental Center
739 Hastings St
Traverse City, MI 49686

Re: **Kieser North Lake** Work Order: **22051795**

Dear Ben,

ALS Environmental received 4 samples on 19-May-2022 09:00 AM for the analyses presented in the following report.

The analytical data provided relates directly to the samples received by ALS Environmental - Holland and for only the analyses requested.

Sample results are compliant with industry accepted practices and Quality Control results achieved laboratory specifications. Any exceptions are noted in the Case Narrative, or noted with qualifiers in the report or QC batch information. Should this laboratory report need to be reproduced, it should be reproduced in full unless written approval has been obtained from ALS Environmental. Samples will be disposed in 30 days unless storage arrangements are made.

The total number of pages in this report is 13.

If you have any questions regarding this report, please feel free to contact me:

ADDRESS: 3352 128th Avenue, Holland, MI, USA
PHONE: +1 (616) 399-6070 FAX: +1 (616) 399-6185

Sincerely,

Jodi Blouw

Electronically approved by: Jodi Blouw

Jodi Blouw

ALS Group, USA

Date: 26-May-22

Client: Great Lakes Environmental Center
Project: Kieser North Lake
Work Order: **22051795**

Work Order Sample Summary

Lab Samp ID	Client Sample ID	Matrix	Tag Number	Collection Date	Date Received	Hold
22051795-01	A1-S	Sediment		4/1/2022 13:15	5/19/2022 09:00	☐
22051795-02	A2-S	Sediment		4/1/2022 13:30	5/19/2022 09:00	☐
22051795-03	A3-S	Sediment		4/1/2022 13:45	5/19/2022 09:00	☐
22051795-04	A1-S	Sediment		4/5/2022 13:37	5/19/2022 09:00	☐

Client: Great Lakes Environmental Center
Project: Kieser North Lake
WorkOrder: **22051795**

QUALIFIERS, ACRONYMS, UNITS

Qualifier	Description
*	Value exceeds Regulatory Limit
**	Estimated Value
a	Analyte is non-accredited
B	Analyte detected in the associated Method Blank above the Reporting Limit
E	Value above quantitation range
H	Analyzed outside of Holding Time
Hr	BOD/CBOD - Sample was reset outside Hold Time, value should be considered estimated.
J	Analyte is present at an estimated concentration between the MDL and Report Limit
n	Analyte accreditation is not offered
ND	Not Detected at the Reporting Limit
O	Sample amount is > 4 times amount spiked
P	Dual Column results percent difference > 40%
R	RPD above laboratory control limit
S	Spike Recovery outside laboratory control limits
U	Analyzed but not detected above the MDL
X	Analyte was detected in the Method Blank between the MDL and Reporting Limit, sample results may exhibit background or reagent contamination at the observed level.

Acronym	Description
DUP	Method Duplicate
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LOD	Limit of Detection (see MDL)
LOQ	Limit of Quantitation (see PQL)
MBLK	Method Blank
MDL	Method Detection Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
PQL	Practical Quantitation Limit
RPD	Relative Percent Difference
TDL	Target Detection Limit
TNTC	Too Numerous To Count
A	APHA Standard Methods
D	ASTM
E	EPA
SW	SW-846 Update III

Units Reported	Description
% of sample	Percent of Sample
mg/Kg-dry	Milligrams per Kilogram Dry Weight

Client:	Great Lakes Environmental Center
Project:	Kieser North Lake
Work Order:	22051795

Case Narrative

Samples for the above noted Work Order were received on 05/19/2022. The attached "Sample Receipt Checklist" documents the status of custody seals, container integrity, preservation, and temperature compliance.

Samples were analyzed according to the analytical methodology previously transmitted in the "Work Order Acknowledgement". Methodologies are also documented in the "Analytical Result" section for each sample. Quality control results are listed in the "QC Report" section. Sample association for the reported quality control is located at the end of each batch summary. If applicable, results are appropriately qualified in the Analytical Result and QC Report sections. The "Qualifiers" section documents the various qualifiers, units, and acronyms utilized in reporting. A copy of the laboratory's scope of accreditation is available upon request.

With the following exceptions, all sample analyses achieved analytical criteria.

Metals:
Batch 196799, Method SW6020B, Sample 22051795-01AMSD: The MSD recovery was outside of the control limit. However, the MS recovery and the RPD between the MS and MSD was in control. No qualification is required for this analyte: Fe

No other deviations or anomalies were noted.

Wet Chemistry:
Batch R344860, Method SW3550C, Sample A1-S (22051795-01A): Sample analyzed after hold time due to being received after expiration date.

Batch R344860, Method SW3550C, Sample A2-S (22051795-02A): Sample analyzed after hold time due to being received after expiration date.

Batch R344860, Method SW3550C, Sample A3-S (22051795-03A): Sample analyzed after hold time due to being received after expiration date.

Batch R344860, Method SW3550C, Sample A1-S (22051795-04A): Sample analyzed after hold time due to being received after expiration date.

No other deviations or anomalies were noted.

ALS Group, USA

Date: *26-May-22*

Client: Great Lakes Environmental Center
Project: Kieser North Lake
Sample ID: A1-S
Collection Date: 4/1/2022 01:15 PM

Work Order: 22051795
Lab ID: 22051795-01
Matrix: SEDIMENT

Analyses	Result	Qual	MDL	Report Limit	Units	Dilution Factor	Date Analyzed
METALS BY ICP-MS		Method:	**SW6020B**		Prep: SW3050B / 5/24/22		Analyst: **STP**
Iron	**13,000**		**110**	**130**	**mg/Kg-dry**	1	5/24/2022 20:21
MOISTURE		Method:	**SW3550C**				Analyst: **ALG**
Moisture	**90**	H	**0.10**	**0.10**	**% of sample**	1	5/20/2022 11:58

Note: See Qualifiers page for a list of qualifiers and their definitions.

ALS Group, USA

Date: *26-May-22*

Client: Great Lakes Environmental Center
Project: Kieser North Lake
Sample ID: A2-S
Collection Date: 4/1/2022 01:30 PM

Work Order: 22051795
Lab ID: 22051795-02
Matrix: SEDIMENT

Analyses	Result	Qual	MDL	Report Limit	Units	Dilution Factor	Date Analyzed
METALS BY ICP-MS		Method:	**SW6020B**		Prep: SW3050B / 5/24/22		Analyst: **STP**
Iron	**13,000**		**210**	**270**	**mg/Kg-dry**	1	5/24/2022 20:57
MOISTURE		Method:	**SW3550C**				Analyst: **ALG**
Moisture	**94**	H	**0.10**	**0.10**	**% of sample**	1	5/20/2022 11:58

Note: See Qualifiers page for a list of qualifiers and their definitions.

ALS Group, USA

Date: *26-May-22*

Client: Great Lakes Environmental Center
Project: Kieser North Lake
Sample ID: A3-S
Collection Date: 4/1/2022 01:45 PM

Work Order: 22051795
Lab ID: 22051795-03
Matrix: SEDIMENT

Analyses	Result	Qual	MDL	Report Limit	Units	Dilution Factor	Date Analyzed
METALS BY ICP-MS		Method:	**SW6020B**		Prep: SW3050B / 5/24/22		Analyst: **STP**
Iron	**6,300**		**110**	**130**	**mg/Kg-dry**	1	5/24/2022 20:59
MOISTURE		Method:	**SW3550C**				Analyst: **ALG**
Moisture	**89**	H	**0.10**	**0.10**	**% of sample**	1	5/20/2022 11:58

Note: See Qualifiers page for a list of qualifiers and their definitions.

ALS Group, USA

Date: *26-May-22*

Client: Great Lakes Environmental Center
Project: Kieser North Lake
Sample ID: A1-S
Collection Date: 4/5/2022 01:37 PM

Work Order: 22051795
Lab ID: 22051795-04
Matrix: SEDIMENT

Analyses	Result	Qual	MDL	Report Limit	Units	Dilution Factor	Date Analyzed
METALS BY ICP-MS		Method:	**SW6020B**		Prep: SW3050B / 5/24/22		Analyst: **STP**
Iron	**9,500**		**140**	**170**	**mg/Kg-dry**	1	5/24/2022 21:01
MOISTURE		Method:	**SW3550C**				Analyst: **ALG**
Moisture	**91**	H	**0.10**	**0.10**	**% of sample**	1	5/20/2022 11:58

Note: See Qualifiers page for a list of qualifiers and their definitions.

ALS Group, USA

Date: 26-May-22

Client: Great Lakes Environmental Center

Work Order: 22051795

Project: Kieser North Lake

QC BATCH REPORT

Batch ID: **196799** Instrument ID **ICPMS3** Method: **SW6020B**

MBLK Sample ID: **MBLK-196799-196799** Units: **mg/Kg** Analysis Date: **5/24/2022 07:51 PM**

Client ID: Run ID: **ICPMS3_220524B** SeqNo: **8453741** Prep Date: **5/24/2022** DF: **1**

Analyte	Result	MDL	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Iron	U	8	10								

LCS Sample ID: **LCS-196799-196799** Units: **mg/Kg** Analysis Date: **5/24/2022 07:52 PM**

Client ID: Run ID: **ICPMS3_220524B** SeqNo: **8453742** Prep Date: **5/24/2022** DF: **1**

Analyte	Result	MDL	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Iron	507.3	8	10	500	0	101	80-120	0			

MS Sample ID: **22051795-01AMS** Units: **mg/Kg** Analysis Date: **5/24/2022 08:22 PM**

Client ID: **A1-S** Run ID: **ICPMS3_220524B** SeqNo: **8453759** Prep Date: **5/24/2022** DF: **1**

Analyte	Result	MDL	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Iron	1768	11	13	665.8	1199	85.5	75-125	0			

MSD Sample ID: **22051795-01AMSD** Units: **mg/Kg** Analysis Date: **5/24/2022 08:56 PM**

Client ID: **A1-S** Run ID: **ICPMS3_220524B** SeqNo: **8453767** Prep Date: **5/24/2022** DF: **1**

Analyte	Result	MDL	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Iron	1580	10	13	632.9	1199	60.3	75-125	1768	11.2	20	S

The following samples were analyzed in this batch:

22051795-01A 22051795-02A 22051795-03A
22051795-04A

Note: See Qualifiers Page for a list of Qualifiers and their explanation.

Client: Great Lakes Environmental Center
Work Order: 22051795
Project: Kieser North Lake

QC BATCH REPORT

Batch ID: **R344860** Instrument ID **MOIST** Method: **SW3550C**

MBLK	Sample ID: **WBLKS-R344860**				Units: **% of sample**			Analysis Date: **5/20/2022 11:58 AM**			
Client ID:	Run ID: **MOIST_220520A**				SeqNo: **8441900**			Prep Date:		DF: **1**	
Analyte	Result	MDL	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Moisture	U	0.1	0.10								

LCS	Sample ID: **LCS-R344860**				Units: **% of sample**			Analysis Date: **5/20/2022 11:58 AM**			
Client ID:	Run ID: **MOIST_220520A**				SeqNo: **8441899**			Prep Date:		DF: **1**	
Analyte	Result	MDL	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Moisture	99.99	0.1	0.10	100	0	100	98-102	0			

DUP	Sample ID: **22051225-01B DUP**				Units: **% of sample**			Analysis Date: **5/20/2022 11:58 AM**			
Client ID:	Run ID: **MOIST_220520A**				SeqNo: **8441873**			Prep Date:		DF: **1**	
Analyte	Result	MDL	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Moisture	18.18	0.1	0.10	0	0	0	0-0	18.34	0.876	10	

DUP	Sample ID: **22051665-02B DUP**				Units: **% of sample**			Analysis Date: **5/20/2022 11:58 AM**			
Client ID:	Run ID: **MOIST_220520A**				SeqNo: **8441879**			Prep Date:		DF: **1**	
Analyte	Result	MDL	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Moisture	14.28	0.1	0.10	0	0	0	0-0	13.39	6.43	10	

The following samples were analyzed in this batch:

22051795-01A 22051795-02A 22051795-03A
22051795-04A

Note: See Qualifiers Page for a list of Qualifiers and their explanation.

22051795

GLEC: Great Lakes Environmental Center
Project: Kieser North Lake

GLEC
Great Lakes Environmental Center

GREAT LAKES ENVIRONMENTAL CENTER, INC.

Trave
739 H
Trave

CHAIN OF CUSTODY RECORD

Section I.

Submitting Company: GLEC
Report Results To: Ben Cook
Address: 739 Hastings Street TC, MI 49686
Phone: 231-941-2230 E-mail: bcook@glec.com

Section II.

Project Name: Kieser ~~Co~~ North Lake
Project Number: 2592-B09
P.O.#: 17625
Sampled by: (initials) ☐ GLEC _____ ☒ Client _____

Section III. Sample Information at Collection

#	GLEC No.	Sample Identification	Sample Information: Date	Time	Matrix	Grab or Composite	Preservative	Filtered Y or N	Sample Containers: Type	Size	No.
1		A1-S	4-1-22	13:15	Sed	Comp	4°C	N	Glass	500ml	1
2		A2-S	↓	13:30	↓	↓	↓	↓	↓	↓	1
3		A3-S	↓	13:45	↓	↓	↓	↓	↓	↓	1
4		A1-S	4-5-22	13:37	↓	↓	↓	↓	↓	250ml	1
5											
6											
7											
8											

Section IV. Requested Analysis

#	Total Fe Sediment								pH of Sample Upon Receipt
1	X								
2	X								
3	X								
4	X								
5									
6									
7									
8									

Client Notes:

RELEASED BY / ORGANIZATION	DATE	TIME	RECEIVED BY / ORGANIZATION	DATE	TIME
Print Name & Organization: Benjamin Cook GLEC			Print Name & Organization FED EX		
Signature	5-18-22	15:00	Signature		
Print Name & Organization FED EX			Print Name & Organization Diane E. Shy		
Signature			Signature	5/19/22	0900

FOR LAB USE ONLY

Temperature of Samples: 1.6 °C Initials: IR3 Bottle ID #, if applicable _____ ☐ Received on Wet Ice

Notes/Anomalies/Discrepancies: _____

GLEC may subcontract out analyses that we do not perform.

MATRIX CODES: S = SEDIMENT; SW = SURFACE WATER; E = EFFLUENT; GW = GROUNDWATER; SL = SLUDGE; AO = AQUATIC ORGANISM

ALS Group, USA

Sample Receipt Checklist

Client Name: **GLEC** Date/Time Received: **19-May-22 09:00**

Work Order: **22051795** Received by: **DS**

Checklist completed by Diane Shaw (eSignature) 20-May-22 (Date) Reviewed by: Jodi Blouw (eSignature) 20-May-22 (Date)

Matrices: Sediment

Carrier name: FedEx

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☐	No ☑	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	
Sample(s) received on ice?	Yes ☑	No ☐	
Temperature(s)/Thermometer(s):	1.6/2.6 c	IR3	
Cooler(s)/Kit(s):			
Date/Time sample(s) sent to storage:	5/20/2022 10:28:06 AM		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	N/A ☑
pH adjusted?	Yes ☐	No ☐	N/A ☑
pH adjusted by:	-		

Login Notes:

Client Contacted: Date Contacted: Person Contacted:

Contacted By: Regarding:

Comments:

CorrectiveAction:

Analytical Laboratory Report

Report ID: S34611.01(01)
Generated on 04/13/2022

Report to

Attention: Zach Harrison
Kieser & Associates
536 E. Michigan Ave. Ste 300
Kalamazoo, MI 49007

Phone: 269-344-7117 FAX:
Email: ZHarrison@kieser-associates.com

Addtional Contacts: Doug Ervin, Becky Hough

Report produced by

Merit Laboratories, Inc.
2680 East Lansing Drive
East Lansing, MI 48823

Phone: (517) 332-0167 FAX: (517) 332-6333

Contacts for report questions:
John Laverty (johnlaverty@meritlabs.com)
Barbara Ball (bball@meritlabs.com)

Report Summary

Lab Sample ID(s): S34611.01-S34611.04
Project: North Lake - Phoslock
Collected Date(s): 04/01/2022 - 04/05/2022
Submitted Date/Time: 04/06/2022 14:10
Sampled by: ZH / JU
P.O. #:

Table of Contents

Maya Murshak
Technical Director

General Report Notes

Analytical results relate only to the samples tested, in the condition received by the laboratory.
Methods may be modified for improved performance.
Results reported on a dry weight basis where applicable.
'Not detected' indicates that parameter was not found at a level equal to or greater than the reporting limit (RL).
When MDL results are provided, then 'Not detected' indicates that parameter was not found at a level equal to or greater than the MDL.
40 CFR Part 136 Table II Required Containers, Preservation Techniques and Holding Times for the Clean Water Act specify that samples for acrolein, acrylonitrile, and 2-chlorovinylethyl ether need to be preserved at a pH in the range of 4 to 5 or if not preserved, analyzed within 3 days of sampling.
QA/QC corresponding to this analytical report is a separate document with the same Merit ID reference and is available upon request.
Full accreditation certificates are available upon request. Starred (*) analytes are not NELAP accredited.
Samples are held by the lab for 30 days from the final report date unless a written request to hold longer is provided by the client.

Limits for drinking water samples, are listed as the MCL Limits (Maximum Contaminant Level Concentrations)
PFAS requirement: Section 9.3.8 of U.S. EPA Method 537.1 states "If the method analyte(s) found in the Field Sample is present in the FRB at a concentration greater than 1/3 the MRL, then all samples collected with that FRB are invalid and must be recollected and reanalyzed."
Samples submitted without an accompanying FRB may not be acceptable for compliance purposes.
Wisconsin PFAs analysis: MDL = LOD; RL = LOQ. LOD and LOQ are adjusted for dilution.

Report Narrative

There is no additional narrative for this analytical report

Laboratory Certifications

Authority	Certification ID
Michigan DEQ	#9956
DOD ELAP/ISO 17025	#69699
WBENC	#2005110032
Ohio VAP	#CL0002
Indiana DOH	#C-MI-07
New York NELAC	#11814
North Carolina DENR	#680
North Carolina DOH	#26702
Alaska CSLAP	#17-001
Pennsylvania DEP	#68-05884
Wisconsin DNR	FID# 399147320

Qualifier Descriptions

Qualifier	Description
!	Result is outside of stated limit criteria
B	Compound also found in associated method blank
E	Concentration exceeds calibration range
F	Analysis run outside of holding time
G	Estimated result due to extraction run outside of holding time
H	Sample submitted and run outside of holding time
I	Matrix interference with internal standard
J	Estimated value less than reporting limit, but greater than MDL
L	Elevated reporting limit due to low sample amount
M	Result reported to MDL not RDL
O	Analysis performed by outside laboratory. See attached report.
R	Preliminary result
S	Surrogate recovery outside of control limits
T	No correction for total solids
X	Elevated reporting limit due to matrix interference
Y	Elevated reporting limit due to high target concentration
b	Value detected less than reporting limit, but greater than MDL
e	Reported value estimated due to interference
j	Analyte also found in associated method blank
p	Benzo(b)Fluoranthene and Benzo(k)Fluoranthene integrated as one peak.
x	Preserved from bulk sample

Glossary of Abbreviations

Abbreviation	Description
RL/RDL	Reporting Limit
MDL	Method Detection Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
SW	EPA SW 846 (Soil and Wastewater) Methods
E	EPA Methods
SM	Standard Methods
LN	Linear
BR	Branched

Method Summary

Method	Version
SM2320B	Standard Method 2320 B 2011
SM2540D	Standard Method 2540 D 2015

Analytical Laboratory Report

Sample Summary (4 samples)

Sample ID	Sample Tag	Matrix	Collected Date/Time
S34611.01	A3 - WQ	Liquid	04/01/22 10:45
S34611.02	A2 - WQ	Liquid	04/01/22 11:50
S34611.03	A1 - WQ	Liquid	04/01/22 12:15
S34611.04	A1 - WQ	Liquid	04/05/22 13:37

Analytical Laboratory Report

Lab Sample ID: S34611.01
Sample Tag: A3 - WQ
Collected Date/Time: 04/01/2022 10:45
Matrix: Liquid
COC Reference: 140002

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	500ml Plastic	None	Yes	3.3	IR
1	250ml Plastic	None	Yes	3.3	IR

Inorganics

Method: SM2320B, Run Date: 04/13/22 11:12, Analyst: JKB

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Alkalinity as CaCO3	118	2		mg/L	2		

Method: SM2540D, Run Date: 04/08/22 18:53, Analyst: SSM

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Total Suspended Solids	Not detected	3		mg/L	2.193		

Analytical Laboratory Report

Lab Sample ID: S34611.02
Sample Tag: A2 - WQ
Collected Date/Time: 04/01/2022 11:50
Matrix: Liquid
COC Reference: 140002

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	500ml Plastic	None	Yes	3.3	IR
1	250ml Plastic	None	Yes	3.3	IR

Inorganics

Method: SM2320B, Run Date: 04/13/22 11:16, Analyst: JKB

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Alkalinity as CaCO3	116	2		mg/L	2		

Method: SM2540D, Run Date: 04/08/22 18:53, Analyst: SSM

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Total Suspended Solids	Not detected	3		mg/L	2.128		

Analytical Laboratory Report

Lab Sample ID: S34611.03
Sample Tag: A1 - WQ
Collected Date/Time: 04/01/2022 12:15
Matrix: Liquid
COC Reference: 140002

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	500ml Plastic	None	Yes	3.3	IR
1	250ml Plastic	None	Yes	3.3	IR

Inorganics

Method: SM2320B, Run Date: 04/13/22 11:18, Analyst: JKB

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Alkalinity as CaCO3	116	2		mg/L	2		

Method: SM2540D, Run Date: 04/08/22 18:53, Analyst: SSM

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Total Suspended Solids	Not detected	3		mg/L	2.105		

Analytical Laboratory Report

Lab Sample ID: S34611.04
Sample Tag: A1 - WQ
Collected Date/Time: 04/05/2022 13:37
Matrix: Liquid
COC Reference: 140002

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	500ml Plastic	None	Yes	3.3	IR
1	250ml Plastic	None	Yes	3.3	IR

Inorganics

Method: SM2320B, Run Date: 04/13/22 11:20, Analyst: JKB

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Alkalinity as CaCO3	118	2		mg/L	2		

Method: SM2540D, Run Date: 04/08/22 18:53, Analyst: SSM

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Total Suspended Solids	Not detected	3		mg/L	2.062		

Merit Laboratories Login Checklist

Lab Set ID: S34611
Client: KIESER (Kieser & Associates)
Project: North Lake - Phoslock
Submitted: 04/06/2022 14:10 Login User: MMC

Attention: Zach Harrison
Address: Kieser & Associates
536 E. Michigan Ave. Ste 300
Kalamazoo, MI 49007

Phone: 269-344-7117 FAX:
Email: ZHarrison@kieser-associates.com

Selection				Description	Note
Sample Receiving					
01.	[X] Yes	[ ] No	[ ] N/A	Samples are received at 4C +/- 2C Thermometer #	IR 3.3
02.	[X] Yes	[ ] No	[ ] N/A	Received on ice/ cooling process begun	
03.	[ ] Yes	[X] No	[ ] N/A	Samples shipped	
04.	[ ] Yes	[X] No	[ ] N/A	Samples left in 24 hr. drop box	
05.	[ ] Yes	[ ] No	[X] N/A	Are there custody seals/tape or is the drop box locked	
Chain of Custody					
06.	[X] Yes	[ ] No	[ ] N/A	COC adequately filled out	
07.	[X] Yes	[ ] No	[ ] N/A	COC signed and relinquished to the lab	
08.	[X] Yes	[ ] No	[ ] N/A	Sample tag on bottles match COC	
09.	[ ] Yes	[X] No	[ ] N/A	Subcontracting needed? Subcontacted to:	
Preservation					
10.	[X] Yes	[ ] No	[ ] N/A	Do sample have correct chemical preservation	
11.	[ ] Yes	[ ] No	[X] N/A	Completed pH checks on preserved samples? (no VOAs)	
12.	[ ] Yes	[X] No	[ ] N/A	Did any samples need to be preserved in the lab?	
Bottle Conditions					
13.	[X] Yes	[ ] No	[ ] N/A	All bottles intact	
14.	[X] Yes	[ ] No	[ ] N/A	Appropriate analytical bottles are used	
15.	[X] Yes	[ ] No	[ ] N/A	Merit bottles used	
16.	[ ] Yes	[X] No	[ ] N/A	Sufficient sample volume received	1L for TSS not provided
17.	[ ] Yes	[X] No	[ ] N/A	Samples require laboratory filtration	
18.	[X] Yes	[ ] No	[ ] N/A	Samples submitted within holding time	
19.	[ ] Yes	[ ] No	[X] N/A	Do water VOC or TOX bottles contain headspace	

Corrective action for all exceptions is to call the client and to notify the project manager.

Client Review By: _____ Date: _____

Merit Laboratories, Inc.

2680 East Lansing Dr., East Lansing, MI 48823
Phone (517) 332-0167 Fax (517) 332-4034
www.meritlabs.com

C.O.C. PAGE # 1 OF 2

140002

CHAIN OF CUSTODY RECORD

REPORT TO

CONTACT NAME: Zach Harrison
COMPANY: Kieser & Associates
ADDRESS: 536 E Michigan Ave
CITY: Kalamazoo STATE: MI ZIP CODE: 49007
PHONE NO.: (269) - 344 - 7117 FAX NO.:
P.O. NO.:
E-MAIL ADDRESS: Zharrison@Kieser-associates.com
QUOTE NO.:

INVOICE TO

CONTACT NAME: Becky Hough ☒ SAME
COMPANY:
ADDRESS:
CITY: STATE: ZIP CODE:
PHONE NO.: E-MAIL ADDRESS: Bhough@Kieser-associates.com

PROJECT NO./NAME: North Lake - Phoslock
SAMPLER(S) - PLEASE PRINT/SIGN NAME: ZH / JU

TURNAROUND TIME REQUIRED ☐ 1 DAY ☐ 2 DAYS ☐ 3 DAYS ☒ STANDARD ☐ OTHER

DELIVERABLES REQUIRED ☒ STD ☐ LEVEL II ☐ LEVEL III ☐ LEVEL IV ☐ EDD ☐ OTHER

MATRIX CODE: GW=GROUNDWATER WW=WASTEWATER S=SOIL L=LIQUID SD=SOLID SL=SLUDGE DW=DRINKING WATER O=OIL WP=WIPE A=AIR W=WASTE

ANALYSIS (ATTACH LIST IF MORE SPACE IS REQUIRED)

Certifications
☐ OHIO VAP ☐ Drinking Water
☐ DoD ☐ NPDES
Project Locations
☐ Detroit ☐ New York
☐ Other
Special Instructions

MERIT LAB NO. (FOR LAB USE ONLY)	YEAR DATE	YEAR TIME	SAMPLE TAG IDENTIFICATION-DESCRIPTION	MATRIX	# OF BOTTLES	# Containers & Preservatives: NONE	HCl	HNO_3	H_2SO_4	NaOH	MeOH	OTHER	Total Alkalinity	TSS	Special Instructions
34611.01	4-1-22	10:45 AM	A3 - WQ	L	2	2							X	X	
.02	4-1-22	11:50 AM	A2 - WQ	L	2	2							X	X	
.03	4-1-22	12:15 PM	A1 - WQ	L	2	2							X	X	
.04	4-5-22	1:31 PM	A1 - WQ	L	2	2							X	X	ICE

RELINQUISHED BY: SIGNATURE/ORGANIZATION	☒ Sampler	DATE 4-5-22	TIME 11:15
RECEIVED BY: SIGNATURE/ORGANIZATION		DATE 4/6/22	TIME 11:15
RELINQUISHED BY: SIGNATURE/ORGANIZATION		DATE 4/6/22	TIME 2:15
RECEIVED BY: SIGNATURE/ORGANIZATION		DATE 4/6/22	TIME 1410

RELINQUISHED BY: SIGNATURE/ORGANIZATION — DATE — TIME
RECEIVED BY: SIGNATURE/ORGANIZATION — DATE — TIME

SEAL NO. — SEAL INTACT YES ☐ NO ☐ — INITIALS
SEAL NO. — SEAL INTACT YES ☐ NO ☐ — INITIALS

NOTES: TEMP. ON ARRIVAL 3.3

PLEASE NOTE: SIGNING ACKNOWLEDGES ADHERENCE TO MERIT'S SAMPLE ACCEPTANCE POLICY ON REVERSE SIDE

Rev. 5.18.12

LIMNOpro
Aquatic Science

Kieser and Associates, LLC
Algae Report
4/22/2022

Samples: 1
Contract: NA
Preservative: Lugol's solution
Client: Kieser and Associates, LLC
Reference Method: EPA 841-B-11-004 Modified for Periphyton
Site: Lake bottom mixed phytoplankton and periphyton
Collection Date/Time: 6/20/2022/ 16:45 CST
Processing Dates: 9/12/2022

Notes: Sample aliquots 10 ml of the agitated contents within original containers were settled for a minimum of 12 hours in an Utermohl chamber. Due to the high density of algae in samples, a dilution procedure was used at 1:100. Identifications and counting were done with an Olympus IMT-2 inverted compound scope having both phase contrast and epifluorescence capabilities.

All samples were scanned twice. The first level scanned randomly selected fields at a magnification of 150X for a minimum of four fields or until 200-400 total natural units were counted. This gave indication of abundance and identification for common taxa. After subsampling, the entire Utermohl chamber was scanned at 60X for large and/or rare taxa not accounted for in the subsample. All counts and identifications were done by Daniel McEwen.

A total of 24 genera were identified in these samples with several genera having multiple species present. The sample was extraordinarily dense and diverse relative to many samples we process. While not given as a concentration or count here, the sample was dominated by the macroalgae *Cladophora*. Because *Cladophora* is a macroalgae, microscopy is generally not used to estimate densities, rather densities can be estimated using common sampling methods for aquatic plants. The microscopic algae were dominated by diatoms, which is not uncommon for early summer in midwestern systems. Many of the microscopic algae were periphyton attached to the body of *Cladophora* stalks.

Taxonomic Keys: Baker, A.L. et al. 2012. Phycokey -- an image-based key to Algae (PS Protista), Cyanobacteria, and other aquatic objects. University of New Hampshire Center for Freshwater Biology. http://cfb.unh.edu/phycokey/phycokey.htm 21 Feb 2018.; Edmondson, W.T. ed. 1959. Ward & Whipple's Fresh-Water Biology. 2nd Edition. New York: John Wiley & Sons.; Needham, J.G. and Needham, P.R., 1962. Prescott, G.W. 1970. How to Know the Freshwater Algae. Dubuque; Guide to the Study of Freshwater Biology. San Francisco: Holden-Day, Inc.; Pennak, R.W. 1978; Bellinger, E.G. and Sigee, D.C., 2015. Freshwater algae: identification and use as bioindicators. John Wiley & Sons. Hillebrand et al., 1999. Biovolume calculation for pelagic and benthic microalgae. J. Phycol. 35, 403-424. Bratbak, G. 1985. Bacterial biovolume and biomass estimations. Applied and Environmental Microbiology, 49: 1488-1493. Kremer et al. 2014. A compendium of cell and natural unit biovolumes for >1200 freshwater phytoplankton species. Ecology 95: 2984.

Summary Results

Counts are given as natural counting units (NCU) per liter. Species abbreviations are given as "sp." if likely only a single species in the sample or "spp." if there were multiple species for given genus. Not shown in the table is the green algae *Cladophora* sp., which is a macroalgae and not properly counted in the same way microalgae are counted. By biomass Cladophora sp. would have been the most abundant algae collected.

Major Division	Genus	NCU per L	% per L
Blue Green	*Coelosphaerium* sp.	36,563,500	1.9%
Blue Green	*Merimopedia* sp.	1,666,900	0.1%
Blue Green	*Microcystis* spp.	71,107,400	3.6%
Blue Green	*Oscillatoria* spp.	60,117,200	3.1%
Desmid	*Cosmarium* sp.	30,862,300	1.6%
Desmid	*Desmidium* sp.	102,700	0.0%
Desmid	*Staurastrum* sp.	181,400	0.0%
Diatom	*Asterionella* spp.	129,258,400	6.6%
Diatom	*Cyclotella* spp.	34,196,900	1.8%
Diatom	*Cymbella* spp.	318,666,200	16.3%
Diatom	*Diatoma* sp.	230,808,400	11.8%
Diatom	*Fragilaria* spp.	311,707,800	16.0%
Diatom	*Melosira* sp.	4,732,000	0.2%
Diatom	*Mougeotia* sp.	3,111,200	0.2%
Diatom	*Navicula* spp.	100,602,100	5.2%
Diatom	*Synedra* spp.	170,328,200	8.7%
Diatom	*Tabellaria* sp.	378,190,700	19.4%
Dinoflaggelate	*Glenodinium* sp.	32,966,000	1.7%
Green	*Actinastrum* sp.	35,452,500	1.8%
Green	*Ankistrodesmus* sp.	315,100	0.0%
Green	*Oocystis* sp.	309,700	0.0%
Green	*Spirogyra* sp.	1,730,000	0.1%

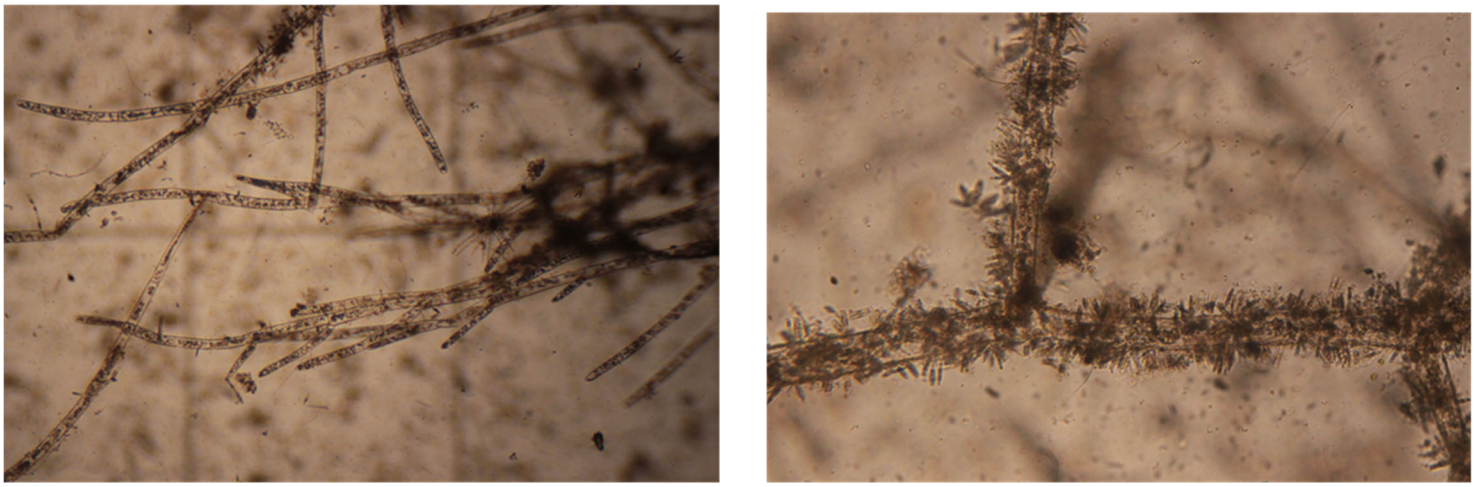
Grand Total	1,952,976,600	100%

Major Division	NCU per L	% per L
Blue Green	169,455,000	8.7%
Desmid	31,146,400	1.6%
Diatom	1,681,601,900	86.1%
Dinoflaggelate	32,966,000	1.7%
Green	37,807,300	1.9%
Grand Total	**1,952,976,600**	**100.0%**

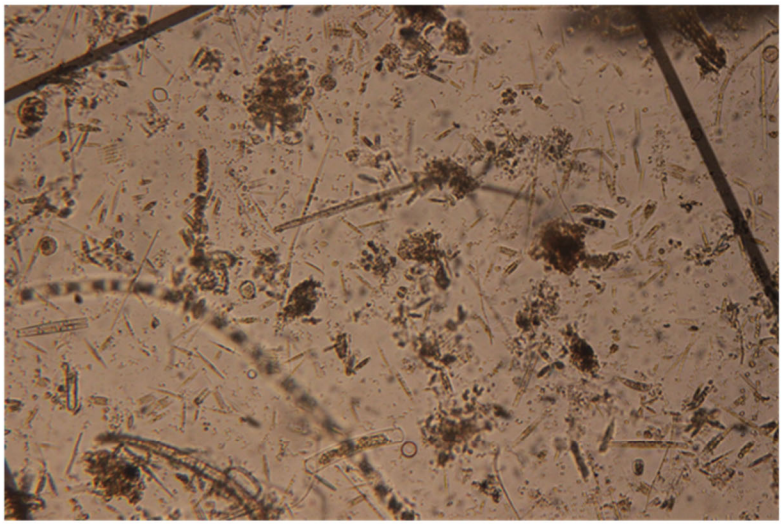
LIMNOpro
Aquatic Science

Selected Photographs

Stock photos of different realizations of Cladophora sp. in the environment.



Micrograph of Kieser and Assoc sample showing Cladophora sp. stalks (left) and close up of the same showing microscopic periphyton growing along the stalks (right)



Micrograph of Kieser and Assoc example microalgae community.

LIMNOpro
Aquatic Science

Conti Testing Laboratories, Inc.
PO Box 174
Bethel Park, PA 15102
412-833-7766 (o), 412-854-0373 (f)
contilab@contitesting.com
PA DEP Reg 02-00869,EPA PA01711, WDBE 12013,WBENC 2005128964,ISO/IEC 17025:2017-97677

Kieser & Associates, LLC
536 E. Michigan Ave. Suite 300
Kalamazoo, MI 49007
Attn Mr. Zach Harrison

Zharrison@kieser-associates.com

8/4/2022

Received: 7/28/2022
Sampled by: client
CTL ID: 292048
vol (ml) 125mL

Sample ID: A1-WQ 4/5/22 1:37PM

RESULTS

Element	ppb	RL (ppb)
Lanthanum (La)	10.98	0.10

ppb parts per billion
RL reporting limit

Method Digestion 3010A / ICP MS

Approved By: *T.G. Otroba, Chemist*

Analytical Laboratory Report

Report ID: S38728.01(01)
Generated on 08/08/2022

Report to

Attention: Zach Harrison
Kieser & Associates
536 E. Michigan Ave. Ste 300
Kalamazoo, MI 49007

Phone: 269-344-7117 FAX:
Email: ZHarrison@kieser-associates.com

Addtional Contacts: Doug Ervin, Becky Hough

Report produced by

Merit Laboratories, Inc.
2680 East Lansing Drive
East Lansing, MI 48823

Phone: (517) 332-0167 FAX: (517) 332-6333

Contacts for report questions:
John Laverty (johnlaverty@meritlabs.com)
Barbara Ball (bball@meritlabs.com)

Report Summary

Lab Sample ID(s): S38728.01
Project: North Lake Phoslock
Collected Date(s): 07/29/2022
Submitted Date/Time: 08/02/2022 13:10
Sampled by: JU
P.O. #:

Table of Contents

Maya Murshak
Technical Director

General Report Notes

Analytical results relate only to the samples tested, in the condition received by the laboratory.
Methods may be modified for improved performance.
Results reported on a dry weight basis where applicable.
'Not detected' indicates that parameter was not found at a level equal to or greater than the reporting limit (RL).
When MDL results are provided, then 'Not detected' indicates that parameter was not found at a level equal to or greater than the MDL.
40 CFR Part 136 Table II Required Containers, Preservation Techniques and Holding Times for the Clean Water Act specify that samples for acrolein and acrylonitrile, and 2-chloroethylvinyl ether need to be preserved at a pH in the range of 4 to 5 or if not preserved, analyzed within 3 days of sampling.
QA/QC corresponding to this analytical report is a separate document with the same Merit ID reference and is available upon request.
Full accreditation certificates are available upon request. Starred (*) analytes are not NELAP accredited.
Samples are held by the lab for 30 days from the final report date unless a written request to hold longer is provided by the client.

Limits for drinking water samples, are listed as the MCL Limits (Maximum Contaminant Level Concentrations)
PFAS requirement: Section 9.3.8 of U.S. EPA Method 537.1 states "If the method analyte(s) found in the Field Sample is present in the FRB at a concentration greater than 1/3 the MRL, then all samples collected with that FRB are invalid and must be recollected and reanalyzed."
Samples submitted without an accompanying FRB may not be acceptable for compliance purposes.
Wisconsin PFAs analysis: MDL = LOD; RL = LOQ. LOD and LOQ are adjusted for dilution.

Report Narrative

There is no additional narrative for this analytical report

Laboratory Certifications

Authority	Certification ID
Michigan DEQ	#9956
DOD ELAP/ISO 17025	#69699
WBENC	#2005110032
Ohio VAP	#CL0002
Indiana DOH	#C-MI-07
New York NELAC	#11814
North Carolina DENR	#680
North Carolina DOH	#26702
Alaska CSLAP	#17-001
Pennsylvania DEP	#68-05884
Wisconsin DNR	FID# 399147320

Qualifier Descriptions

Qualifier	Description
!	Result is outside of stated limit criteria
B	Compound also found in associated method blank
E	Concentration exceeds calibration range
F	Analysis run outside of holding time
G	Estimated result due to extraction run outside of holding time
H	Sample submitted and run outside of holding time
I	Matrix interference with internal standard
J	Estimated value less than reporting limit, but greater than MDL
L	Elevated reporting limit due to low sample amount
M	Result reported to MDL not RDL
O	Analysis performed by outside laboratory. See attached report.
R	Preliminary result
S	Surrogate recovery outside of control limits
T	No correction for total solids
X	Elevated reporting limit due to matrix interference
Y	Elevated reporting limit due to high target concentration
b	Value detected less than reporting limit, but greater than MDL
e	Reported value estimated due to interference
j	Analyte also found in associated method blank
p	Benzo(b)Fluoranthene and Benzo(k)Fluoranthene integrated as one peak.
x	Preserved from bulk sample

Glossary of Abbreviations

Abbreviation	Description
RL/RDL	Reporting Limit
MDL	Method Detection Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
SW	EPA SW 846 (Soil and Wastewater) Methods
E	EPA Methods
SM	Standard Methods
LN	Linear
BR	Branched

Method Summary

Method	Version
SM2320B	Standard Method 2320 B 2011
SM2540D	Standard Method 2540 D 2015

Analytical Laboratory Report

Sample Summary (1 samples)

Sample ID	Sample Tag	Matrix	Collected Date/Time
S38728.01	AS-1	Liquid	07/29/22 12:00

Analytical Laboratory Report

Lab Sample ID: S38728.01
Sample Tag: AS-1
Collected Date/Time: 07/29/2022 12:00
Matrix: Liquid
COC Reference: 140028

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	500ml Plastic	None	Yes	4.1	IR
1	1L Plastic	None	Yes	4.1	IR

Inorganics

Method: SM2320B, Run Date: 08/02/22 13:16, Analyst: JKB

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Alkalinity as CaCO3	92	2		mg/L	2		

Method: SM2540D, Run Date: 08/04/22 17:05, Analyst: ASB

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Total Suspended Solids	13	3		mg/L	1.00		

Merit Laboratories Login Checklist

Lab Set ID: S38728
Client: KIESER (Kieser & Associates)
Project: North Lake Phoslock
Submitted: 08/02/2022 13:10 Login User: MMC

Attention: Zach Harrison
Address: Kieser & Associates
536 E. Michigan Ave. Ste 300
Kalamazoo, MI 49007

Phone: 269-344-7117 FAX:
Email: ZHarrison@kieser-associates.com

Selection				Description	Note
Sample Receiving					
01.	[X] Yes	[ ] No	[ ] N/A	Samples are received at 4C +/- 2C Thermometer #	IR 4.1
02.	[X] Yes	[ ] No	[ ] N/A	Received on ice/ cooling process begun	
03.	[ ] Yes	[X] No	[ ] N/A	Samples shipped	
04.	[ ] Yes	[X] No	[ ] N/A	Samples left in 24 hr. drop box	
05.	[ ] Yes	[ ] No	[X] N/A	Are there custody seals/tape or is the drop box locked	
Chain of Custody					
06.	[X] Yes	[ ] No	[ ] N/A	COC adequately filled out	
07.	[X] Yes	[ ] No	[ ] N/A	COC signed and relinquished to the lab	
08.	[X] Yes	[ ] No	[ ] N/A	Sample tag on bottles match COC	
09.	[ ] Yes	[X] No	[ ] N/A	Subcontracting needed? Subcontacted to:	
Preservation					
10.	[X] Yes	[ ] No	[ ] N/A	Do sample have correct chemical preservation	
11.	[ ] Yes	[ ] No	[X] N/A	Completed pH checks on preserved samples? (no VOAs)	
12.	[ ] Yes	[X] No	[ ] N/A	Did any samples need to be preserved in the lab?	
Bottle Conditions					
13.	[X] Yes	[ ] No	[ ] N/A	All bottles intact	
14.	[X] Yes	[ ] No	[ ] N/A	Appropriate analytical bottles are used	
15.	[X] Yes	[ ] No	[ ] N/A	Merit bottles used	
16.	[X] Yes	[ ] No	[ ] N/A	Sufficient sample volume received	
17.	[ ] Yes	[X] No	[ ] N/A	Samples require laboratory filtration	
18.	[X] Yes	[ ] No	[ ] N/A	Samples submitted within holding time	
19.	[ ] Yes	[ ] No	[X] N/A	Do water VOC or TOX bottles contain headspace	

Corrective action for all exceptions is to call the client and to notify the project manager.

Client Review By: _____ Date: _____

Merit Laboratories, Inc.
2680 East Lansing Dr., East Lansing, MI 48823
Phone (517) 332-0167 Fax (517) 332-4034
www.meritlabs.com

C.O.C. PAGE # 1 OF 1

140028

CHAIN OF CUSTODY RECORD

REPORT TO

CONTACT NAME: Zach Harrison
COMPANY: Kieser & Associates
ADDRESS: 536 E Michigan Ave
CITY: Kalamazoo STATE: MI ZIP CODE: 49007
PHONE NO.: (269) 344-7117 FAX NO.: P.O. NO.:
E-MAIL ADDRESS: Zharrison@Kieser-Associates.com QUOTE NO.:

INVOICE TO

CONTACT NAME: Becky Hough ☒ SAME
COMPANY:
ADDRESS:
CITY: STATE: ZIP CODE:
PHONE NO.: E-MAIL ADDRESS: Bhough@Kieser-Associates.com

PROJECT NO./NAME: North Lake Phoslock
SAMPLER(S) - PLEASE PRINT/SIGN NAME: JU

TURNAROUND TIME REQUIRED ☐ 1 DAY ☐ 2 DAYS ☐ 3 DAYS ☒ STANDARD ☐ OTHER _____

DELIVERABLES REQUIRED ☒ STD ☐ LEVEL II ☐ LEVEL III ☐ LEVEL IV ☐ EDD ☐ OTHER _____

MATRIX CODE: GW=GROUNDWATER WW=WASTEWATER S=SOIL L=LIQUID SD=SOLID SL=SLUDGE DW=DRINKING WATER O=OIL WP=WIPE A=AIR W=WASTE

ANALYSIS (ATTACH LIST IF MORE SPACE IS REQUIRED)

Certifications
☐ OHIO VAP ☐ Drinking Water
☐ DoD ☐ NPDES
Project Locations
☐ Detroit ☐ New York
☐ Other _____
Special Instructions

MERIT LAB NO. FOR LAB USE ONLY	YEAR DATE	YEAR TIME	SAMPLE TAG IDENTIFICATION-DESCRIPTION	MATRIX	# OF BOTTLES	# Containers & Preservatives: NONE	HCl	HNO_3	H_2SO_4	NaOH	MeOH	OTHER	Total Suspended Solids	Total Alkalinity								
38728.01	7-29-22	12:00 p.m.	AS-1	L	2	2							X	X								

ICE

RELINQUISHED BY: SIGNATURE/ORGANIZATION	☐ Sampler	DATE	TIME
Zach Harrison		8-2-22	11:15 AM
RECEIVED BY: SIGNATURE/ORGANIZATION		DATE	TIME
		8/2/22	11:15
RELINQUISHED BY: SIGNATURE/ORGANIZATION		DATE	TIME
		8/2/22	1:10
RECEIVED BY: SIGNATURE/ORGANIZATION		DATE	TIME
M Ailcott		8/2/22	1310

RELINQUISHED BY: SIGNATURE/ORGANIZATION	DATE	TIME
RECEIVED BY: SIGNATURE/ORGANIZATION	DATE	TIME

SEAL NO.	SEAL INTACT YES ☐ NO ☐	INITIALS
SEAL NO.	SEAL INTACT YES ☐ NO ☐	INITIALS

NOTES: TEMP. ON ARRIVAL 4.1

PLEASE NOTE: SIGNING ACKNOWLEDGES ADHERENCE TO MERIT'S SAMPLE ACCEPTANCE POLICY ON REVERSE SIDE

Rev. 5.18.12

Conti Testing Laboratories, Inc.
PO Box 174
Bethel Park, PA 15102
412-833-7766 (o), 412-854-0373 (f)
contilab@contitesting.com
PA DEP Reg 02-00869,EPA PA01711, WDBE 12013,WBENC 2005128964,ISO/IEC 17025:2017-97677

Kieser & Associates, LLC
536 E. Michigan Ave. Suite 300
Kalamazoo, MI 49007
Attn Mr. Zach Harrison

Zharrison@kieser-associates.com

10/17/2022

Received: 10/13/2022
Sampled by: client
CTL ID: 296534
vol (ml) 125

Sample ID: S5 North Lake 8/19/22 2:00PM

RESULTS

Element	ppb	RL (ppb)
Lanthanum (La)	<0.10	0.10

ppb parts per billion
RL reporting limit

Method Digestion 3010A / ICP MS

Approved By: *T.G. Otroba, Chemist*