November 2026

WABEEK LAKE

WATER QUALITY & PLANT CONTROL SUMMARY

PREPARED FOR:
WABEEK LAKE IMPROVEMENT BOARD
OAKLAND COUNTY, MI

PROGRESSIVE COMPANIES

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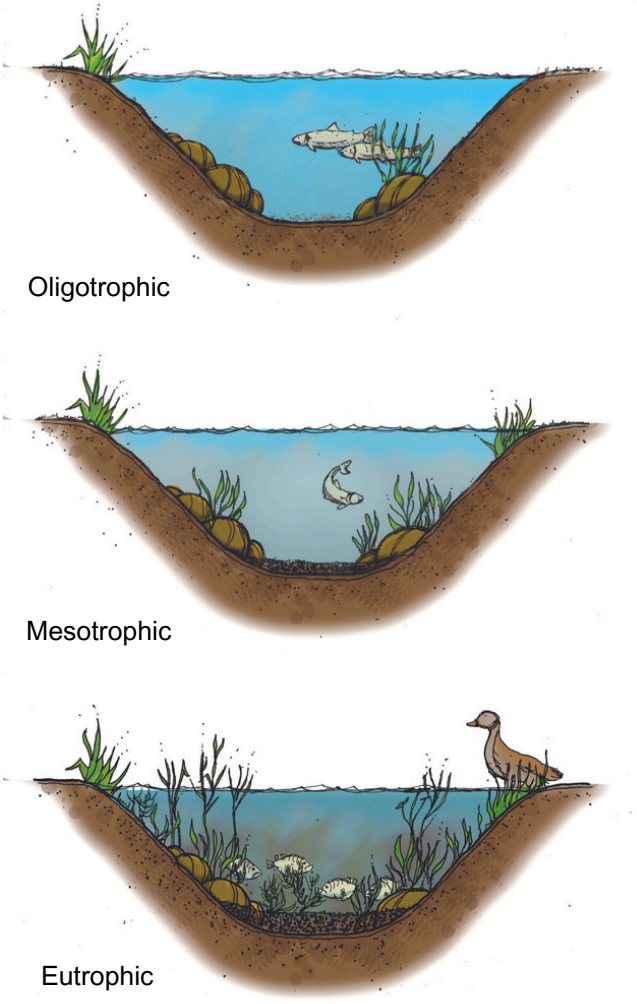
Aqua-Weed Control, Inc.



LAKE WATER QUALITY

Lake water quality is determined by a unique combination of processes that occur both within and outside of the lake. In order to make sound management decisions, it is necessary to have an understanding of the current physical, chemical, and biological condition of the lake, and the potential impact of drainage from the surrounding watershed.

Lakes are commonly classified as oligotrophic, mesotrophic, or eutrophic. Oligotrophic lakes are generally deep and clear with little aquatic plant growth. These lakes maintain sufficient dissolved oxygen in the cool, deep bottom waters during late summer to support cold-water fish such as trout and whitefish. By contrast, eutrophic lakes are generally shallow, turbid, and support abundant aquatic plant growth. In deep eutrophic lakes, the cool bottom waters usually contain little or no dissolved oxygen. Therefore, these lakes can only support warmwater fish such as bass and pike. Lakes that fall between these two extremes are called mesotrophic lakes.



Lake classification.

Under natural conditions, most lakes will ultimately evolve to a eutrophic state as they gradually fill with sediment and organic matter transported to the lake from the surrounding watershed. As the lake becomes shallower, the process accelerates. When aquatic plants become abundant, the lake slowly begins to fill in as sediment and decaying plant matter accumulate on the lake bottom. Eventually, terrestrial plants become established and the lake is transformed to a marshland. The aging process in lakes is called "eutrophication" and may take anywhere from a few hundred to several thousand years, generally depending on the size of the lake and its watershed. The natural lake aging process can be greatly accelerated if excessive amounts of sediment and nutrients (which stimulate aquatic plant growth) enter the lake from the surrounding watershed. Because these added inputs are usually associated with human activity, this accelerated lake aging process is often referred to as "cultural eutrophication." The problem of cultural eutrophication can be managed by identifying sources of sediment and nutrient loading (i.e., inputs) to the lake and developing strategies to halt or slow the inputs. Key parameters used to evaluate a lake's productivity or trophic state include total phosphorus, chlorophyll-*a*, and Secchi transparency.

PHOSPHORUS

Phosphorus is the nutrient that most often controls aquatic plant growth and the rate at which a lake ages and becomes more eutrophic. In the presence of oxygen, lake sediments act as a phosphorus trap, making it unavailable for aquatic plant and algae growth. If bottom-water oxygen is depleted, phosphorus will be released from the sediments and may be available to promote aquatic plant and algae growth. In some lakes, the internal release of phosphorus from the bottom sediments is the primary source of phosphorus loading.

By reducing the amount of phosphorus in a lake, it may be possible to limit the amount of aquatic plant and algae growth. In general, lakes with a phosphorus concentration greater than 20 µg/L (micrograms per liter, or parts per billion) are able to support abundant growth and are classified as nutrient-enriched or eutrophic.

CHLOROPHYLL-*a*

Chlorophyll-*a* is a pigment that imparts the green color to plants and algae. A rough estimate of the quantity of algae present in lake water can be made by measuring the amount of chlorophyll-*a* in the water column. A chlorophyll-*a* concentration greater than 6 µg/L is considered characteristic of a eutrophic condition.

SECCHI TRANSPARENCY

A Secchi disk is often used to estimate water clarity. The measurement is made by fastening a round, black and white, 8-inch disk to a calibrated line. The disk is lowered over the deepest point of the lake until it is no longer visible, and the depth is noted. The disk is then raised until it reappears. The average between these two depths is the Secchi transparency. Generally, it has been found that aquatic plants can grow at a depth of approximately twice the Secchi transparency measurement. In eutrophic lakes, water clarity is often reduced by algae growth in the water column, and Secchi disk readings of 7.5 feet or less are common.

Generally, as phosphorus inputs (both internal and external) to a lake increase, the amount of algae the lake can support will also increase. Thus, the lake will exhibit increased chlorophyll-*a* levels and decreased transparency. A summary of lake classification criteria is shown in Table 1.

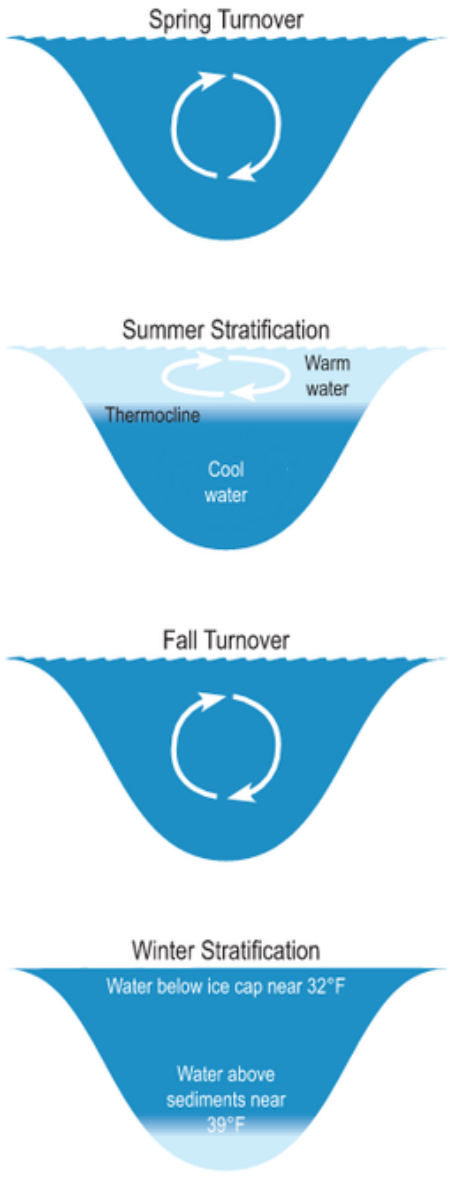
TABLE 1 - LAKE CLASSIFICATION CRITERIA

Lake Classification	Total Phosphorus (µg/L)*	Chlorophyll-*a* (µg/L)*	Secchi Transparency (feet)
Oligotrophic	Less than 10	Less than 2.2	Greater than 15.0
Mesotrophic	10 to 20	2.2 to 6.0	7.5 to 15.0
Eutrophic	Greater than 20	Greater than 6.0	Less than 7.5

* µg/L = micrograms per liter = parts per billion

TEMPERATURE

Temperature is important in determining the type of organisms which may live in a lake. For example, trout prefer temperatures below 68°F. Temperature also determines how water mixes in a lake. As the ice cover breaks up on a lake in the spring, the water temperature becomes uniform from the surface to the bottom. This period is referred to as "spring turnover" because water mixes throughout the entire water column. As the surface waters warm, they are underlain by a colder, more dense strata of water. This process is called thermal stratification. Once thermal stratification occurs, there is little mixing of the warm surface waters with the cooler bottom waters. The transition layer that separates these layers is referred to as the "thermocline." The thermocline is characterized as the zone where temperature drops rapidly with depth. As fall approaches, the warm surface waters begin to cool and become more dense. Eventually, the surface temperature drops to a point that allows the lake to undergo complete mixing. This period is referred to as "fall turnover." As the season progresses and ice begins to form on the lake, the lake may stratify again. However, during winter stratification, the surface waters (at or near 32°F) are underlain by slightly warmer water (about 39°F). This is sometimes referred to as "inverse stratification" and occurs because water is most dense at a temperature of about 39°F. As the lake ice melts in the spring, these stratification cycles are repeated.



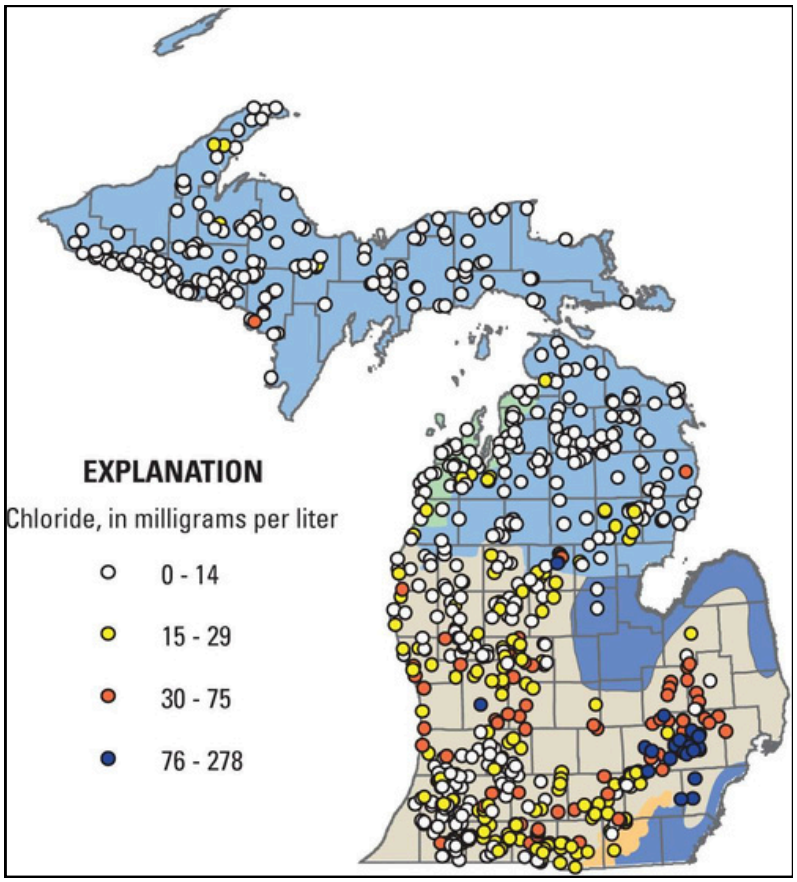
Seasonal thermal stratification cycles.

DISSOLVED OXYGEN

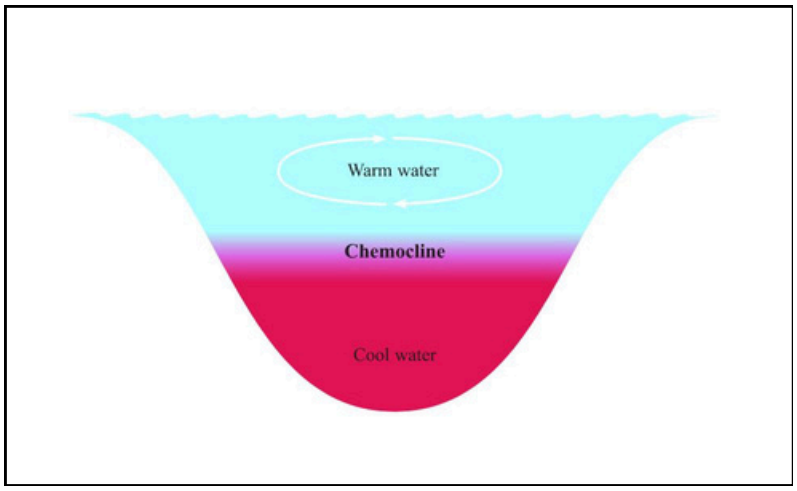
An important factor influencing lake water quality is the quantity of dissolved oxygen in the water column. The major inputs of dissolved oxygen to lakes are the atmosphere and photosynthetic activity by aquatic plants. An oxygen level of about 5 mg/L (milligrams per liter, or parts per million) is required to support warmwater fish. In lakes deep enough to exhibit thermal stratification, oxygen levels are often reduced or depleted below the thermocline once the lake has stratified. This is because the oxygen has been consumed, in large part, by bacteria that use oxygen as they decompose organic matter (plant and animal remains) at the bottom of the lake. Bottom-water oxygen depletion is a common occurrence in eutrophic and some mesotrophic lakes. Thus, eutrophic and most mesotrophic lakes cannot support coldwater fish because the cool, deep water (that the fish require to live) does not contain sufficient oxygen.

CHLORIDE

Normally, chloride is a very minor component of freshwater systems and background concentrations are generally less than about 10 milligrams per liter (Wetzel 2001; Fuller and Taricska 2012, Figure 5). However, chloride pollution from sources such as road salting, industrial or municipal wastewater, water softeners, and septic systems can increase chloride levels in lakes. Increased chloride levels can reduce biological diversity and, because chloride increases the density of water, elevated chloride levels can prevent a lake from completely mixing during spring and fall. The U.S. Environmental Protection Agency's acute and chronic standards for protection of freshwater aquatic life are 860 and 230 milligrams per liter of chloride, respectively (USEPA 2021). EPA states that “[a]quatic life criteria for toxic chemicals are the highest concentration of specific pollutants or parameters in water that are not expected to pose a significant risk to the majority of species in a given environment or a narrative description of the desired conditions of a water body being 'free from' certain negative conditions."



Lake chloride levels (2001–10) in USEPA ecoregions. Fuller and Taricska 2012.



High chloride inputs can result in a chemocline, preventing lake mixing.

pH and TOTAL ALKALINITY

pH is a measure of the amount of acid or base in the water. The pH scale ranges from 0 (acidic) to 14 (alkaline or basic) with neutrality at 7. The pH of most lakes in the Upper Midwest ranges from 6.5 to 9.0 (Michigan Department of Environmental Quality (MDEQ)* 2012; Table 2). In addition, according to EGLE (2020):

While there are natural variations in pH, many pH variations are due to human influences. Fossil fuel combustion products, especially automobile and coal-fired power plant emissions, contain nitrogen oxides and sulfur dioxide, which are converted to nitric acid and sulfuric acid in the atmosphere. When these acids combine with moisture in the atmosphere, they fall to earth as acid rain or acid snow. In some parts of the United States, especially the Northeast, acid rain has resulted in lakes and streams becoming acidic, resulting in conditions which are harmful to aquatic life. The problems associated with acid rain are lessened if limestone is present, since it is alkaline and neutralizes acidity.

Most aquatic plants and animals are adapted to a specific pH range, and natural populations may be harmed by water that is too acidic or alkaline. Immature stages of aquatic insects and young fish are extremely sensitive to pH values below 5. Even microorganisms which live in the bottom sediment and decompose organic debris cannot live in conditions which are too acidic. In very acidic waters, metals which are normally bound to organic matter and sediment are released into the water. Many of these metals can be toxic to fish and humans. Below a pH of about 4.5, fish are unable to survive. The Michigan Water Quality Standard (Part 4 of Act 451) states that pH shall be maintained within the range of 6.5 to 9.0 in all waters of the state.

Alkalinity, also known as acid-neutralizing capacity, is the measure of the pH-buffering capacity of water in that it is the quantitative capacity of water to neutralize an acid. pH and alkalinity are closely linked and are greatly impacted by the geology and soil types that underlie a lake and its watershed. According to MDEQ (2012):

Michigan's dominant limestone geology in the Lower Peninsula and the eastern Upper Peninsula contributes to the vast majority of Michigan lakes being carbonate-bicarbonate dominant [which increases alkalinity and moderates pH] and lakes in the western Upper Peninsula having lower alkalinity and thus lesser buffering capacity. The alkalinity of most lakes in the Upper Midwest is within the range of 23 to 148 milligrams per liter, or parts per million, as calcium carbonate (MDEQ 2012; Table 2).

TABLE 2 - pH AND ALKALINITY OF UPPER MIDWEST LAKES

Measurement	Low	Moderate	High
pH (in standard units)	Less than 6.5	6.5 to 9.0	Greater than 9.0
Total Alkalinity or ANC (in mg/L as CaCO3)*	Less than 23	23 to 148	Greater than 148

* MDEQ now the Michigan Department of Environment, Great Lakes, and Energy

* mg/L as CaCO3 = milligrams per liter as calcium carbonate

SAMPLING METHODS

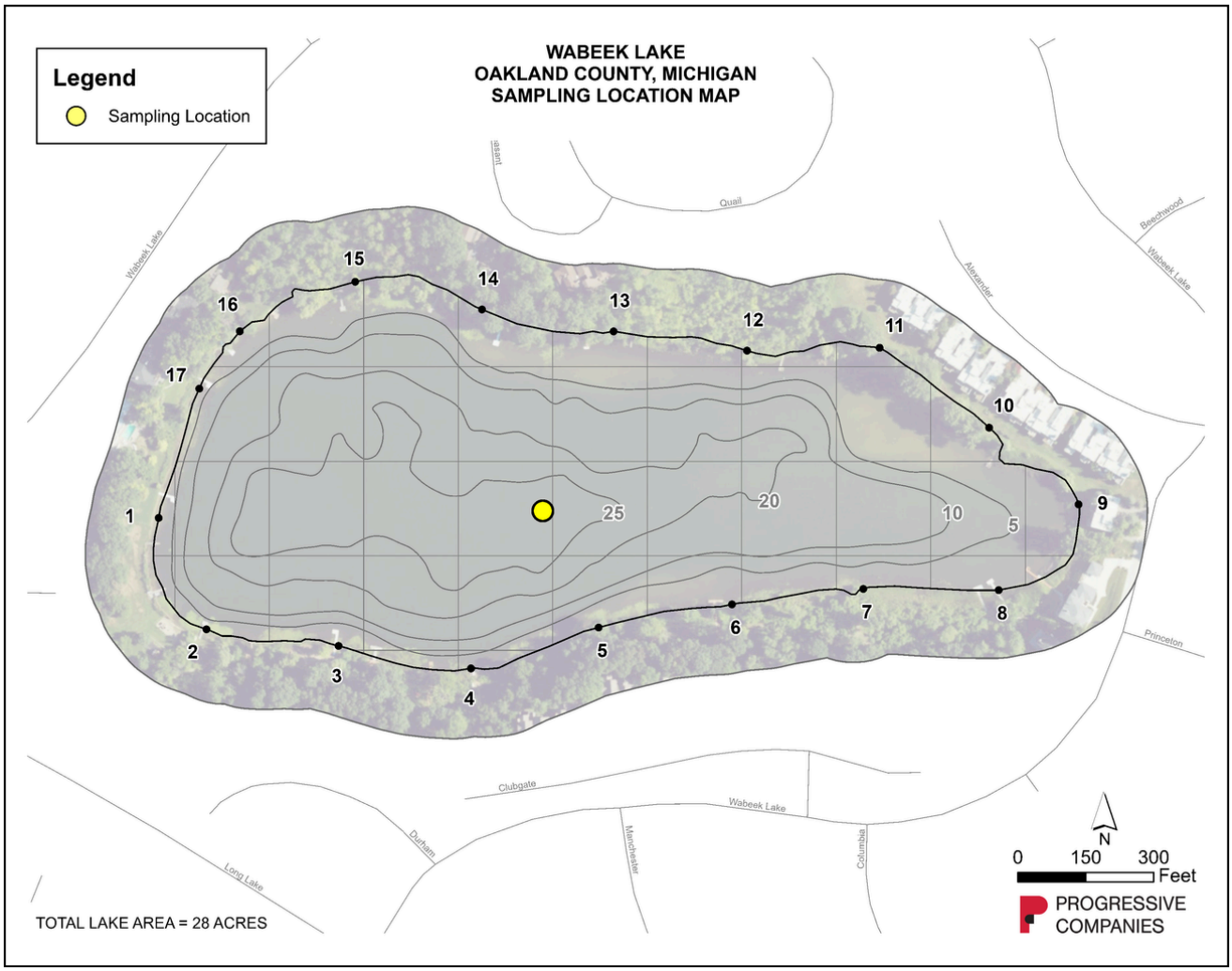
Water quality sampling was conducted in September of 2026 at the deep basin within Wabeek Lake. Temperature and dissolved oxygen were measured using a YSI Prosolo ODO/T probe. Samples were collected at the surface, mid-depth, and just above the lake bottom with a Van Dorn bottle. pH was measured in the field using a Hach Pocket Pro pH meter. Samples were placed on ice and transported to Paragon Laboratories* to analyze for alkalinity, total phosphorus, and chloride using Standard Methods procedures 2320 B, 4500-P B5+E, and EPA 300.0, respectively. In addition to the depth-interval samples at the deep basin, Secchi transparency was measured and a composite chlorophyll-*a* sample was collected from the surface to a depth equal to twice the Secchi transparency. The chlorophyll-*a* sample was analyzed by Prein and Newhof Laboratories* using Standard Methods procedure 10200 H.

SAMPLING RESULTS AND DISCUSSION

Sampling results are provided in Tables 3 and 4. During the September sampling period, Wabeek Lake was thermally stratified; the lake was warm and well-oxygenated at the surface, and was cool with low oxygen near the bottom. In 2026, total phosphorus concentrations were elevated in the bottom waters. The elevated bottom-water phosphorus is likely due to internal release of phosphorus from the lake sediments. pH and total alkalinity were generally within the moderate range for Upper Midwest lakes. Chloride levels were elevated, as is common in southeast Michigan lakes, but below the EPA threshold for chronic risk to aquatic life. Based upon recent sampling results, Wabeek Lake would be classified as meso-eutrophic, that is with moderate total phosphorus concentrations and Secchi transparency and elevated chlorophyll-*a* concentrations.

Due in part to elevated phosphorus levels and the relatively small size of the lake, Wabeek Lake may be a good candidate for nutrient remediation efforts. Several nutrient capture/inactivation technologies exist, including lanthanum-modified bentonite (LMB) products and biochar bags. LMBs are applied as clay slurries, which strip phosphorus from the water column and/or cap the sediment to mitigate internal nutrient loading. Biochar bags are strung from docks, posts, or buoys, and contain a charcoal-adjacent carbon material which captures phosphorus alongside other nutrients and pollutants.

* Paragon Laboratories, 12649 Richfield Ct, Livonia, MI 48150
* Prein and Newhof Laboratories, 3260 Evergreen Dr NE, Grand Rapids, MI 49525



Wabeek Lake sampling location map.

TABLE 3 - WABEEK LAKE 2023-2026 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (F)	Dissolved Oxygen (mg/L)*	Total Phosphorus (µg/L)*	pH (S.U.)*	Alkalinity (mg/L CaCO3)*	Chloride (mg/L)*
8-Jun-23	1	1	73	12.4	<10	8.8	145	137
8-Jun-23	1	13	59	10.5	10	8.5	153	157
8-Jun-23	1	26	45	0.4	202	7.9	185	181
21-Aug-23	1	1	78	8.8	<10	8.6	139	-
21-Aug-23	1	13	72	5.7	<10	8.5	146	-
21-Aug-23	1	26	49	0.2	177	7.6	195	-
31-Jul-24	1	1	82	8.9	<10	8.4	141	-
31-Jul-24	1	13	74	0.4	14	8.1	143	-
31-Jul-24	1	26	53	0.2	61	7.2	197	-
30-Jul-25	1	1	84	7.9	19	8.8	142	-
30-Jul-25	1	14	76	2.3	<10	8.1	165	-
30-Jul-25	1	27	49	0.1	202	7.6	*n/d	-
17-Sep-26	1	1	72	7.0	<10	9.1	150	170
17-Sep-26	1	12	72	6.5	11	9.0	170	-
17-Sep-26	1	25	53	0.1	81	7.9	270	170

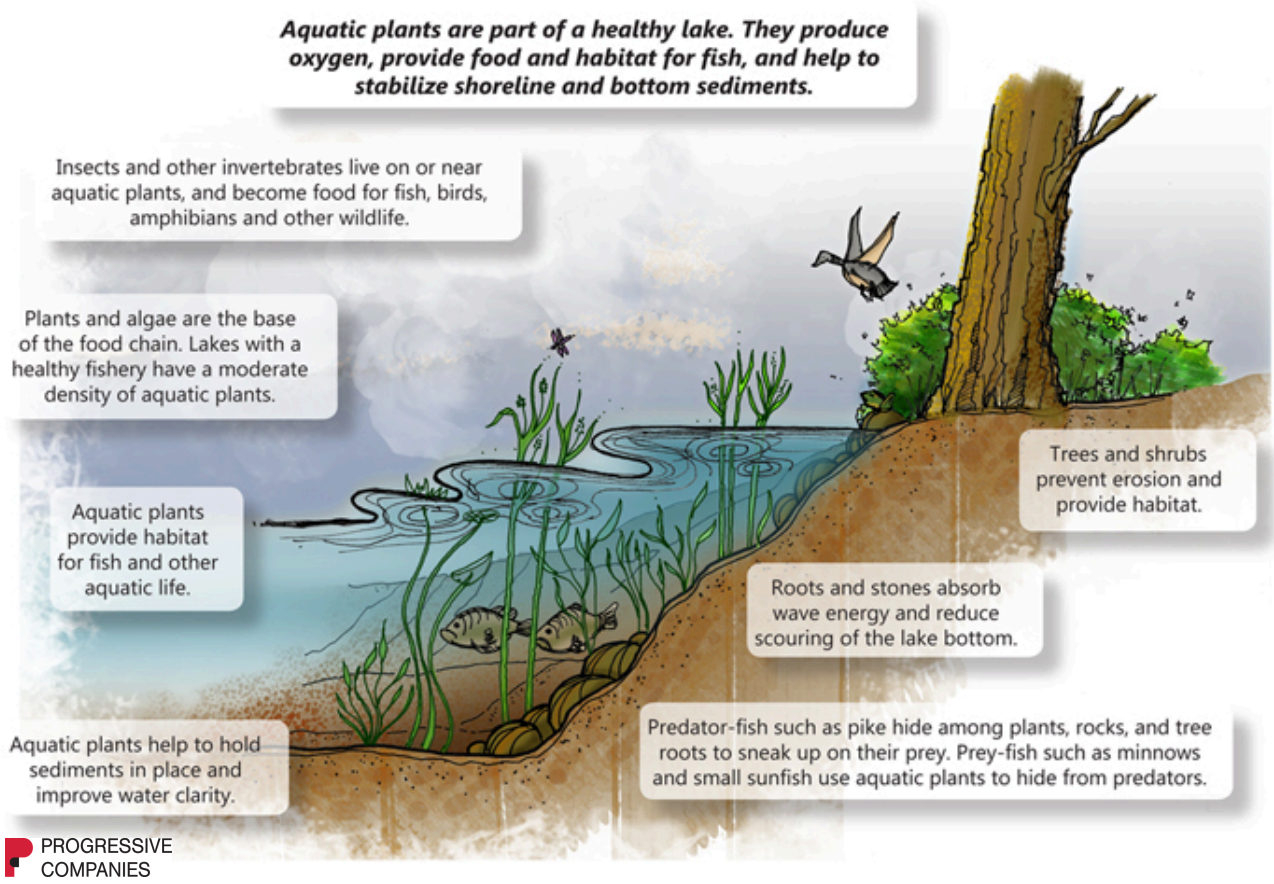
TABLE 4 - WABEEK LAKE 2023-2026 SURFACE WATER QUALITY DATA

Date	Station	Secchi Transparency (feet)	Chlorophyll-*a* (µg/L)*
8-Jun-23	1	3.5	4
21-Aug-23	1	6.0	3
31-Jul-24	1	8.0	36
30-Jul-25	1	10.0	2
17-Sep-26	1	12.0	7

* mg/L = milligrams per liter = parts per million
* µg/L = micrograms per liter = parts per billion
* mg/L CaCO3 = milligrams per liter as calcium carbonate
* n/d = no data

PLANT CONTROL PROGRAM SUMMARY

A nuisance aquatic plant control program has been ongoing on Wabeek Lake for several years. The primary objective of the program is to prevent the spread of invasive aquatic plants while preserving beneficial native plant species. This report contains an overview of plant control activities conducted on Wabeek Lake in 2026.



Aquatic plants are an important component of lakes. They produce oxygen during photosynthesis, provide food, habitat and cover for fish, and help stabilize shoreline and bottom sediments. There are four main aquatic plant groups: submersed, floating-leaved, free-floating, and emergent. Each plant group provides important ecological functions. Maintaining a diversity of native aquatic plants is important to sustaining a healthy fishery and a healthy lake. Invasive aquatic plant species have negative impacts on the lake's ecosystem. It is important to maintain an active plant control program to reduce the establishment and spread of invasive species within Wabeek Lake. Plant control efforts in 2026 consisted of three surveys and two aquatic herbicide treatments.

PLANT CONTROL

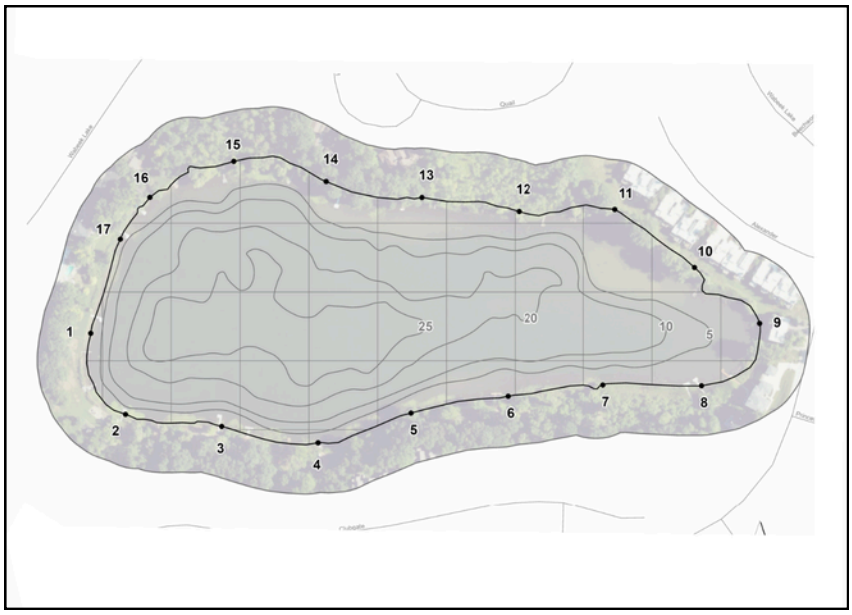
Plant control activities are coordinated under the direction of an environmental consultant, Progressive Companies. Scientists from Progressive conduct GPS-guided surveys of the lake to identify problem areas, and georeferenced plant control maps are provided to the plant control contractor. GPS reference points are established along the shoreline and drop-off areas of the lake. These waypoints are used to accurately identify the location of invasive and nuisance plant growth areas.



Eurasian milfoil
Myriophyllum spicatum



Curly-leaf pondweed
Potamogeton crispus



Primary plants targeted for control in Wabeek Lake include Eurasian milfoil and curly-leaf pondweed. These plants are non-native (exotic) species that tend to be highly invasive and have the potential to spread quickly if left unchecked. Plant control activities conducted on the lake in 2026 are summarized in Table 5.

In Michigan, an Aquatic Nuisance Control (ANC) permit must be acquired from the Department of Environment, Great Lakes, and Energy (EGLE) before herbicides are applied to inland lakes. The permit lists the herbicides that are approved for use, maximum dose rates, use restrictions, and indicates specific areas of the lake where herbicides may be applied. Permit requirements are designed to protect public health and the environment. The contracted herbicide applicator on Wabeek Lake, Aqua-Weed Control, Inc., holds the ANC permit for the lake.

TABLE 5 - WABEEK LAKE 2026 PLANT CONTROL ACTIVITIES

Date	Work Type	Plants Targeted	Acreage
May 20	Survey	NA	-
May 28	Herbicide Treatment	Non-native milfoil, curly-leaf	7.0
June 29	Survey	NA	-
August 20	Survey	NA	-
October 8	Herbicide Treatment	Water lilies	0.5
Total			**7.5**

In 2026, 7.5 acres of Wabeek Lake were treated with aquatic herbicides throughout the season. Non-native milfoil was treated with the systemic herbicide, ProcellaCOR, for season-long control. Curly-leaf pondweed was treated with contact herbicides. A water lily treatment was conducted in the fall.

Active monitoring and management of the aquatic invasive plant community within Wabeek Lake should continue. Non-native milfoil and curly-leaf pondweed should be controlled early in the season to prevent their spread. Emergent invasives should be targeted for control in 2027. Purple loosestrife should be treated in mid-summer, prior to seed production, to reduce regrowth in subsequent seasons. *Phragmites* around the shoreline of the lake should be treated in the fall months, to gain extended systemic control and reduce regrowth.

PLANT INVENTORY SURVEY

In addition to the surveys of the lake to identify invasive plant locations, a detailed vegetation survey of Wabeek Lake was conducted on August 20 to evaluate the type and abundance of all plants in the lake. The table below lists each plant species observed during the survey and the relative abundance of each. At the time of the survey, five submersed species, two floating-leaved species, and seven emergent species were found in the lake. Wabeek Lake maintains a moderate diversity of beneficial native plant species.

TABLE 6 - WABEEK LAKE 2026 PLANT INVENTORY DATA

Common Name	Scientific Name	Group	Percentage of sites where present
Variable pondweed	*Potamogeton gramineus*	Submersed	47
Thin-leaf pondweed	*Potamogeton* sp.	Submersed	29
Chara	*Chara* sp.	Submersed	18
Wild celery	*Vallisneria americana*	Submersed	12
Sago pondweed	*Stuckenia pectinata*	Submersed	6
White waterlily	*Nymphaea odorata*	Floating-leaved	94
Yellow waterlily	*Nuphar* sp.	Floating-leaved	24
Cattail	*Typha sp.*	Emergent	65
Swamp loosestrife	*Decodon verticillatus*	Emergent	47
Phragmites	*Phragmites australis*	Emergent	35
Bulrush	*Schoenoplectus* sp.	Emergent	29
Pickerelweed	*Pontederia cordata*	Emergent	29
Lake sedge	*Carex lacustris*	Emergent	12
Buttonbush	*Cephalanthus occidentalis*	Emergent	6

Exotic invasive species