Improvement Feasibility Report

Wabeek Lake
Improvement Feasibility Study Report

Prepared for:
Wabeek Lake – Lake Board
4200 Telegraph Road
PO Box 489
Bloomfield, MI 48303-0489

Prepared by:
Progressive AE
1811 4 Mile Road, NE
Grand Rapids, MI 49525-2442
616/361-2664

March 2019
Revised May 1, 2019

Project No: 84940001

progressive|ae

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Introduction

Wabeek Lake is located in Section 18 of Bloomfield Township, Michigan (T.2N, R.10E; Figure 1). In June of 2018, the Wabeek Lake - Lake Board retained Progressive AE to conduct a lake improvement feasibility study and to prepare an updated lake improvement plan for Wabeek Lake. As part of the study, Progressive AE evaluated the physical characteristics of the lake, current water quality conditions, aquatic vegetation, drainage to the lake, and alternatives to improve lake conditions. This report contains a summary of study findings, conclusions and recommendations.

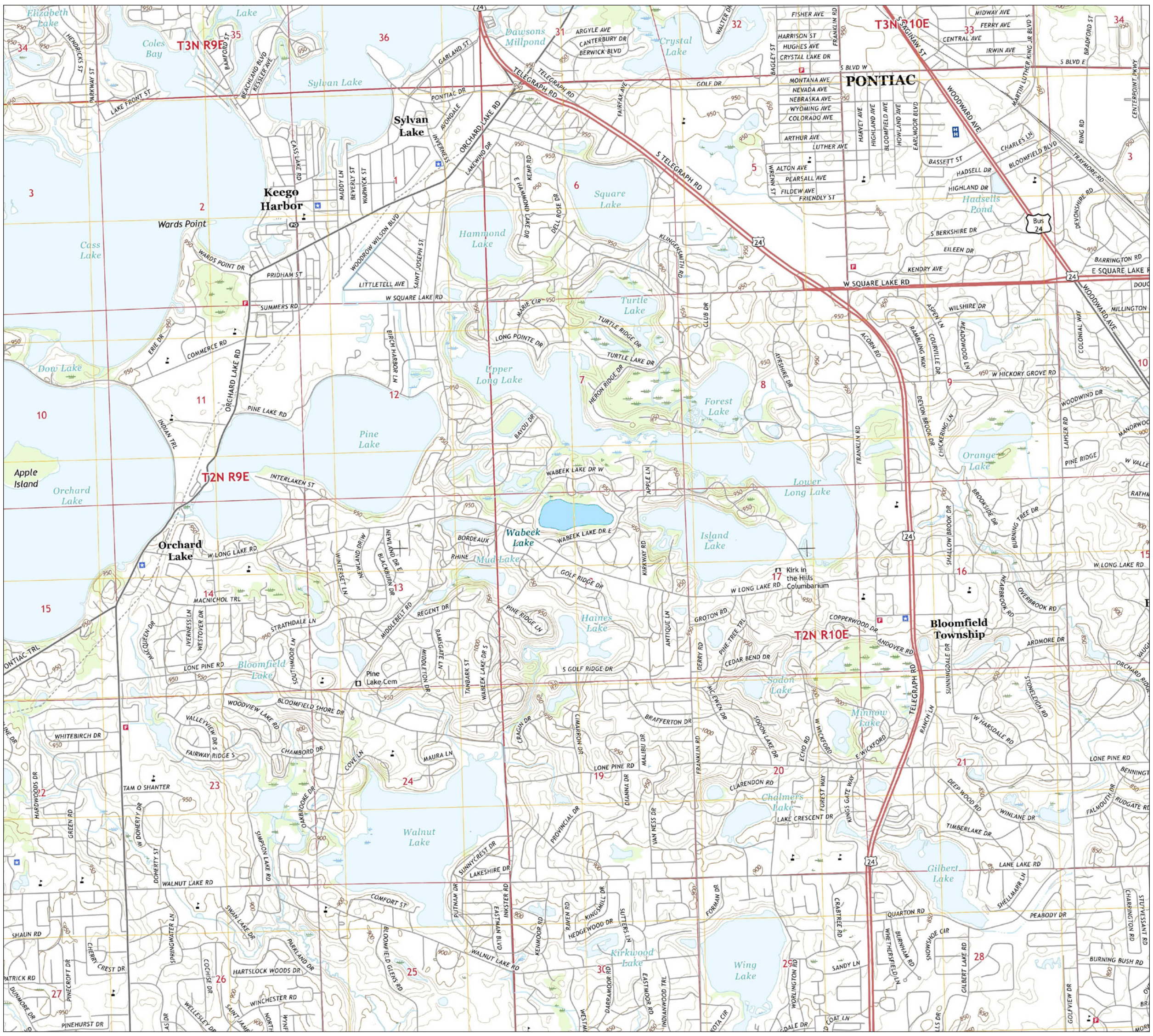

Figure 1. Project location map.

Lake Physical Characteristics

A summary of the physical characteristics of Wabeek Lake is provided in Table 1. A depth contour map of Wabeek Lake created during the study is shown in Figure 2. Wabeek Lake has a surface area of 28 acres, a maximum depth of 28 feet, and a mean or average depth of 15.7 feet. Shoreline development factor is a measure of the irregularity of the shore. A lake this is perfectly round has a shoreline development factor of 1.0. Wabeek Lake has a shoreline development factor of 1.3 which indicates the lake shore is 30% longer than if the lake was perfectly round. The lake contains 439 acre-feet of water which equates to 143 million gallons. Water flows from Wabeek Lake to Upper Long Lake and eventually to the Rouge River and the Detroit River.

TABLE 1
WABEEK LAKE PHYSICAL CHARACTERISTICS

Lake Surface Area	28	Acres
Maximum Depth	28	Feet
Mean Depth	15.7	Feet
Lake Volume	439	Acre-Feet
Shoreline Length	0.9	Miles
Lake Elevation	922	Feet Above Sea Level

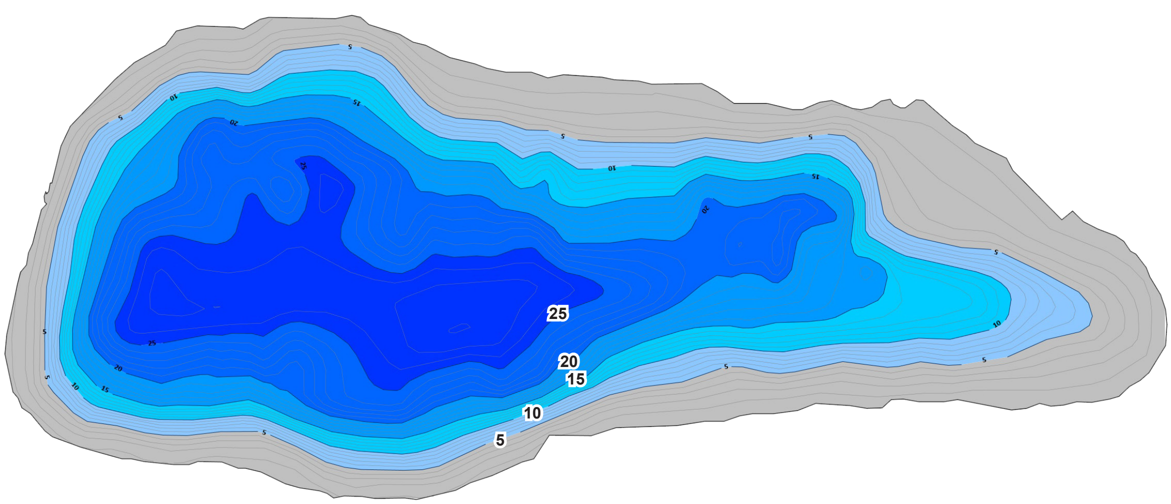

Figure 1. Wabeek Lake depth contour map. Source: Aqua-Weed Control, Inc.

Lake Water Quality

Lakes can be classified into three broad categories based on their productivity or ability to support plant and animal life. The three basic lake classifications are oligotrophic, mesotrophic, and 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.

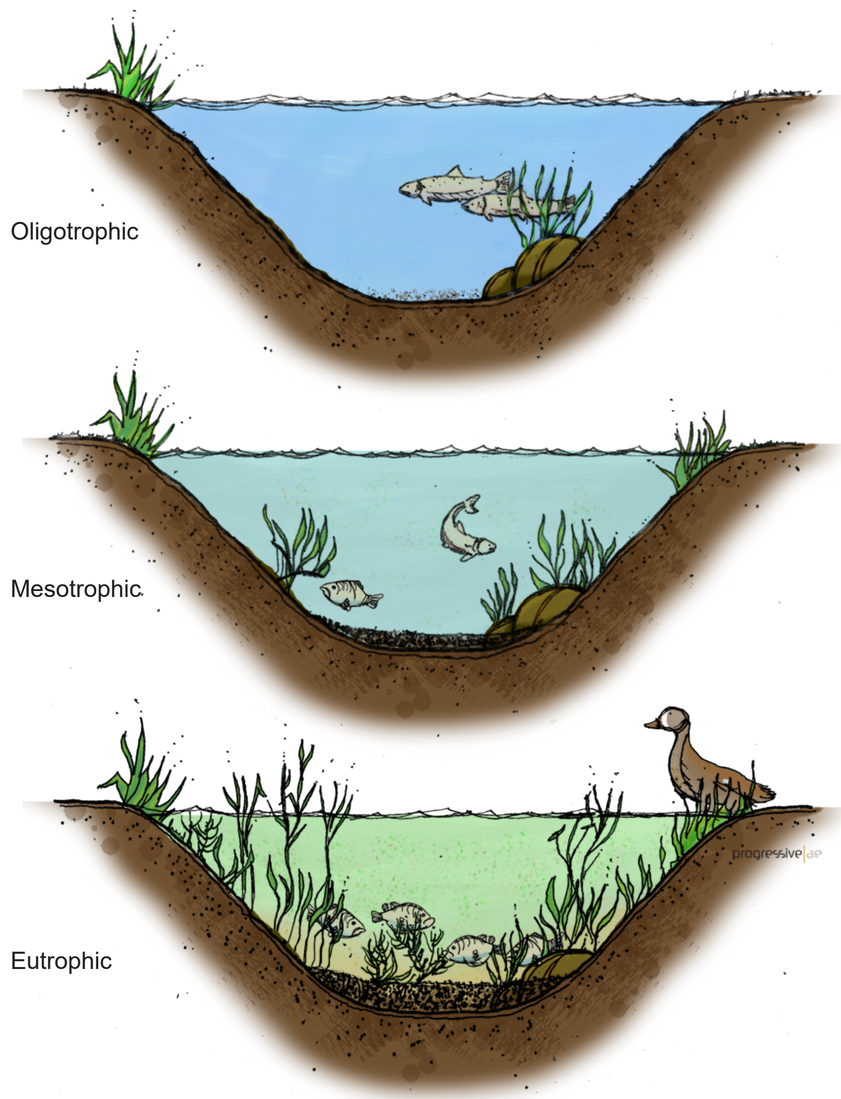

Figure 3. Lake classification.

Eutrophic lakes have poor clarity 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 warm water fish such as bass and pike.

Lakes that fall between the two extremes of oligotrophic and eutrophic are called *mesotrophic* lakes.

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 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*.

WABEEK LAKE WATER QUALITY

On May 16, 2018 and April 10, 2019, Aqua-Weed Control, Inc. collected surface samples to evaluate baseline water quality conditions in Wabeek Lake (Appendix A). Key parameters used to evaluate a lake's productivity or trophic state include total phosphorus, chlorophyll-*a*, and Secchi transparency.

Phosphorus is the nutrient that most often stimulates excessive growth of aquatic plants and causes premature lake aging. By measuring phosphorus levels, it is possible to gauge the overall health of a lake.

Chlorophyll-*a* is a pigment that imparts the green color to plants and algae. A rough estimate of the quantity of algae present in the water column can be made by measuring the amount of chlorophyll-*a* in the water column.

A Secchi disk is a round, black and white, 8-inch disk that is used to estimate water clarity. Generally, it has been found that plants can grow to a depth of about twice the Secchi disk transparency.

Generally, as phosphorus inputs to a lake increase, algae growth and chlorophyll-*a* increase and Secchi transparency decreases.

TABLE 2
LAKE CLASSIFICATION CRITERIA

Lake Classification	Total Phosphorus (µg/L)[1]	Chlorophyll-*a* (µg/L)[1]	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

On the May 16, 2018 sampling date, the average surface water total phosphorus concentration in Wabeek Lake was 24 parts per billion, the average chlorophyll-*a* level was less than 1 part per billion, and Secchi transparency was 8.75 feet. During the April 10, 2019 sampling period, the average surface water total phosphorus concentration was 51 parts per billion, the average chlorophyll-*a* level was 8 parts per billion, and Secchi transparency was 2.75 feet. The increased total phosphorus and chlorophyll-*a* levels and reduced transparency readings in April of 2019 may be related to increased spring runoff into Wabeek Lake. Based on the criteria in Table 2, water quality in 2018 was mesotrophic while the 2019 readings exceeded the eutrophic threshold for all measurements. During both sampling periods, *E. coli* levels were well below the state water quality standard for safe swimming and total body contact recreation.

1 µg/L = micrograms per liter = parts per billion.

Aquatic Plants

In evaluating aquatic plant growth and plant control alternatives, it is important to remember that aquatic plants are an important ecological component of lakes. They produce oxygen from photosynthesis, provide food and habitat for fish, and help stabilize shoreline and bottom sediments (Figure 4).

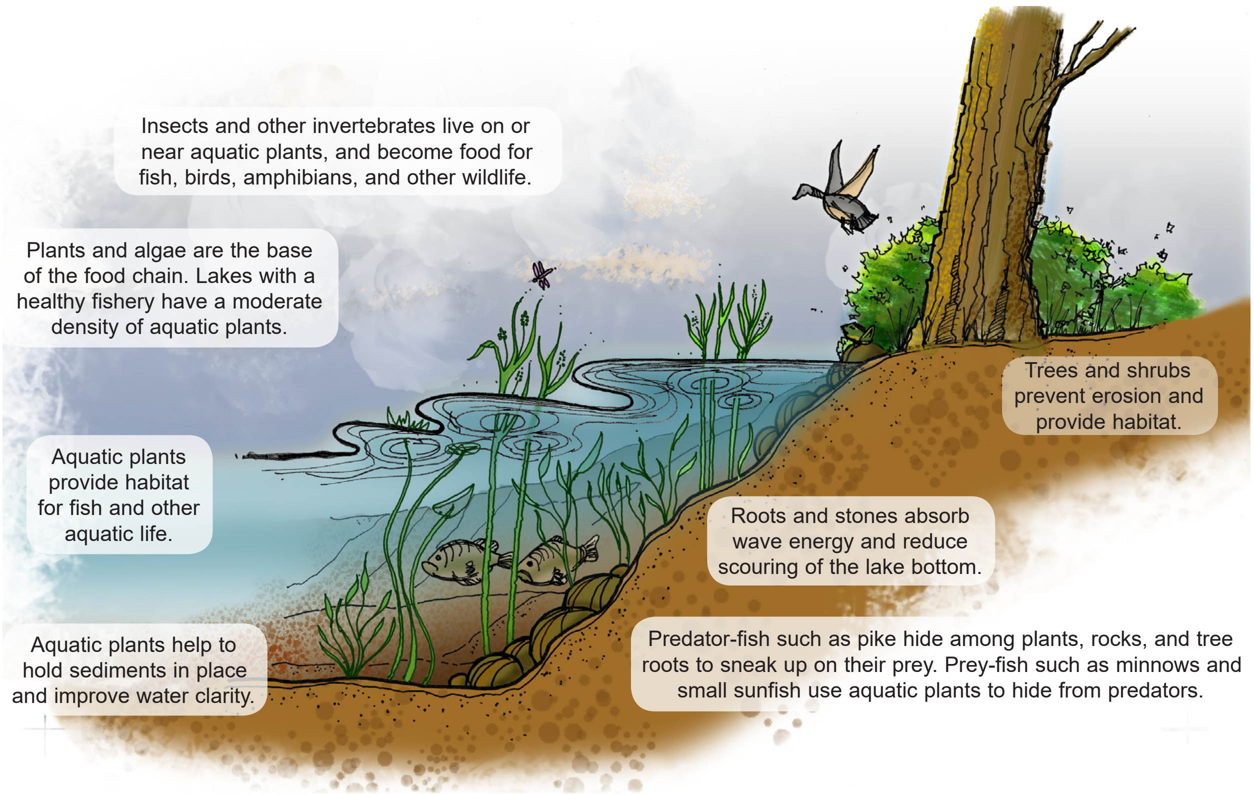

Figure 4. Benefits of aquatic plants.

The distribution and abundance of aquatic plants are dependent on several variables, including light penetration, bottom type, temperature, water levels, and the availability of plant nutrients. The term "aquatic plants" includes both the algae and the larger aquatic plants or macrophytes. The macrophytes can be categorized into four groups: the emergent, the floating-leaved, the submersed, and the free floating (Figure 5). Each plant group provides unique habitat essential for a healthy fishery.

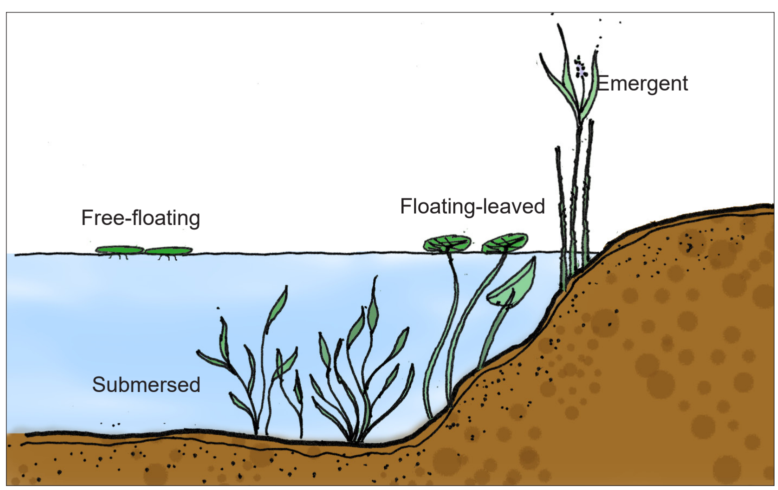

Figure 5. Aquatic plant groups.

However, while most aquatic plants are beneficial, exotic (i.e., non-native) plant species are a problem in many lakes. Exotic aquatic plants often have aggressive and invasive growth tendencies and, in some lakes, they quickly out-compete native plants and gain dominance. In Michigan lakes, exotic plants of primary concern include Eurasian milfoil (*Myriophyllum spicatum*, Figure 6) and starry stonewort (*Nitellopsis obtusa*, Figure 7). Both of these plants have been documented in Wabeek Lake (Pullman 2017).

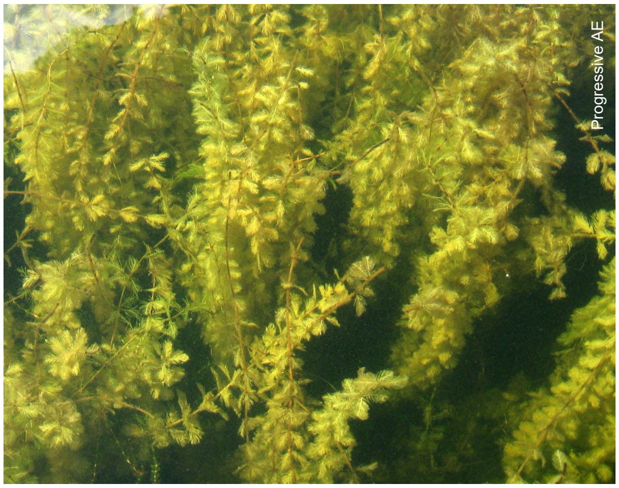

Figure 6. Eurasian milfoil (*Myriophyllum spicatum*).

Figure 7. Starry stonewort (*Nitellopsis obtusa*).

Eurasian milfoil and hybrid milfoil generally become established early in the growing season and can grow at greater depths than most plants. Eurasian milfoil often forms a thick canopy at the lake surface that can degrade fish habitat and seriously hinder recreational activity. Once introduced into a lake system, Eurasian milfoil may out-compete and displace more desirable plants and become the dominant species.

Starry stonewort looks like a rooted plant, but it is actually an alga. It was first found in the Detroit River in the 1980's and has since infested hundreds of inland lakes (Midwest Invasive Species Information Network 2019, Schloesser et al. 1986). Starry stonewort closely resembles the native aquatic plant Chara. However, unlike Chara, which is generally considered to be a beneficial plant, starry stonewort tends to colonize deeper water and can form dense mats several feet thick. Starry stonewort can impede navigation, and quickly displace native plants. Fisheries biologists have expressed concern that starry stonewort may cover valuable fish habitat and spawning areas.

WABEEK LAKE AQUATIC PLANTS

On July 25, 2018, an aquatic vegetation survey was conducted to determine the type and distribution of aquatic plants in Wabeek Lake (Table 3). The littoral zone of Wabeek Lake (i.e., the portion of the lake shallow enough to support plant growth) extends from the shore to a depth of about 15 feet, an area of about 15 acres. At the time of the survey, six submersed plant species, two floating-leaved, and eight emergent plant species were observed. Eurasian milfoil and Illinois pondweed were the dominant submersed species present in the lake. Although starry stonewort was not found during the current survey, it has been a problem in Wabeek Lake in the past (Pullman 2017).

Emergent vegetation grows along much of the Wabeek Lake shoreline and provides a natural buffer between the lake and the developed upland areas around the lake (Figure 8). In a recent nation-wide study, the U.S. Environmental Protection Agency found that lakes that lacked natural shoreline habitat were three times more likely to be in poor biological conditions (USEPA 2010). The natural shoreline areas around Wabeek Lake help to protect water quality by filtering and trapping fertilizers and other pollutants. For long-term water quality protection, the natural shoreline areas around Wabeek Lake should be preserved to the extent practical (Appendix B).

TABLE 3
WABEEK LAKE AQUATIC PLANTS

July 25, 2018

Common Name	Scientific Name	Group	Percent of Sites Where Plant Was Found
Eurasian milfoil	*Myriophyllum spicatum*	Submersed	93
Illinois pondweed	*Potamogeton illinoensis*	Submersed	50
Thin-leaf pondweed	*Potamogeton* sp.	Submersed	23
Coontail	*Ceratophyllum demersum*	Submersed	17
Bladderwort	*Utricularia vulgaris*	Submersed	13
Brittle-leaf naiad	*Najas minor*	Submersed	3
White waterlily	*Nymphaea odorata*	Floating-leaved	83
Yellow waterlily	*Nuphar* sp.	Floating-leaved	17
Swamp loosestrife	*Decodon verticillatus*	Emergent	70
Pickerelweed	*Pontederia cordata*	Emergent	47
Cattail	*Typha* sp.	Emergent	40
Bulrush	*Scirpus* sp.	Emergent	27
Purple loosestrife	*Lythrum salicaria*	Emergent	20
Phragmites	*Phragmites australis*	Emergent	13
Buttonbush	*Cephalanthus occidentalis*	Emergent	3
Arrowhead	*Sagittaria latifolia*	Emergent	3

Figure 8. Wabeek Lake natural shoreline.

Lake Improvement Alternatives

AQUATIC PLANT CONTROL

Given the problems caused by Eurasian milfoil infestations, considerable effort and funds are spent in Michigan and nationwide to control the plant. The most common method of milfoil control is the application of aquatic herbicides. There are two types of herbicides: systemic and contact. Systemic herbicides are taken up by the plant and translocated to the roots, resulting in more effective control. Contact herbicides only impact the portions of the plant that come into contact with the herbicide. They also tend to be broad spectrum; they kill both milfoil and desirable native plants. By contrast, systemic herbicides kill milfoil with little or no impact to native plants. Contact herbicides work relatively quickly while systemic herbicides generally take several weeks to kill the targeted plant. However, control with contact herbicides is usually short-lived and milfoil can re-grow within a few weeks. Other methods of control include mechanical harvesting and diver-assisted suction harvesting (DASH). Because Eurasian milfoil can spread by vegetative propagation, it is generally ill-advised to attempt to control Eurasian milfoil by mechanical harvesting. DASH is being used on a limited number of lakes, but is relatively expensive, labor-intensive and time-consuming. In recent years, a native aquatic insect called the milfoil weevil (Euhrychiopsis lecontei) has also been used in an attempt to control milfoil. However, these attempts have been largely unsuccessful.

Control of starry stonewort remains a challenge. Herbicide treatments and mechanical harvesting are partially effective at controlling starry stonewort infestations and may work best when used in combination (Glisson et al. 2017). However, neither herbicides nor mechanical harvesting reduce the viability of bulbils, therefore, the plants can continue to overwinter and reproduce. Control of starry stonewort infestations via DASH is time- and labor-intensive and may require repeat visits to maintain control (Hackett et al. 2014). Repeated herbicide treatments will likely be required to effectively control starry stonewort in Wabeek Lake.

An aquatic plant control program, consisting of the use of aquatic herbicides to control nuisance plant growth, has been ongoing on Wabeek Lake for several years. Coupled with the treatment program, annual monitoring of the aquatic plant community is conducted to evaluate species abundance and diversity. It is recommended that the monitoring and plant control program continue with a focus of controlling invasive species such as Eurasian milfoil and starry stonewort while preserving beneficial, native plants species.

LAKE DREDGING

There are two major dredging methods: mechanical and hydraulic. While both methods involve removing sediment from the water, the operations are quite different. Mechanical dredging involves removing lake sediments with an excavator operating from shore or from a floating barge (Figure 9). Dredged material is disposed of on shore or contained on the barge and off-loaded for final disposal. By contrast, material excavated with a hydraulic dredge is pumped in a slurry through a floating pipeline to the point of disposal (Figure 10).

Figure 9. Mechanical excavator.

Figure 10. Hydraulic dredge.

Since placing dredged materials on shoreline properties is generally not feasible, a primary consideration in a lake dredging project is identifying a suitable location (or locations) for the placement of dredged material. With mechanical dredging operations, dredged materials are often trucked to the disposal site. With hydraulic dredging, disposal sites are usually constructed by excavating an area and creating an earthen dike to contain the dredged slurry (Figure 11). The disposal cell must be adequately sized to accommodate the amount of dredged material and water produced during the dredging operation. The disposal cell should be designed to maximize the settling of solids while allowing excess water to drain off-site.

Another method of disposal that has gained popularity in recent years is to pump dredged materials into sealed, geotextile tubes (Figure 12). The tubes are filled with dredged materials and excess water percolates though the geotextile fabric walls and can be routed off-site.

Figure 11. Dredge material disposal cell.

Figure 12. Geotextile tubes for disposal of dredged material.

Pursuant to provisions of Part 301 (Inland Lakes and Streams) of Michigan's Natural Resource and Environmental Protection Act, a permit must be acquired from the Department of Environmental Quality (DEQ) before a dredging project on an inland lake can be initiated. As part of the approval process, DEQ may require that sediments be sampled for contaminants. Permit conditions will generally require that the dredge disposal site be located in an upland location and that steps be taken during the dredging operation to prevent excessive sediment transport to adjacent areas. The DEQ does not typically allow dredge spoils to be placed in wetland areas. As a condition of the permit, the DEQ may limit the timing of dredge operations to minimize impacts upon spawning fish and other aquatic animals.

One of the major challenges in a dredging project is locating a suitable location to dispose of dredged material. Given the extent of development near Wabeek Lake, nearby placement of dredged material is unlikely. An alternative to address this issue would be to conduct dredging in stages. With this approach, material dredged from the lake would be temporality stored near the lake and dewatered, and eventually trucked to a suitable disposal site for final disposal. Another consideration with dredging is cost. In order to deepen about one-third of the lake by a depth of five feet, approximately 72,600 cubic yards of material would need to be removed from the lake. Assuming a cost of $50 per cubic yard to dredge and dispose of material, a project of this scope would cost $2.9 million to $3.6 million, plus additional costs for engineering, legal, permitting and contingencies (35%). Given the cost and the limited need for dredging in Wabeek Lake, dredging does not appear to be a cost-effective lake improvement alternative.

STORM DRAIN IMPROVEMENTS

In recent decades, considerable development has occurred around Wabeek Lake. With this development, stormwater infrastructure was constructed to control drainage and prevent flooding. In several locations, storm drains discharge directly to Wabeek Lake (Figure 13). From a water quality perspective, stormwater drains are a concern because they have the potential to transport fertilizer, sediment, oil, gas and other pollutants to the lake.

Of the storm drains entering Wabeek Lake, the largest is a 30-inch corrugated metal pipe that discharges at the east end of the lake (Figure 14). This storm drain receives drainage from a large area of the eastern portion of the watershed. Given its relatively large drainage area, the east storm drain has the greatest potential to adversely impact lake water quality. One way to reduce the potential impact of this storm drain would be to install a stormwater treatment device such as a Vortechs® near the end of the pipe (Appendix C). These systems are designed to capture and retain trash, debris, sediment, and hydrocarbons from stormwater runoff. Maintenance is required on a periodic basis to remove trapped pollutants. Given its proximity to the lake, a project of this nature would require a soil erosion permit pursuant to Part 91 (Soil Erosion and Sedimentation Control) of the Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended. An estimate of probable construction costs to implement this improvement is provided in Table 4.

Figure 13. Storm drain map.

TABLE 4
WABEEK LAKE STORM DRAIN IMPROVEMENTS
ESTIMATE OF PROBABLE CONSTRUCTION COSTS

Item	Cost
Stormwater Treatment Unit	$80,000
Engineering, Administration and Permitting	$20,000
Contingency	$15,000
Total	$115,000

LAUNCH SITE IMPROVEMENTS

Wabeek Lake is a private lake that does not have a public access site. However, a small, unpaved launch site exists on the east end of the lake that is used for lake maintenance, such as the launching of treatment boats and mechanical harvesting equipment (Figure 14). The launch is just over 100-feet long, 15 feet wide, and is steeply sloped. The current launch is difficult to use and is in need to rehabilitation to serve its intended purpose.

Figure 14. Wabeek Lake launch site.

It is recommended that crushed concrete be placed on the ramp path and a concrete launch pad be placed at the foot of the ramp to stabilize the bottom and facilitate the launching of equipment (Appendix D). A project of this nature would require permits pursuant to Part 91 (Soil Erosion and Sedimentation Control) and Part 301 (Inland Lakes and Streams) of the Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended. An estimate of probable costs to construct the recommended launch improvements is provided in Table 5.

TABLE 5
WABEEK LAKE LAUNCH SITE IMPROVEMENTS
ESTIMATE OF PROBABLE CONSTRUCTION COSTS

Item	Cost
Aggregate Approach ($2,500) with Concrete Landing ($12,500)	$15,000
Engineering, Administration and Permitting	$10,000
Contingency	$5,000
Total	$30,000

Conclusions and Recommendations

Wabeek Lake has a surface area of 28 acres and a mean, or average, depth of almost 16 feet. The lake contains abundant vegetation including several beneficial submersed and emergent species. The emergent plants along the shoreline are especially beneficial in that they stabilize the shore and buffer the lake from pollution runoff from developed upland areas. Ongoing management of the lake to control nuisance exotic plants appears to be preventing the spread of these species in the lake. Overall water quality conditions in the lake are moderate to good.

Based on study findings, the following is being recommended:

- Annual monitoring of the aquatic plant community and select treatment and/or mechanical harvesting of invasive exotic plants should be continued. Plant control activities should focus on controlling invasive species such as non-native milfoil (both Eurasian and hybrid) and starry stonewort while preserving beneficial, native plants species.
- Storm drain improvements should be considered to minimize potential pollution loading to the lake from the large storm drain at the east end of the lake.
- Launch site improvements should be considered to ensure that maintenance equipment can safely and efficiently gain access to the lake.

Project Financing

Improvements to Wabeek Lake are currently financed through a special assessment district established in accordance with Part 309 (Inland Lake Improvements) of the Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended. The existing special assessment district for the project includes all waterfront properties and back lots with deeded or dedicated access to Wabeek Lake. Waterfront properties are assessed one unit of benefit; back lots with access are assessed one-quarter unit of benefit. Based on these criteria, there are approximately 88 assessment units within the existing special assessment district.

In June of 2018, a four-year (2019 – 2022) special assessment roll was confirmed to finance ongoing plant control activities and other improvements in Wabeek Lake. If the Wabeek Lake – Lake Board desires to expand the program to include the recommendations presented herein, and the costs of the improvements are apportioned as described above, approximate unit costs would be as outlined in Table 6.

TABLE 6
WABEEK LAKE RECOMMENDED LAKE IMPROVEMENT COSTS

Recommended Improvement	Approximate Unit Cost	Approximate Amortized Cost[1]
Storm Drain Improvements	$1,300	$264
Launch Site Improvements	$340	$69

1 Assumes improvements are financed over 5 years at 6% interest.

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Appendix A
Wabeek Lake Water Quality Data

Water Quality Summary – Wabeek Lake Spring 2018

Parameter	Site 1	Site 2	Site 3	Target Range	Status
Chlorophyll α	1.05	0.100	0.203	1-140 mg/m3	Normal
Total Dissolved Solids	536.1	534.6	537.8	0-1,000 ppm	Normal
Dissolved Oxygen	7.73	7.71	7.67	4.0-12.0 ppm	Normal
Phosphate	0.14	.07	.018	15-100 ppb	Normal
Nitrate	< 0.5	< 0.5	< 0.5	0-50 ppm	Normal
Conductivity	826	824	827	100-2000 µs/cm	Normal
E. Coli	32	24	40	<300 CFU/100 mL	Normal

CRITICAL CAUTION NORMAL

Secchi Disk	**8 Feet 9 inches**
Average Water Temperature	**65.6 Degrees Fahrenheit**
Average Salinity	**0.41 ppt**

Discussion

These results show that water body is normal in all aspects according to the findings from the tests. It allows safe use of the water for recreational purposes. It has the proper characteristics to support healthy conditions for aquatic plants and animals.

Chlorophyll α: A measurement of projected biomass and photosynthesis rate of algae and plants within the waterbody. This measurement translates to a trophic state of the lake, or how active the lake is to produce algae and plants. There are four trophic states: Oligotrophic (< 2.5 mg/m3, very inactive), Mesotrophic (2.6-20 mg/m3, moderately active), Eutrophic (20-56 mg/m3, very active) and Hyper Eutrophic (> 56 mg/m3, extremely active). Many lakes and ponds in urbanized areas are Eutrophic to Hyper Eutrophic, meaning there is continuous production of algae and plants due to constant to excessive nutrient loading.

Total Dissolved Solids: The measurement of the combined content of all inorganic and organic substances contained in a waterbody. The principle constituents are usually the cations calcium, magnesium, sodium and potassium and the anions carbonate, bicarbonate, chloride, sulfate and, particularly in groundwater nitrate, pure water will contain no dissolved solids. Storm water run-off is the primary source of dissolved solids. Drinking water must have reading below 500 ppm. Reading of up to 1,000 ppm are generally considered safe for plants and other aquatic organisms.

Dissolved Oxygen: Measures the amount of microscopic bubbles of oxygen gas in the water column. Just like animals on land, animals underwater require oxygen to breath. Warmer water tends to hold less oxygen, so this measurement becomes very important during summer months. Reading below 4 ppm can be fatal. An ideal reading for a waterbody is around 8 ppm, this allows for a healthy ecosystem to exist.

Phosphate and Nitrate: Essential nutrients for all aquatic life. A lack or excess of these components can lead to a change in the trophic state of a waterbody. Phosphate readings between 1-3 ppb are needed to maintain normal aquatic life. Nitrate levels over 50 ppm are polluted waters and unsafe for consumption. When the levels of Nitrates and Phosphates are exceeded excess growth and algal blooms are more prone to occur.

Conductivity: Is the numeric representation of the water's ability to allow electrical flow to pass through. The salinity and TDS are related back to conductivity. The ions in the water are what contributes to the conductivity value. This is important to monitor to make sure there isn't any large amounts of ions flowing into the waterbody that could upset the aquatic life. The normal parameters are quite large and change from waterbody to waterbody. If the reading is between 100-2000 µs/cm that is acceptable, and the readings need to stay consistent.

E. Coli: Are a form of bacteria that live in the intestines and fecal matter of warm blooded organisms. Although the E. coli may not be the agent of disease, high levels of this bacteria indicate the presence of disease-carrying organisms. Per the MDEQ, a single reading over 300 CFU/100 ml or sustained readings over 130 CFU/100ml for 30 days is considered unsafe for swimming.

Secchi Disk: Is a simple tool that is used to determine the water clarity. This is accomplished by lowering the Secchi disk into the water until it disappears from sight and then is raised back until it reappears, and the distance is averaged to determine the amount of water that can be seen through. This creates an absolute determination of the water clarity.

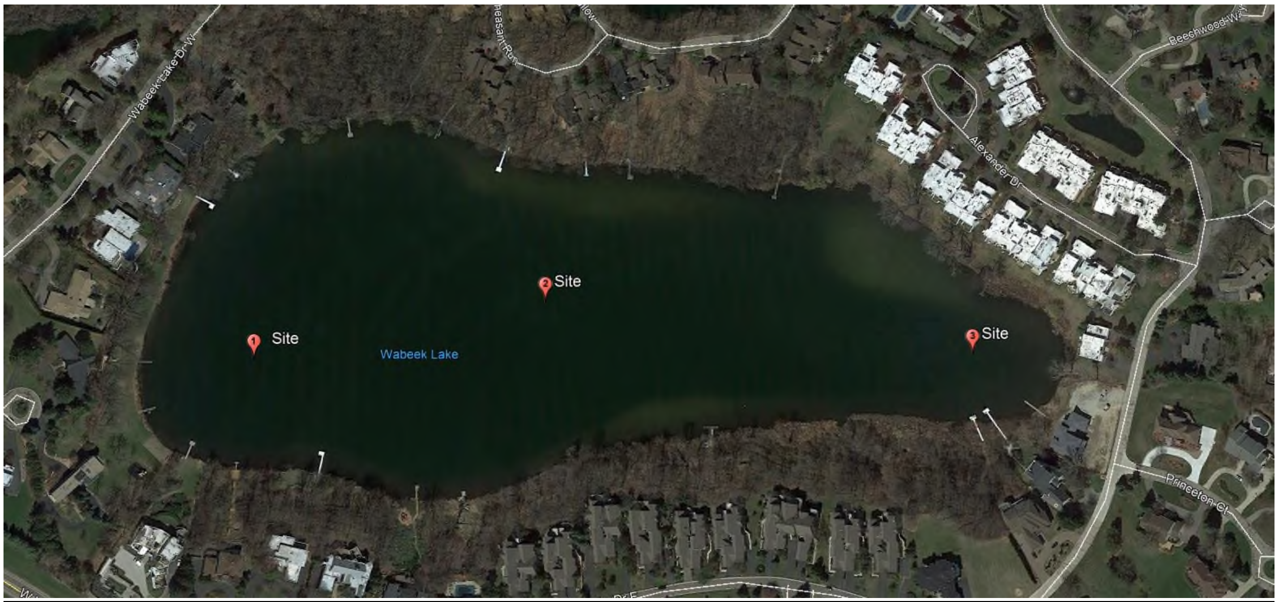
Salinity: The average salinity of ocean water is 35 ppt. To be classified as freshwater the salinity must be below 0.5 ppt

Water samples were taken on 5/16/18. Water tests were completed on 5/21/18. This report describes conditions at the time the samples were taken. The quality of the water was tested only to the parameters listed above.

Compiled and Certified by: ______________________ Date: 6/1/2018
Water Quality Specialist and Environmental Biologist

Reviewed and Approved by: ______________________ Date: 6/1/2018
Aqua-Weed Control Inc.

Site Map


Site
Site
Site
Wabeek Lake
Wabeek Lake Dr W
Alexander Dr
Princeton Ct
Beechwood Way

Water Quality Summary – Wabeek Lake

Parameter	Site 1	Site 2	Site 3	Target Range	Status
Chlorophyll α	8.83	8.17	7.04	1-140 mg/m3	Normal
Total Dissolved Solids	546.1	546.5	548.0	0-1,000 ppm	Normal
Dissolved Oxygen	13.3	13.4	12.86	4.0-12.0 ppm	Normal
Phosphorous	27	47	80	15-100 ppb	Normal
Nitrogen	<.5	<.5	<.5	0-50 ppm	Normal
Conductivity	840	841	843	100-2000 µs/cm	Normal
E. Coli	<1.0	<1.0	4.0	<300 CFU/100 mL	Normal

CRITICAL CAUTION NORMAL

Secchi Disk	**2 Feet 9 Inches**
Average Water Temperature	**52.3 Degrees Fahrenheit**
Average Salinity	**0.42 ppt**

Discussion

These results show that Wabeek Lake is normal in all aspects according to the findings from the tests. It allows safe use of the water for recreational purposes. It has the proper characteristics to support healthy conditions for aquatic plants and animals.

Chlorophyll α: A measurement of projected biomass and photosynthesis rate of algae and plants within the waterbody. This measurement translates to a trophic state of the lake, or how active the lake is to produce algae and plants. There are four trophic states: Oligotrophic (< 2.5 mg/m3, very inactive), Mesotrophic (2.6-20 mg/m3, moderately active), Eutrophic (20-56 mg/m3, very active) and Hyper Eutrophic (> 56 mg/m3, extremely active). Many lakes and ponds in urbanized areas are Eutrophic to Hyper Eutrophic, meaning there is continuous production of algae and plants due to constant to excessive nutrient loading.

Total Dissolved Solids: The measurement of the combined content of all inorganic and organic substances contained in a waterbody. The principle constituents are usually the cations calcium, magnesium, sodium and potassium and the anions carbonate, bicarbonate, chloride, sulfate and, particularly in groundwater nitrate, pure water will contain no dissolved solids. Storm water run-off is the primary source of dissolved solids. Drinking water must have reading below 500 ppm. Reading of up to 1,000 ppm are generally considered safe for plants and other aquatic organisms.

Dissolved Oxygen: Measures the amount of microscopic bubbles of oxygen gas in the water column. Just like animals on land, animals underwater require oxygen to breath. Warmer water tends to hold less oxygen, so this measurement becomes very important during summer months. Reading below 4 ppm can be fatal. An ideal reading for a waterbody is around 8 ppm, this allows for a healthy ecosystem to exist.

Phosphate and Nitrate: Essential nutrients for all aquatic life. A lack or excess of these components can lead to a change in the trophic state of a waterbody. Phosphate readings between 1-3 ppb are needed to maintain normal aquatic life. Nitrate levels over 50 ppm are polluted waters and unsafe for consumption. When the levels of Nitrates and Phosphates are exceeded excess growth and algal blooms are more prone to occur.

Conductivity: Is the numeric representation of the water's ability to allow electrical flow to pass through. The salinity and TDS are related back to conductivity. The ions in the water are what contributes to the conductivity value. This is important to monitor to make sure there isn't any large amounts of ions flowing into the waterbody that could upset the aquatic life. The normal parameters are quite large and change from waterbody to waterbody. If the reading is between 100-2000 µs/cm that is acceptable, and the readings need to stay consistent.

E. Coli: Are a form of bacteria that live in the intestines and fecal matter of warm blooded organisms. Although the E. coli may not be the agent of disease, high levels of this bacteria indicate the presence of disease-carrying organisms. Per the MDEQ, a single reading over 300 CFU/100 ml or sustained readings over 130 CFU/100ml for 30 days is considered unsafe for swimming.

Secchi Disk: Is a simple tool that is used to determine the water clarity. This is accomplished by lowering the Secchi disk into the water until it disappears from sight and then is raised back until it reappears, and the distance is averaged to determine the amount of water that can be seen through. This creates an absolute determination of the water clarity.

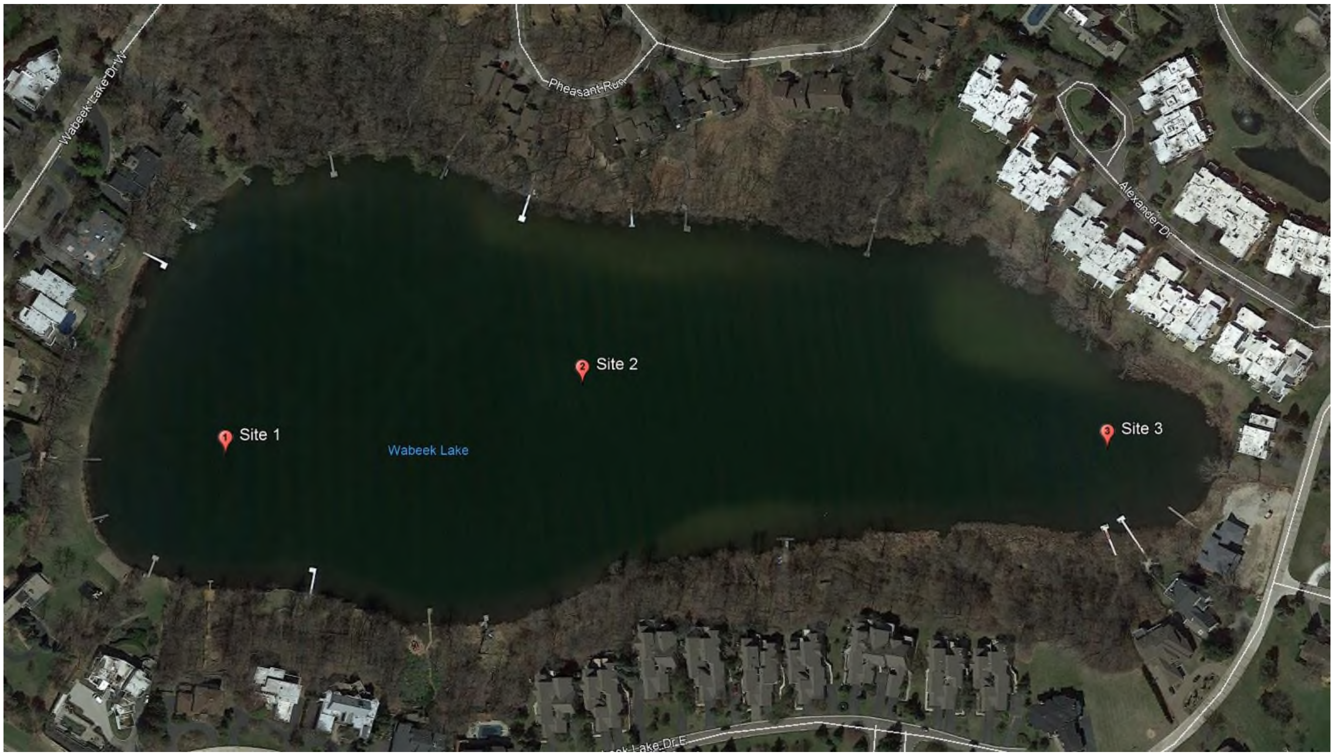
Salinity: The average salinity of ocean water is 35 ppt. To be classified as freshwater the salinity must be below 0.5 ppt

Water samples were taken on 4/10/19. Water tests were completed on 4/12/19. This report describes conditions at the time the samples were taken. The quality of the water was tested only to the parameters listed above.

Compiled and Certified by: ________________________________ Date: 4/20/2019

Water Quality Specialist and Environmental Biologist

Site Locations



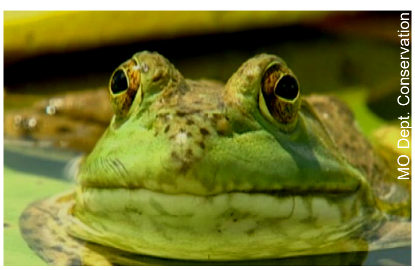
Appendix B
Shoreland Management

Shoreland Management

A publication of the Wabeek Lake — Lake Board

Natural shorelands areas around lakes help to reduce pollution runoff and provide valuable fish and wildlife habitat. As such, natural shorelands are essential to a healthy lake. In a recent U.S. Environmental Protection Agency nation-wide study, loss of natural shoreland was identified as the greatest threat to the nation's lakes. The study found that lakes with poor shoreland habitat were three times more likely to be in poor biological condition. Preserving (or restoring) natural shoreland is one of the most important things we can do to protect the lake.

Due to historical shoreline development patterns, natural shorelands are nearly non-existent on many inland lakes. The challenge and opportunity in the future will be to restore the many ecological benefits of natural shorelands while maintaining full recreational use and enjoyment of our lake. We need to work together to strike a healthy balance.



Seen me lately? Probably not. No plants = no cover = no frogs or other critters.

In addition to providing important environmental benefits, natural shorelands can be beautiful. Recognizing the value of natural shorelands, several states including Minnesota, Wisconsin, Vermont, Maine, and New Hampshire have adopted state-wide shoreland protection regulations. In Michigan, restoration of natural shorelands is fast becoming a priority and several voluntary initiatives are being undertaken to restore natural shorelands. Many lake communities have realized that restoring natural shorelands is a win-win-win scenario: a healthier lake with better water quality; improved fisheries; and better lake living.

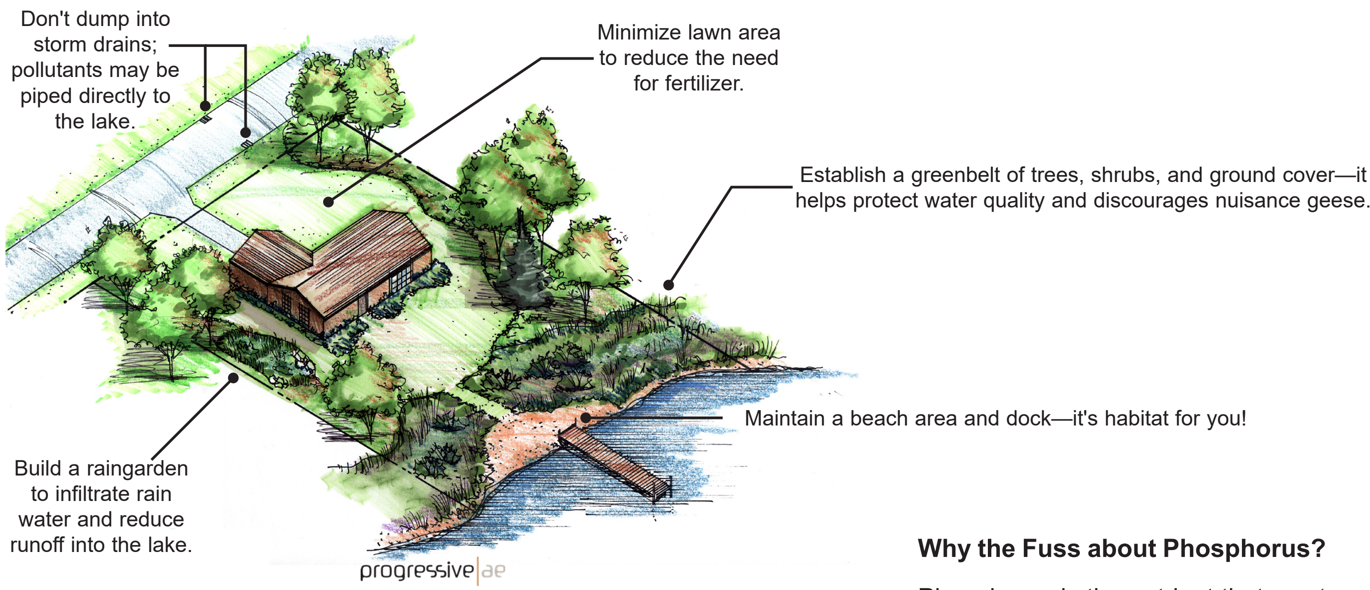
This booklet illustrates several shoreland management practices and provides useful links to shoreland management resources. Please take a minute to review this information and see what practices might work on your property.

Environmental Consultant
Progressive AE

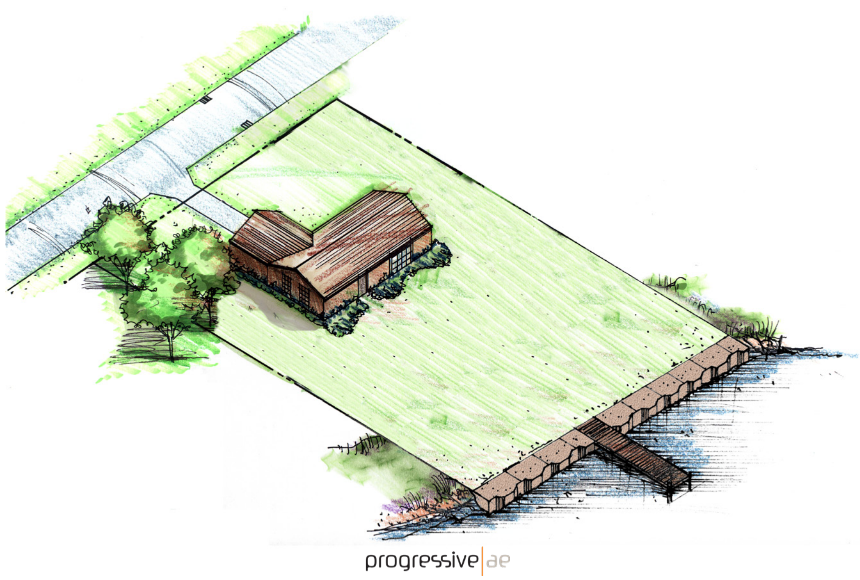
progressive | ae

Shoreland Management

What you can do to enhance your shorelands and protect Wabeek Lake.



Failure to preserve some of the natural features of the shoreland will diminish the quality of the lake.



If you think your shoreline can never be restored to a more natural condition, think again! The Michigan Natural Shoreline Partnership is an excellent resource for those wanting to restore natural features on their shorelands. To find out more about the Partnership, visit www.mishorelinepartnership.org.

Why the Fuss about Phosphorus?

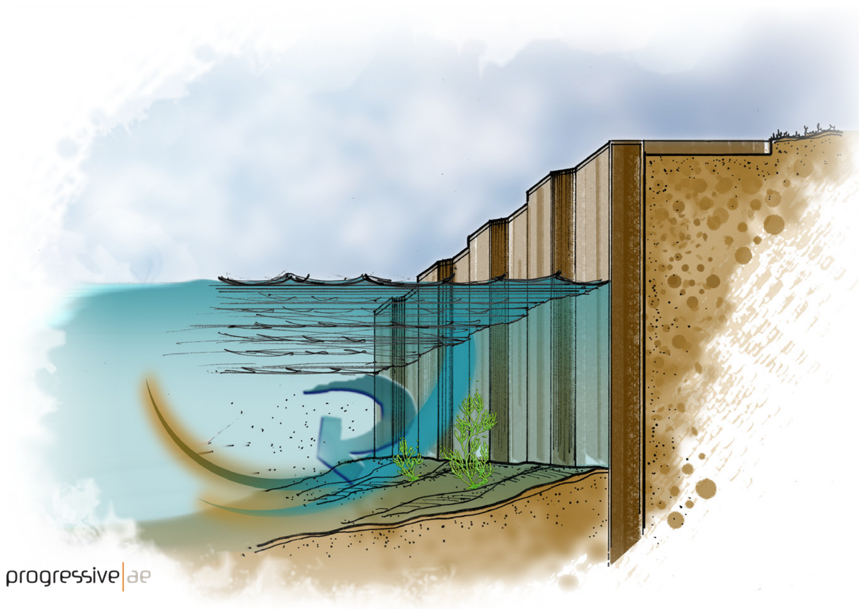
Phosphorus is the nutrient that most often stimulates the excessive growth of aquatic plants and algae, leading to a number of problems collectively known as eutrophication. Once in a lake, a pound of phosphorus can generate hundreds of pounds of aquatic vegetation. Lawn fertilizers are a primary source of phosphorus. Michigan law prohibits the application of lawn fertilizers containing phosphorus unless a soil test documents a phosphorus deficiency or a new lawn is being established.

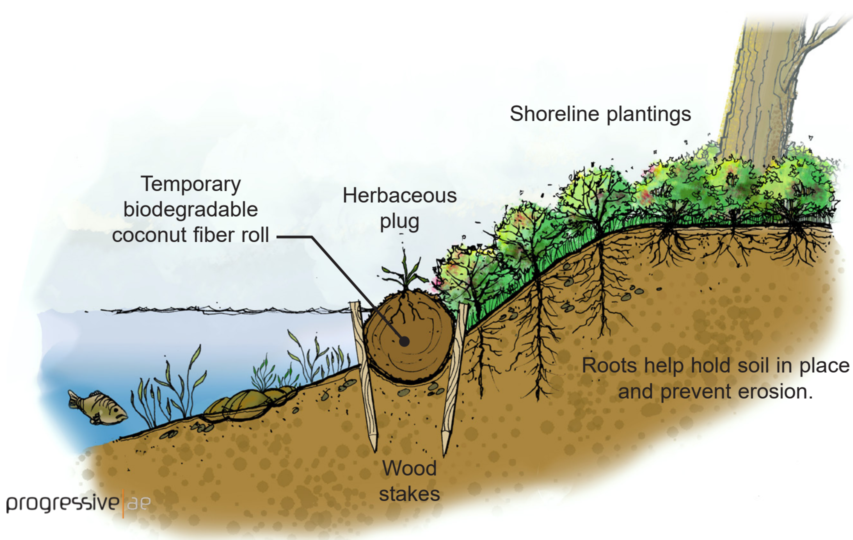
MICHIGAN NATURAL SHORELINE PARTNERSHIP

What's wrong with a seawall?

Most seawalls were built to help prevent erosion and stabilize the shoreline. However, there have been several unintended consequences of seawall construction:

- Seawalls deflect waves and can accelerate erosion at the foot of the seawall and nearby properties that lack seawalls.
- When a wave hits a seawall, its energy is not dissipated. Instead the wave is redirected back to the lake creating rough water conditions.
- Seawalls block the migration of frogs and other animals to shore.
- Some of the problems with seawalls can be lessened by placing large stone in the water at the base of the seawall. Remember, any work below the ordinary high water mark will require a permit from the Michigan Department of Environmental Quality (MDEQ). The MDEQ recently created an expedited permitting process for natural shoreline restoration.
- If you are considering altering or removing your seawall, consider a "bio-engineering" approach in which natural materials are used.



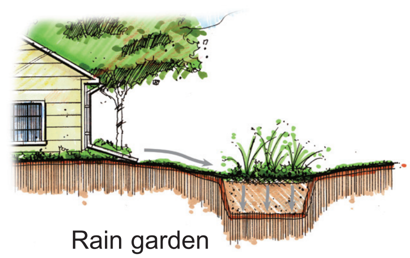


Bio-engineering is a method of stabilizing shorelines with shrubs, trees, and groundcover to prevent erosion and provide fish and wildlife habitat.

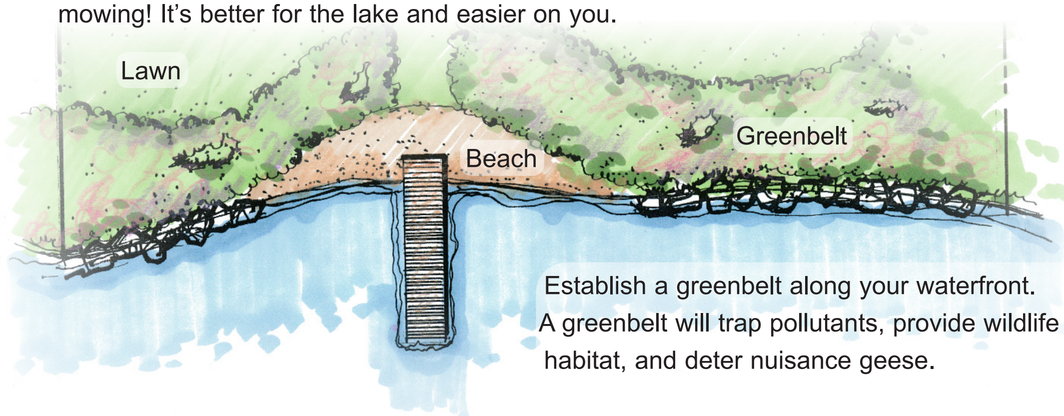
10 Ways to Protect Wabeek Lake

1. Don't use lawn fertilizer that contains phosphorus. If you use a professional lawn care service, insist upon a fertilizer that does not contain phosphorus.
2. Use the minimum amount of fertilizer recommended on the label—more is not necessarily better!
3. Water the lawn sparingly to avoid washing nutrients and sediments into the lake.
4. Don't feed ducks and geese near the lake. Waterfowl droppings are high in nutrients and may cause swimmer's itch.
5. Don't burn leaves and grass clippings near the shoreline. Nutrients concentrate in the ash and can easily wash into the lake.
6. Don't mow to the water's edge. Instead, allow a strip of natural vegetation (i.e., a greenbelt) to become established along your waterfront. A greenbelt will trap pollutants and discourage nuisance geese from frequenting your property. Visit www.shoreline.msu.edu
7. Where possible, promote infiltration of stormwater into the ground. Build a rain garden to capture runoff from driveways and downspouts. Visit www.raingardennetwork.com
8. Don't dump anything in area wetlands. Wetlands are natural purifiers.
9. Collecting roof runoff in rain barrels reduces the amount of water that flows from your property. To find out more, visit epa.gov/soakuptherain/soak-rain-rain-barrels
10. Don't be complacent—our collective actions will make or break the lake!

When buying fertilizer, look at the number in the middle on the label—it should be zero.


Rain garden

Minimize lawn area. Less turf means less fertilizer, less pesticides—and less mowing! It's better for the lake and easier on you.



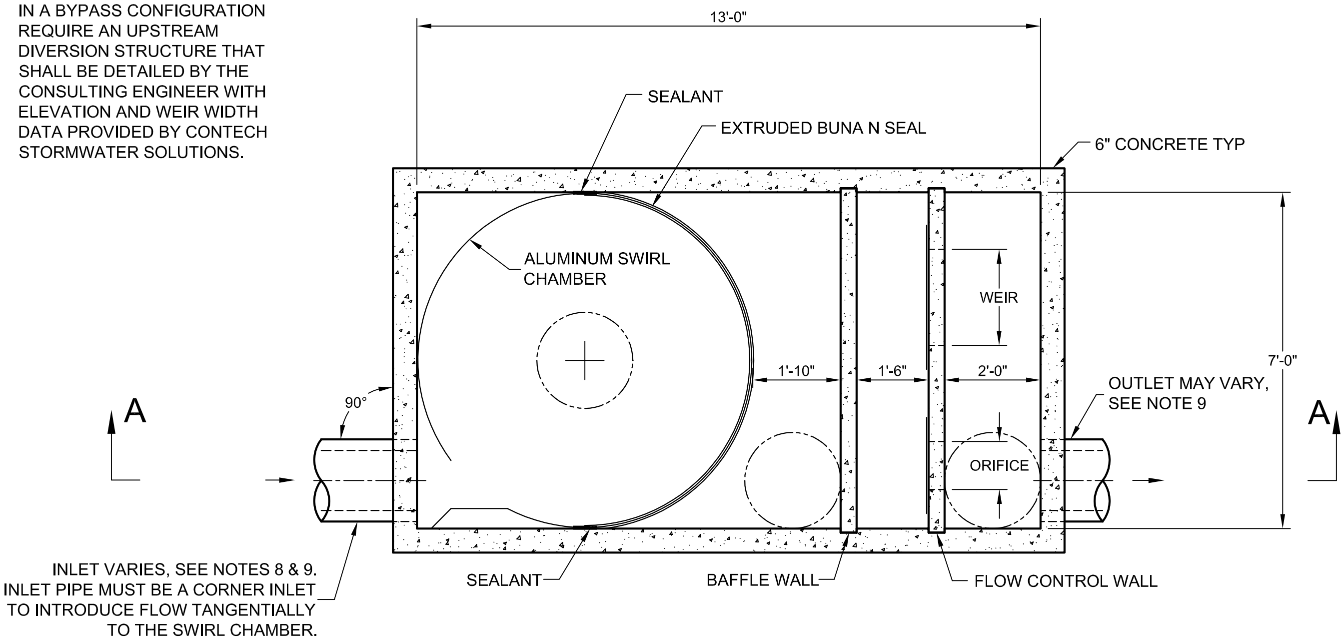
Establish a greenbelt along your waterfront. A greenbelt will trap pollutants, provide wildlife habitat, and deter nuisance geese.

For more information, vist michiganlakeinfo.com

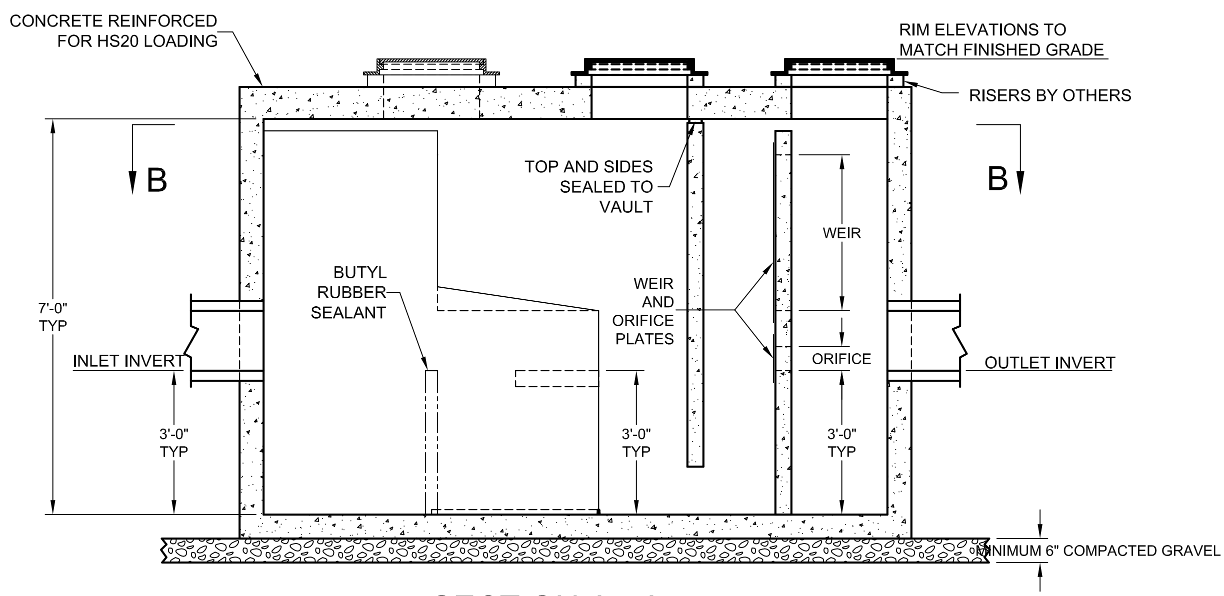
michiganlakeinfo
www.michiganlakeinfo.com

Appendix C
Vortechs Stormwater Unit

NOTE:
VORTECHS SYSTEMS INSTALLED IN A BYPASS CONFIGURATION REQUIRE AN UPSTREAM DIVERSION STRUCTURE THAT SHALL BE DETAILED BY THE CONSULTING ENGINEER WITH ELEVATION AND WEIR WIDTH DATA PROVIDED BY CONTECH STORMWATER SOLUTIONS.



PLAN VIEW B - B



SECTION A - A

NOTES:

1. STORMWATER TREATMENT SYSTEM (SWTS) SHALL HAVE:
   PEAK TREATMENT CAPACITY: 8.5 CFS
   SEDIMENT STORAGE: 3.25 CU YD
   SEDIMENT CHAMBER DIA: 7' MIN
2. SWTS SHALL BE CONTAINED IN ONE RECTANGULAR STRUCTURE
3. SWTS REMOVAL EFFICIENCY SHALL BE DOCUMENTED BASED ON PARTICLE SIZE
4. SWTS SHALL RETAIN FLOATABLES AND TRAPPED SEDIMENT UP TO AND INCLUDING PEAK TREATMENT CAPACITY
5. SWTS INVERTS IN AND OUT ARE TYPICALLY AT THE SAME ELEVATION
6. SWTS SHALL NOT BE COMPROMISED BY EFFECTS OF DOWNSTREAM TAILWATER
7. SWTS SHALL HAVE NO INTERNAL COMPONENTS THAT OBSTRUCT MAINTENANCE ACCESS
8. INLET PIPE MUST BE PERPENDICULAR TO THE STRUCTURE
9. PIPE ORIENTATION MAY VARY; SEE SITE PLAN FOR SIZE AND LOCATION
10. PURCHASER SHALL NOT BE RESPONSIBLE FOR ASSEMBLY OF UNIT
11. MANHOLE FRAMES AND PERFORATED COVERS SUPPLIED WITH SYSTEM, NOT INSTALLED
12. PURCHASER TO PREPARE EXCAVATION AND PROVIDE CRANE FOR OFF-LOADING AND SETTING AT TIME OF DELIVERY
13. VORTECHS SYSTEMS BY CONTECH STORMWATER SOLUTIONS; PORTLAND, OR (800)548-4667; SCARBOROUGH, ME (877) 907-8676; ELKRIDGE, MD (866) 740-3318.

PROPRIETARY INFORMATION - NOT TO BE USED FOR CONSTRUCTION PURPOSES

CONTECH® STORMWATER SOLUTIONS INC.
contechstormwater.com

STANDARD DETAIL
STORMWATER TREATMENT SYSTEM
VORTECHS® MODEL 5000

U.S. PATENT No. 5,759,415

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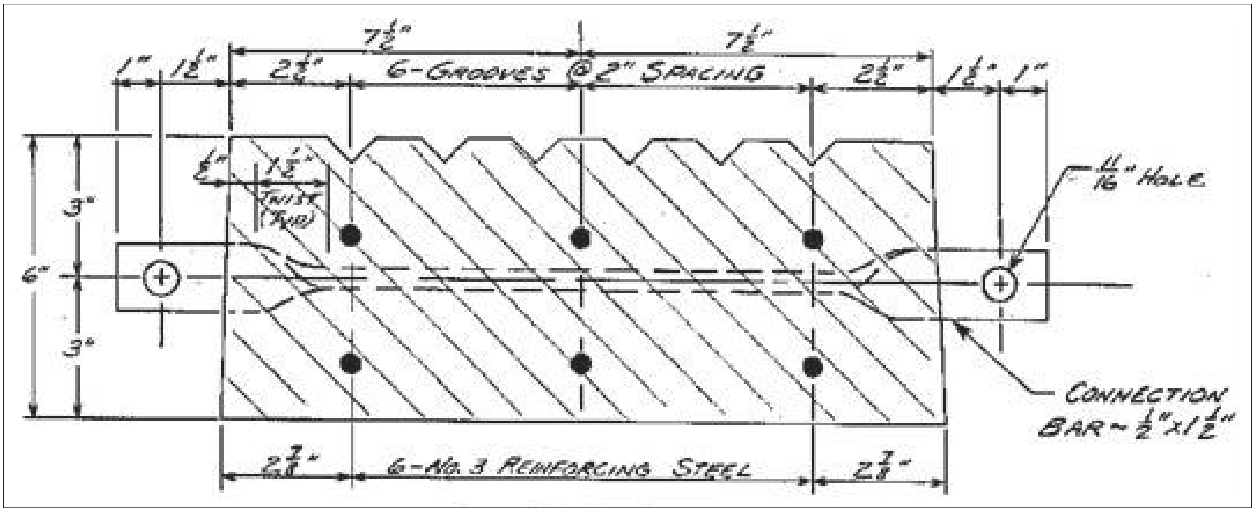
Appendix D
Launch Site Improvements


7 1/2"
7 1/2"
1"
1 1/2"
2 3/4"
6-GROOVES @ 2" SPACING
2 1/2"
1 1/2"
1"
1 1/2"
TWIST (TYP)
11/16" HOLE
3"
6"
3"
CONNECTION BAR ~ 1/2" x 1 1/2"
2 7/8"
6-No. 3 REINFORCING STEEL
2 7/8"