VLAWMO

VADNAIS LAKE AREA WATER MANAGEMENT ORGANIZATION

Sustainable Lake Management Plan

Pleasant Lake, Ramsey County, MN

Prepared by Dawn Tanner and Tyler Thompson

January 2019

VADNAIS LAKE AREA WATER MANAGEMENT ORGANIZATION SUSTAINABLE LAKE MANAGEMENT PLAN – PLEASANT LAKE JANUARY 2019

VLAWMO would like to thank: St. Paul Regional Water Service, the City of North Oaks, North Oaks Homeowners' Association, and the many stakeholders living near Pleasant Lake for partnership, cooperation, and participation.

Our mission at VLAWMO is to protect and enhance water resources in the watershed through water quality monitoring, wetland protection, and water quality improvement projects. The cornerstone of our success is our partnerships. We appreciate your work and assistance to help us fulfill our mission.

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1 INTRODUCTION

1.1 INTRODUCTION

Pleasant Lake in the early morning light. Photo by Nick Voss.

Pleasant Lake is located in the City of North Oaks, Ramsey County, and is the largest lake in the Vadnais Lake Area Water Management Organization (VLAWMO) watershed area. Pleasant Lake is 625 acres, with a maximum depth of 58 feet and average depth of 20 feet. The subwatershed drains 1,852 acres of surrounding land. The lake has a private beach for use by the North Oaks Community and is surrounded by private, residential development. Pleasant Lake is part of a chain of lakes utilized by the St. Paul Regional Water Service (SPRWS) to move water from the Mississippi River to McCarrons Water Treatment Plant. Water is pumped into Charley Lake, flows via a channel into Pleasant Lake, links via an underground culvert network into Sucker Lake, and then to East Vadnais Lake. On average, 20-25 million gallons of water are pumped into the lake by the SPRWS daily to service over 430,000 customers. The amount of water pumped into the system varies according to demand. No motorized recreational use is allowed on the lake because of its role in the chain of lakes transporting drinking water. Water from Deep Lake flows into Pleasant on the north end through Deep Lake Channel. An important factor regarding the health of Pleasant Lake is the water quality of the Mississippi River in addition to the surrounding subwatershed area that drains into the lake.

Water quality in Pleasant Lake is generally lower than similar lakes in the region. Lake chemistry, and especially phosphorus loads, more closely reflect the Mississippi River than other lakes in the region. Consideration for potential new invasive species introductions is high in the chain of lakes due to the input from the river. Invasive species already established and present throughout the chain of lakes include: Curly

Leaf Pondweed, Eurasian Watermilfoil, Common Carp, Zebra Mussels, Purple Loosestrife, Reed Canary Grass, Common Buckthorn, and others in upland areas.

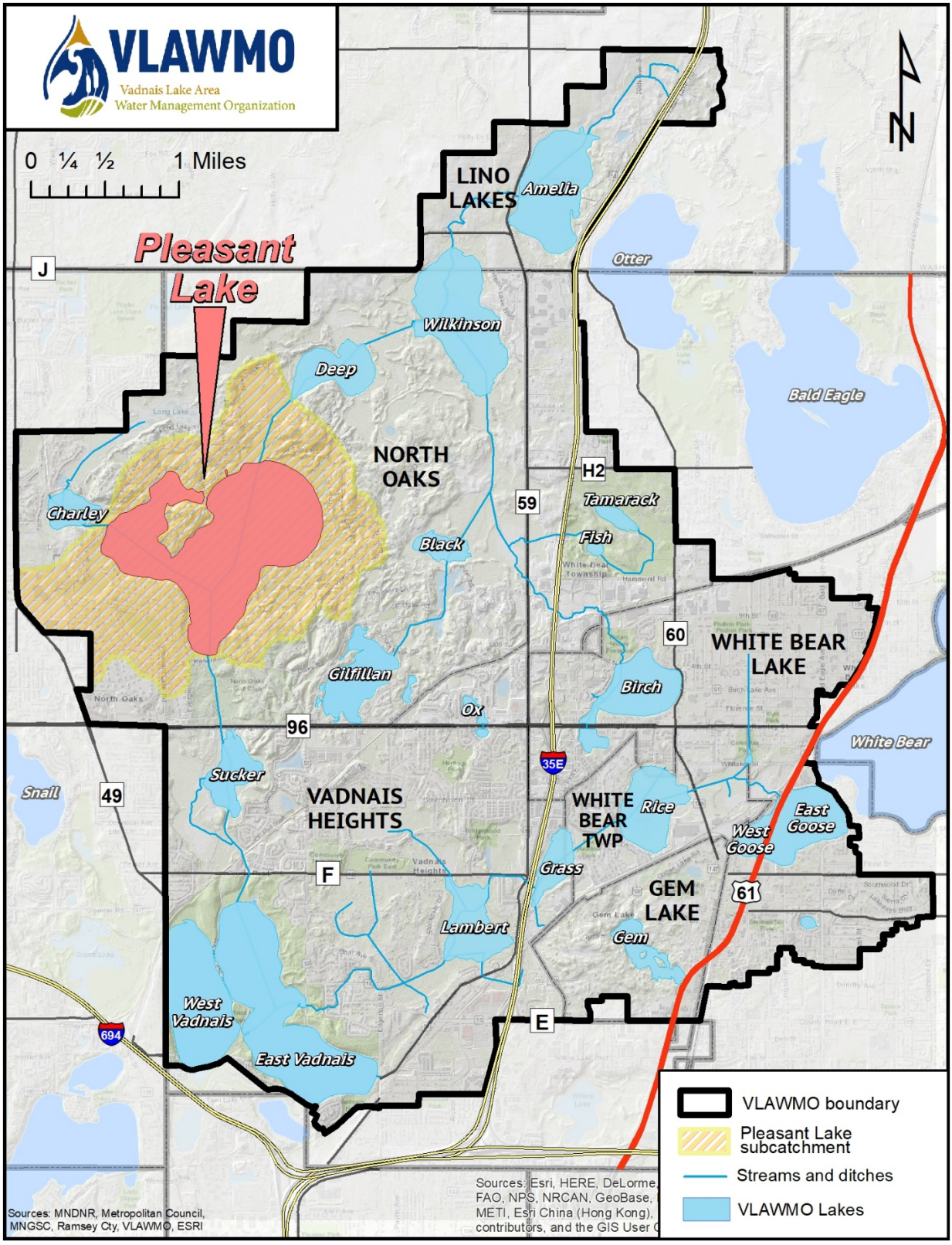
Pleasant Lake is a high priority lake for the City of North Oaks because of the large number of residents living around it and community-wide use of the trail system. It is the only lake in the community with a private beach for residents. Declining water quality, submerged vegetation and algae growth, regular outbreaks of swimmers' itch, and shoreline erosion are problematic for residents who would like access to high-quality natural areas and an ability to recreate in and around the lake. Many residents perceive that water quality has declined over time, as expressed in responses to the stakeholder survey that is part of this SLMP. They commented that, although they used to swim in the lake, they no longer do, and they don't allow children and grandchildren to swim in the lake anymore either. Pleasant Lake is an impaired deep lake on the MPCA Impaired Waters List; it does not have a TMDL for nutrients in place.

Efforts have been made to improve Pleasant Lake through projects and collaborations involving the North Oaks Homeowners' Association (NOHOA), SPRWS, and VLAWMO. Following a shoreline vegetation study in 2009, shoreline stabilization projects were installed. High wave action and fluctuating water levels from varying SPRWS pumping rates hampered success of those projects. NOHOA owns a buffer of shoreline area around the lake, and a North Oaks Shoreland Ordinance prohibits removal of vegetation (Appendix 1). Better enforcement of existing regulations is needed to protect the buffer zone. Yards that are mowed to the water's edge exacerbate erosion problems.

An aeration system was installed in 2013 to remediate phosphorus levels in the lake. Although phosphorus levels were reduced, algae blooms remain a problem. This trend is consistent with new research showing that, while aeration systems do provide oxygen and prevent fish kills, they do not prevent phosphorus uptake from sediments and therefore algae blooms (Wilson, personal communication, 2018). In the 1980s and early 1990s, copper sulfate applications were made on the North Oaks Chain in Sucker Lake, but were ceased after several years of treatment. Only short-term effects were seen with copper sulfate treatments. The chemical treatment would kill algae directly, but the dead and decaying algae in the Lake's sediment would only worsen conditions by releasing more nutrients into the water column, and lead to increased algae blooms later in the season. These treatments are also toxic to plant and animal life and corrosive to structural components. Copper sulfate is a short-term control method for temporary aesthetic purposes, with no long-term, beneficial effect to water quality. Aeration systems replaced copper sulfate treatments.

Pleasant Lake view from Charley Channel Picture Post.

Figure 1: Map of Pleasant Lake Subwatershed in the Vadnais Lake Area Watershed

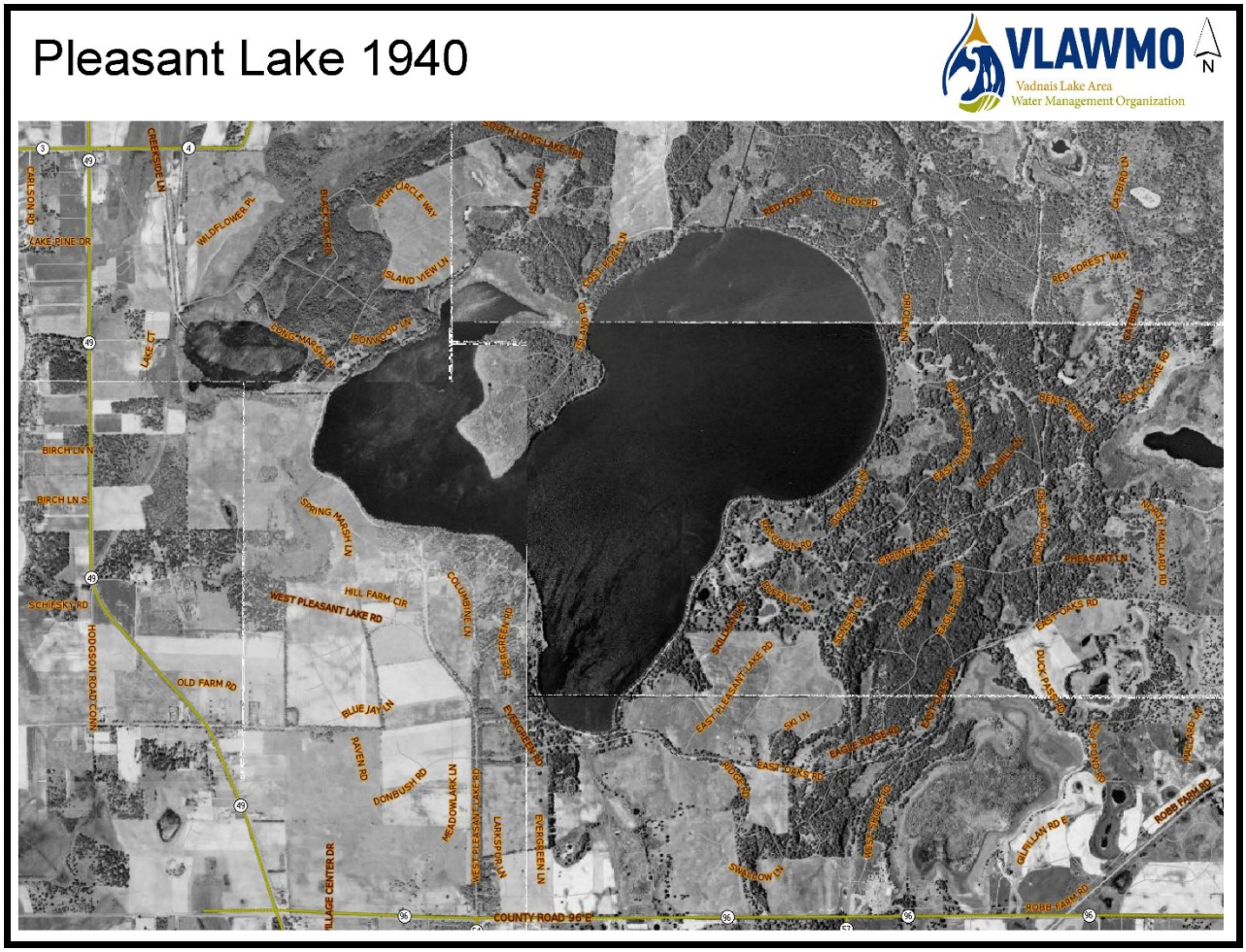


2 WATERSHED FEATURES

2.1 HISTORY

AERIAL PHOTO HISTORY

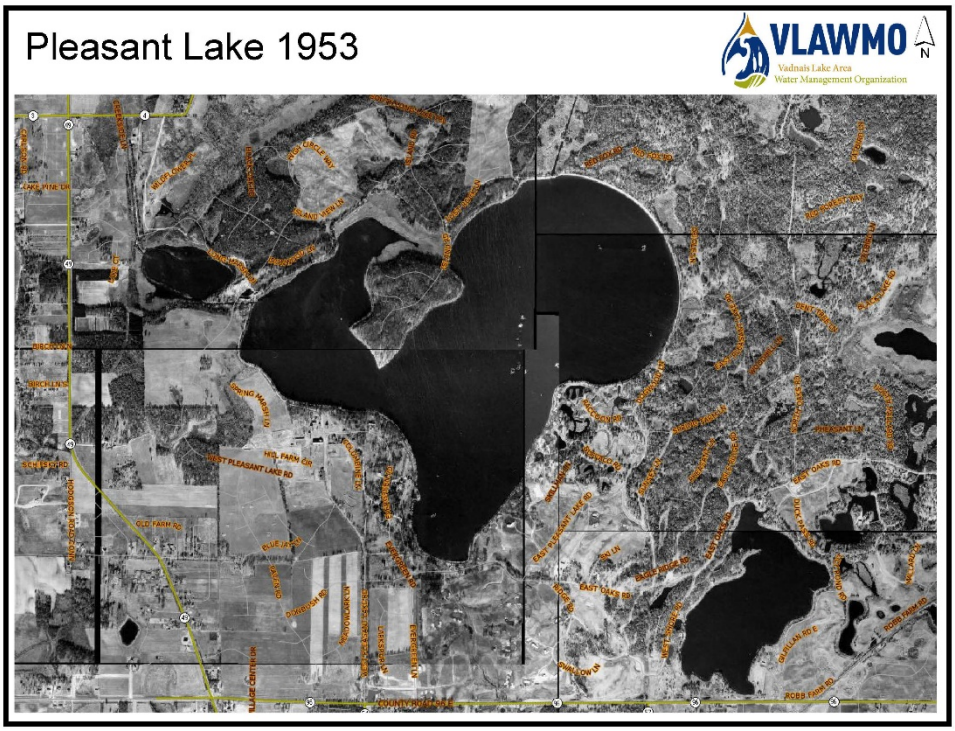
Figure 2: 1940 aerial photo of Pleasant Lake



In 1940, residential development had not yet begun in the area. The area around Pleasant Lake was favored by the James J. Hill family. Louis W. Hill, Sr. built and maintained a chalet on the east shore of the lake in the 1930s. Trails and early roads are visible. As much as possible, roads follow natural landscape contours. Plans were sometimes redesigned to avoid cutting individual trees, moving large boulders, and impacting other natural features. Louis W. Hill, Jr. disliked straight roadways, insisted on curves and a natural feel for roads, and often located and followed deer trails as original routes for roads (Brainard and Leonard 2007). These design features are evident today in the North Oaks road network.

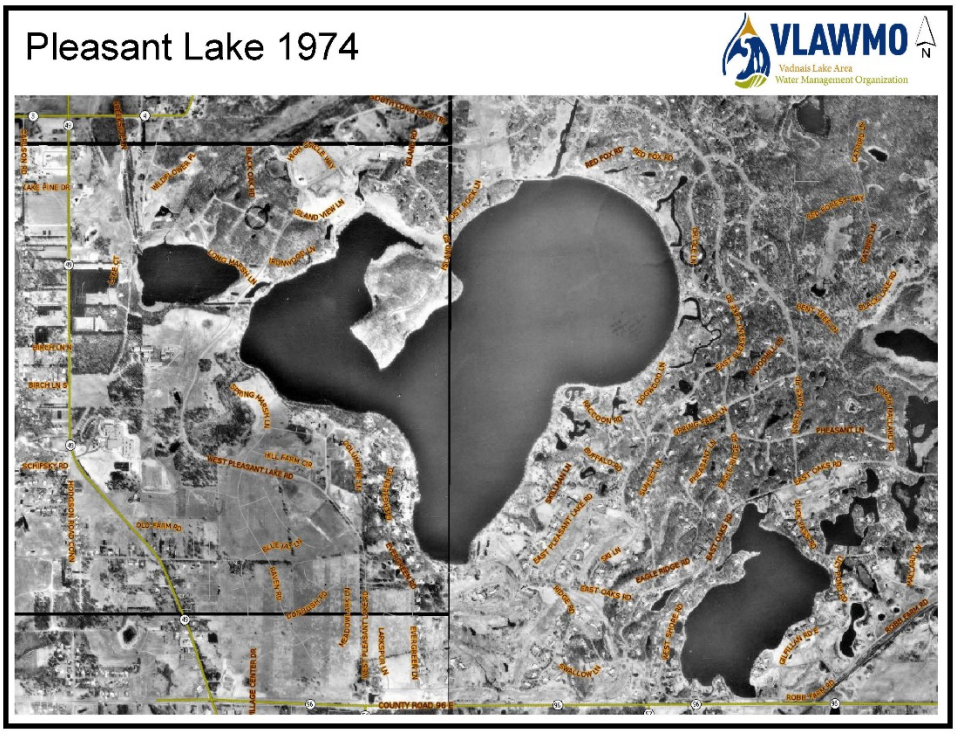
Road names are included on the map to allow viewers to orient themselves; they were not in place at the time of this aerial photo.

Figure 3: 1953 aerial photo of Pleasant Lake



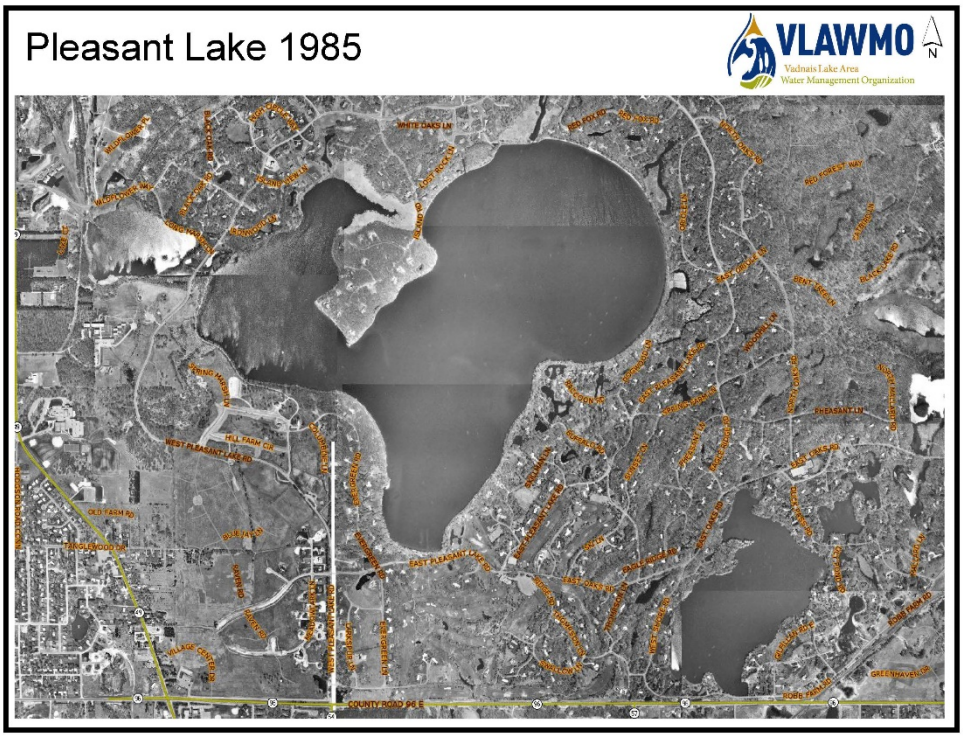
In 1953, North Oaks was in early stages of development. The Ridge Road homes are visible near the southern tip of Pleasant Lake. The North Oaks Golf Club opened in 1951 at East Oaks Road, next to the Ridge Road development.

Figure 4: 1974 aerial photo of Pleasant Lake



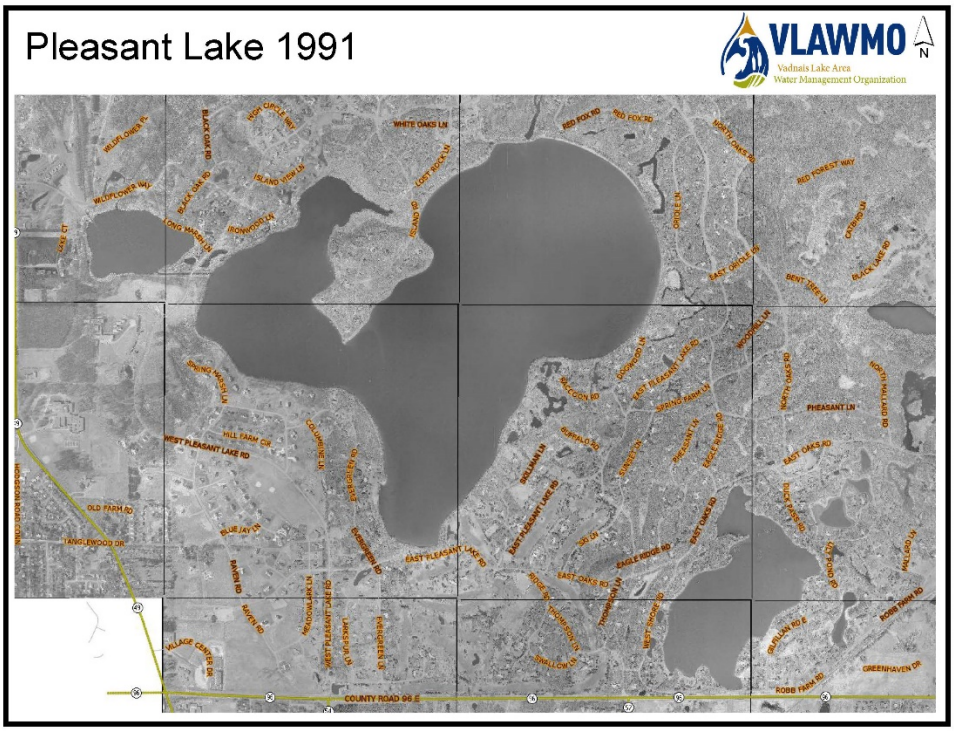
By the 1970s, development is progressing around Pleasant Lake. In the 1950s, building focused in the SE area between Pleasant and Gilfillan Lakes. In the 1960s, homes were added on the north side. In the 1970s, the peninsula and adjacent area to the west were developed.

Figure 5: 1985 aerial photo of Pleasant Lake



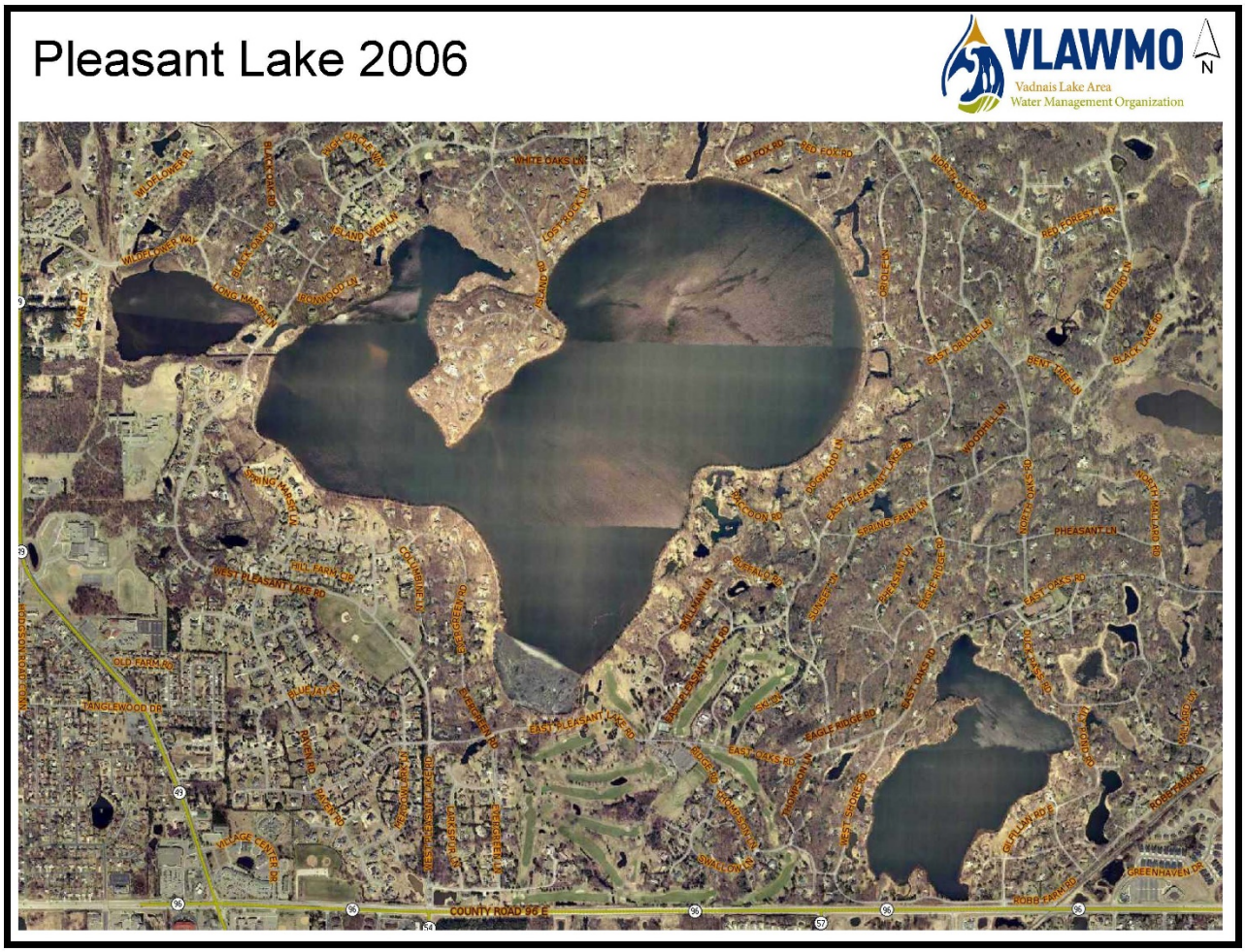
In 1985, development largely encircles Pleasant Lake. Homes were added in the SW portion of the lake along Pleasant Lake Road. Wildflower Way and Long Marsh Lane were added to reduce traffic on East Pleasant Lake Road.

Figure 6: 1991 aerial photo of Pleasant Lake



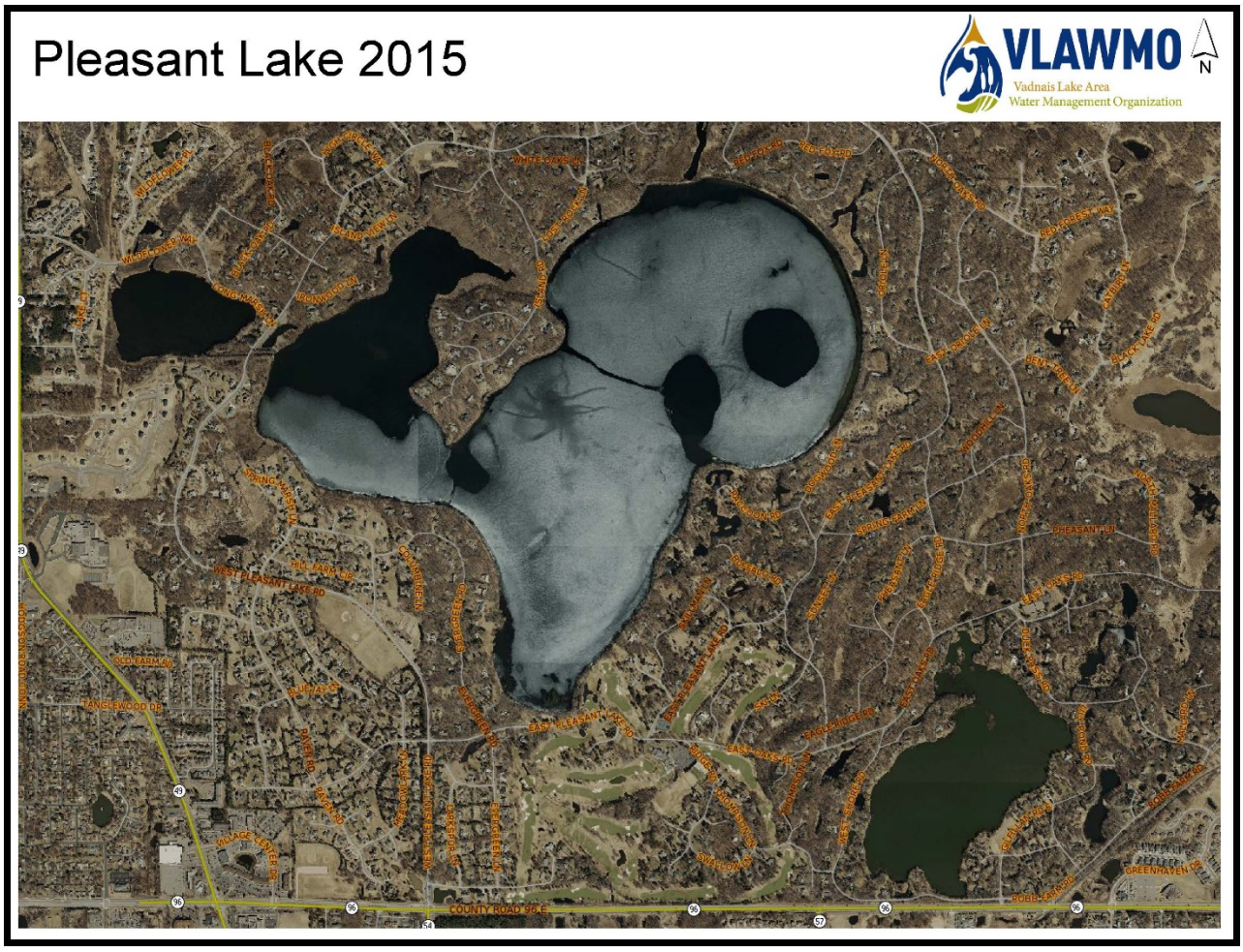
In 1991, the east shore development is completed, and development fills in on the west side toward Black Lake (just visible on the right side of the photo). This completes a 40-year plan to convert the area into high-density, single-family homes or townhouses.

Figure 7: 2006 aerial photo of Pleasant Lake



In 2006, additional development continues outside the boundaries of this photo.

Figure 8: 2015 aerial photo of Pleasant Lake

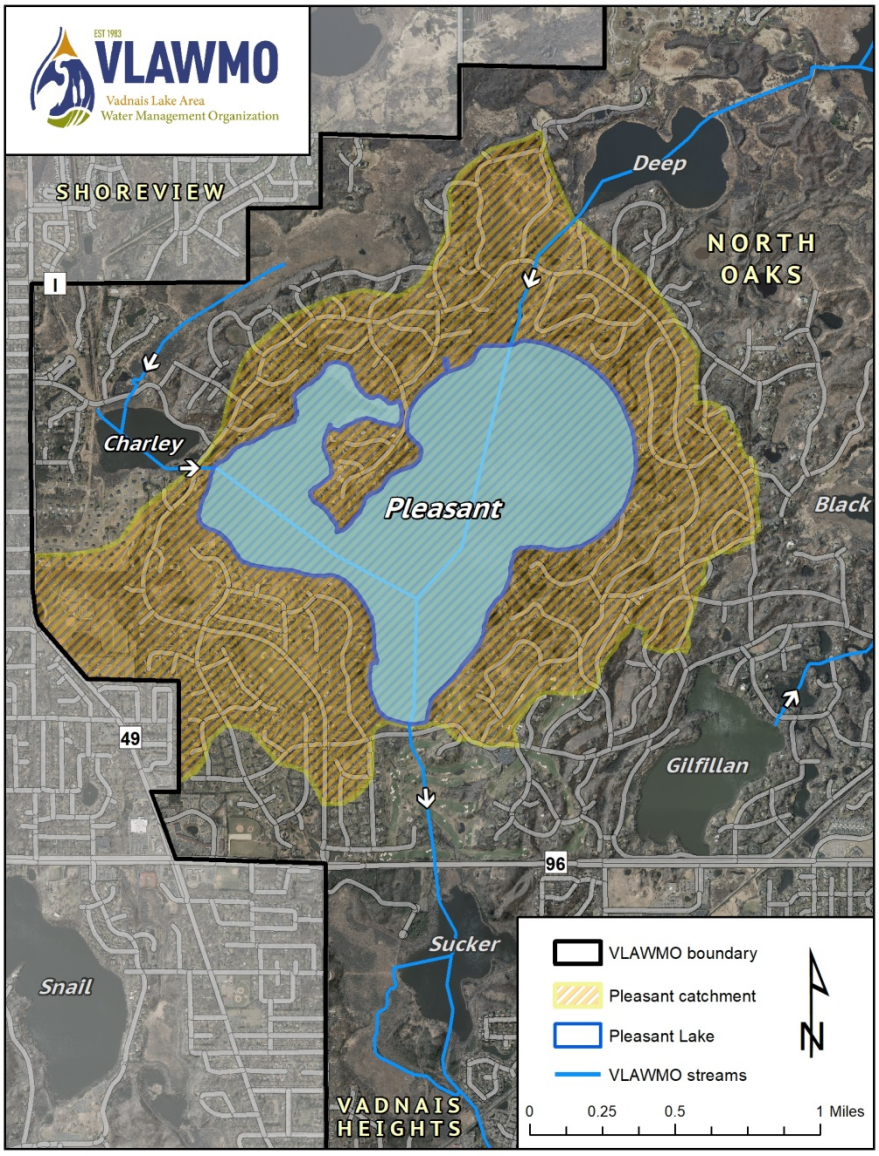


In 2015, little has changed since the 2006 aerial with regard to land use and development. North Oaks Company continues developing surrounding areas. In 2018, final proposals are made to develop land around Black Lake, while protecting the fragile wetland environment and wild rice habitat.

2.2 PLEASANT LAKE DRAINAGE AREA

Pleasant Lake receives direct inflow from Charley Lake as part of the SPRWS water network that moves water from the Mississippi River to McCarrons Water Treatment Plant. Water is pumped into Charley Lake, flows via a channel into Pleasant Lake, links via an underground culvert network into Sucker Lake, and then to East Vadnais Lake.via Pleasant Lake Channel that flows west from Wilkinson Lake. A **subcatchment** is an area of land that drains locally to a central location. The subcatchment drainage area surrounding the Lake is comprised of an area of 1,852 acres; Pleasant Lake itself is 625 acres. The subcatchment to surface area ratio is relatively low; however, the effective subcatchment of Pleasant Lake includes the Mississippi River.

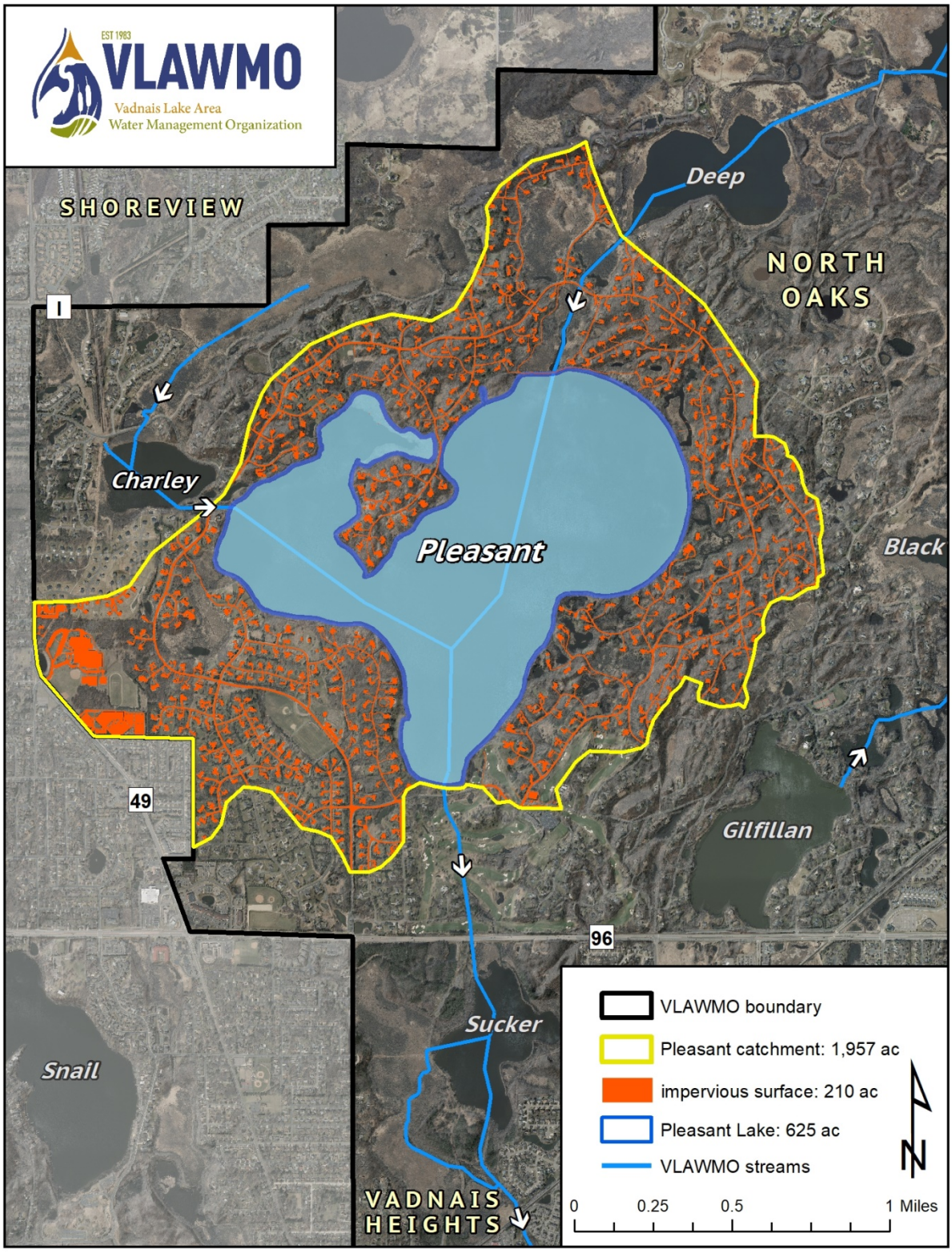
Figure 9: Pleasant Lake Drainage Area



Pleasant Lake is bordered by low-density residential housing. Most of these houses are larger-than-average, single-family homes, with large yards and mixed open space. These yards combined with streets that do not have curb and gutter result in low direct stormwater runoff from development into the basin.

NOHOA owns the buffer zone and trail system around the lake. Areas where lawns are mowed into the buffer zone and to the water exacerbate problems of shoreline stabilization and nutrient input from lawn applications.

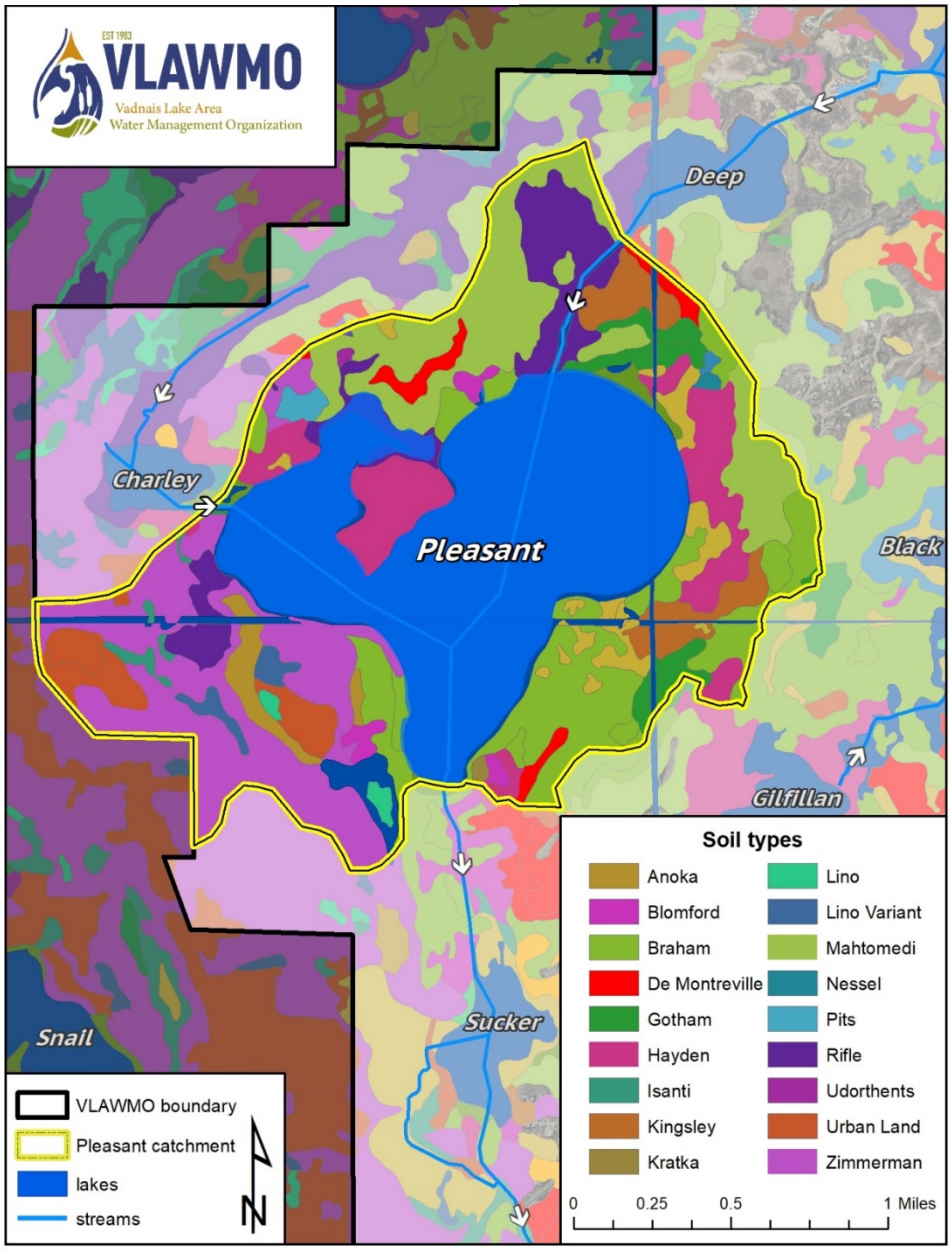
Figure 10: Impervious Surfaces in the Pleasant Lake



2.3 PLEASANT LAKE SOILS

A variety of soil types are found around Pleasant Lake. Dominant types include: Mahtomedi, Braham, Hayden, Blomford, and Rifle. Areas that were developed first tend to have deep, well-drained to excessively drained soils. Runoff is low in these areas; permeability tends to be fairly rapid. These areas include: Mahtomedi, Braham, and Hayden soil types in the north, south, and eastern areas. Hayden soils make up the peninsula. These soils are fine, sandy loam that is well drained, surface runoff is medium to rapid, and permeability is moderate. Blomford soils, to the west, and Rifle soils, along the Deep Channel to the north, are deep, poorly drained soils. Blomford soils consist of loamy, fine sand. Rifle soils consist of muck and are common in wetlands and bogs. *Source: UC-Davis, SoilWeb.*

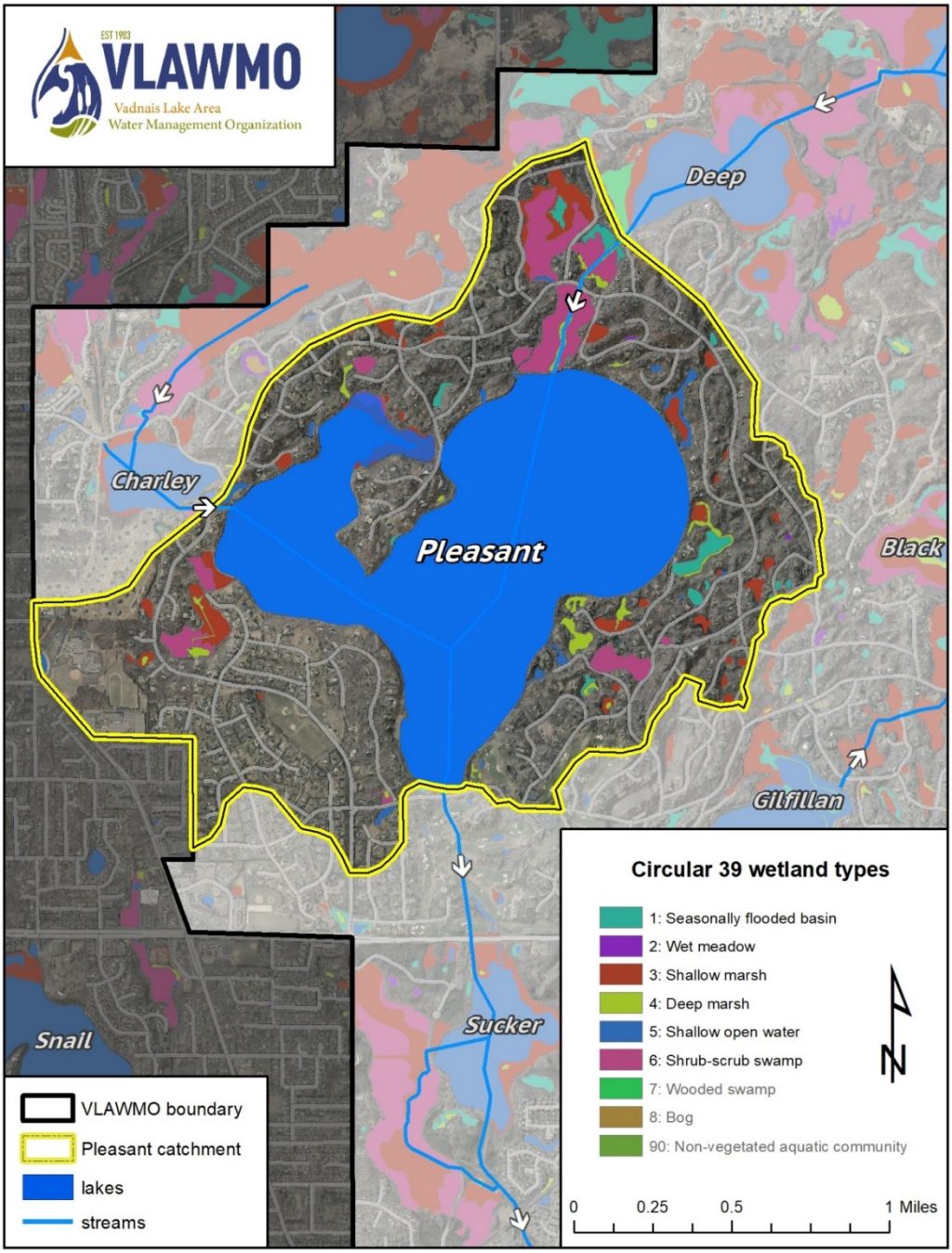
Figure 11: Pleasant Lake Drainage Soils



2.4 PLEASANT LAKE WETLANDS

Areas around Pleasant Lake have been the focus of development over recent decades. Wetland areas have been slightly reduced. Some areas remain, especially along the Deep Lake Channel, along the eastern shore, and a small area on the western shore. These wetlands are primarily shrub-scrub (type 6) wetland fringes, shallow marsh (type 3), and deep marsh (type 4).

Figure 12: Pleasant Lake Drainage Wetlands



Vegetation has been modified around Pleasant Lake. In the subwatershed, native vegetation areas remain and should be a priority for conservation efforts. These areas include wetlands between Charley Lake and Deep Lake, shoreline around Deep Lake, the 620-acre conservation easement south and east of Wilkinson Lake, and the area surrounding Black Lake.

Figure 83: Priority Conservation Areas

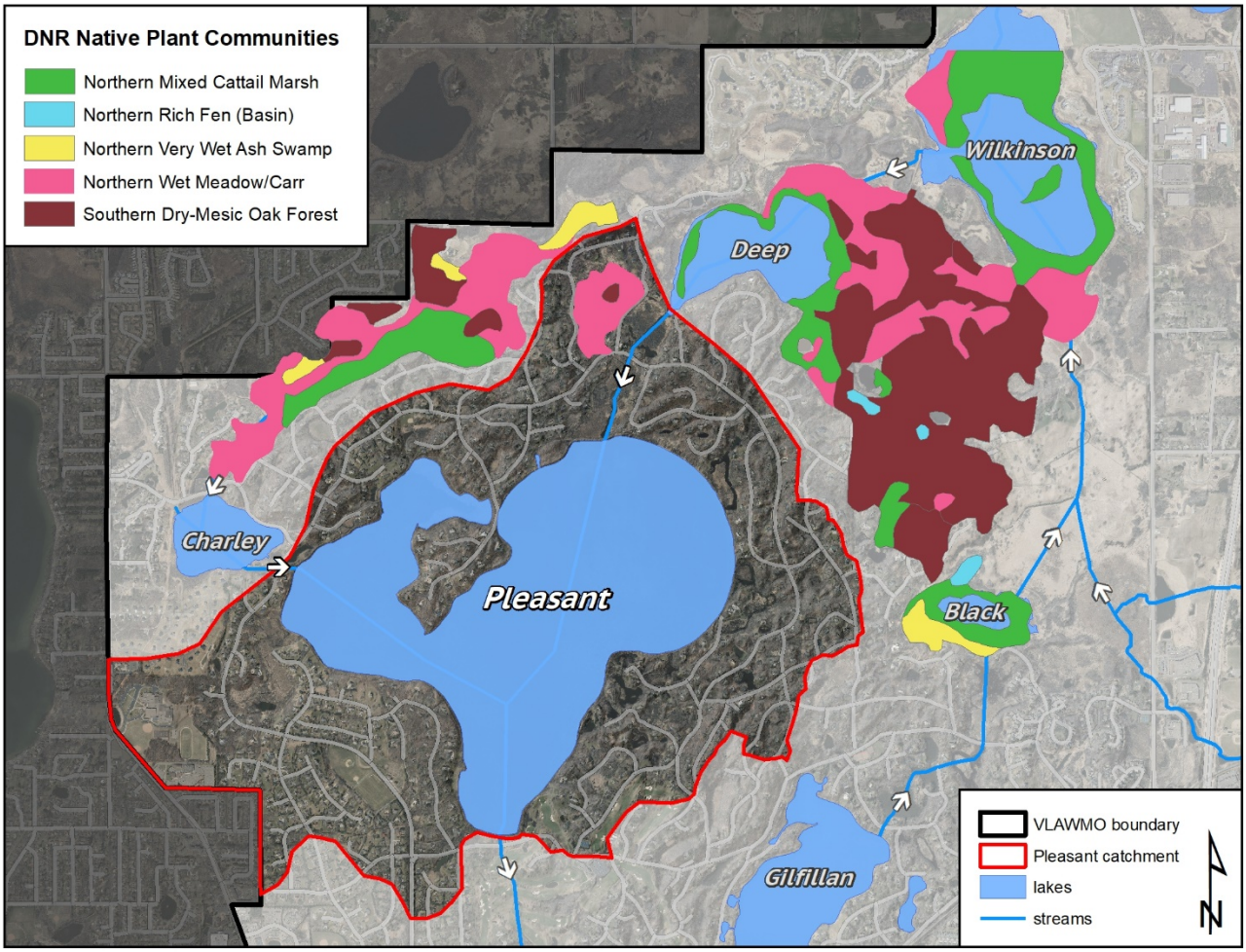
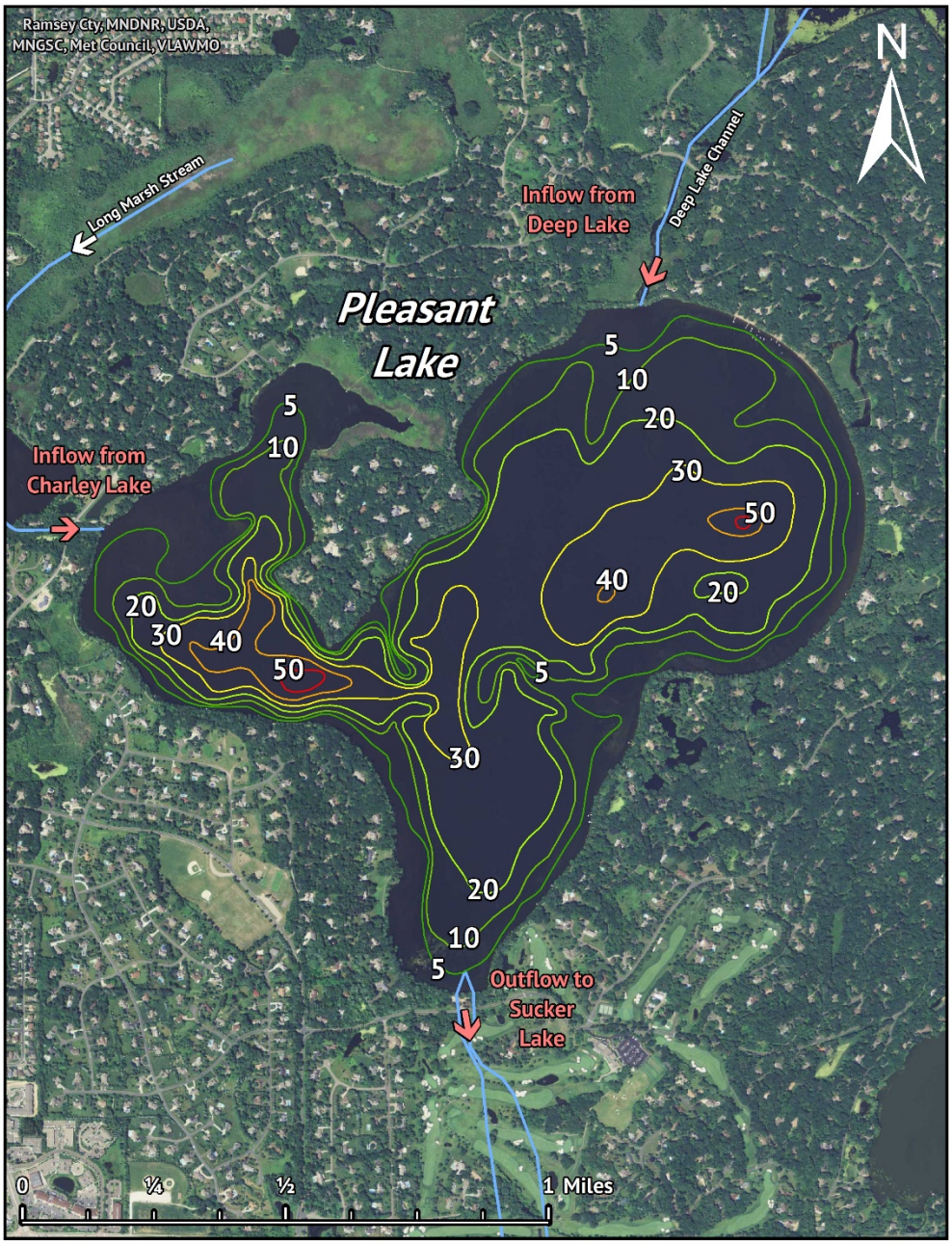


Figure 13: Priority conservation areas near Pleasant Lake as classified by native plant community (Source: MNDNR Native Plant Community shapefile). Some development extends into the Mesic Hardwood Forest System (MHs37, green polygon NW of Black Lake).

3.1 PLEASANT LAKE DEPTH

Pleasant Lake has a maximum depth of 58 feet. It generally follows a typical lake bottom shape, with shallower areas along the outer portions of the lake and deeper sections towards the middle. Pleasant Lake has 2 deep pockets, 1 in each basin of the lake. The size and shape of Pleasant influence the way wind moves across the lake and contributes to erosion. Locations especially prone to erosion include the peninsula, SW tip, and NE shoreline.

Figure 14: Pleasant Lake Depth Map



3.2 PLEASANT LAKE AQUATIC VEGETATION

Blue Water Science conducted an assessment of species and abundance of aquatic plants in Pleasant Lake on July 15, 2015. Abundance was calculated as a percentage of total points and density at each point on a 1-5 scale (5 = most dense). Data were collected at 102 points, located in the littoral zone. Coontail was the dominant species sampled. It was found at 81/102 (79%) points. Overall, 14 species were documented, 2 of which are invasive. Eurasian watermilfoil was found at 11 points; Curly Leaf pondweed was found at 12 points. Mechanical removal was recommended for the swimming area and boating areas. For more information, see the Pleasant Lake Aquatic Plant Delineation (Appendix 2).

Figure 15: Pleasant Lake Aquatic Plant Survey Points

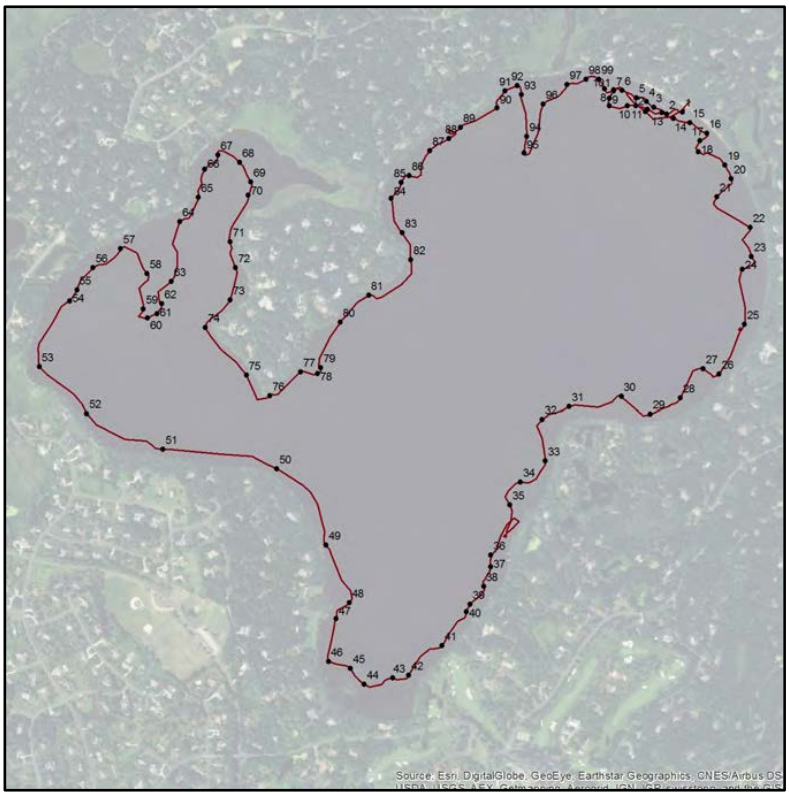


Table 1: Aquatic Plant Survey Results

Common Name	Scientific Name	Percent Occurrence	Native to MN?
Coontail	*Ceratphyllum demersum*	79%	Yes
Water Stargrass	*Zosterella dubia*	22%	Yes
Canada Waterweed	*Elodea canadensis*	13%	Yes
*Curly Leaf Pondweed	*Potamogeton crispus*	12%	No
*Eurasian watermilfoil	*Myriophyllum spicatum*	11%	No
Water Celery	*Vallisneria americana*	9%	Yes
Northern Watermilfoil	*Myriophyllum sibiricum*	8%	Yes
Claspingleaf Pondweed	*Potamogeton richardsonii*	7%	Yes
Stringy Pondweed	*Potamogeton spp.*	4%	Yes
Sago Pondweed	*Stuckenia pectinate*	3%	Yes
Chara	*Chara spp.*	2%	Yes
Buttercup	*Ranunculus spp.*	1%	Yes
White Water Lily	*Nymphaea spp.*	1%	Yes
Flatstem Pondweed	*Potamogeton zosteriformis*	1%	Yes

Figure 16: Eurasian Watermilfoil distribution and density

Figure 16: Eurasian Watermilfoil for coverage in Pleasant Lake. Numbers are the designation for the sample point (N = 102). Points shown indicate Eurasian Watermilfoil present. Color codes for density are: green = light, yellow = moderate, and red = heavy growth.

3.3 SHORELINE EROSION

Pleasant Lake was the focus of a capstone engineering course at the University of Minnesota in 2017. The student group conducted site visits and a map analysis to identify erosion areas, analyzed lake characteristics and pumping regime by SPRWS, and made recommendations for shoreline stabilization. They identified factors contributing to shoreline erosion: soils types that are susceptible to eroding, alterations to the shoreline areas, pumping water from the Mississippi River, and wind energy moving across the lake for long distances creating high-energy waves (Kerber *et al.* 2017). The group developed the Pleasant Lake Sustainability Study (Appendix 3).

Shoreline buffer zone and gravel trail on Pleasant Lake. Photo by Tyler Thompson.

Buffer zones provide protection for water bodies and are a focus of management efforts statewide. The North Oaks community incorporates buffer zones into planning and ordinances. NOHOA owns the buffer zone area around Pleasant Lake. The shoreland ordinance states that: "Vegetation may not be altered, trimmed, or removed within 20 feet of the ordinary high water level of any public water without first obtaining the approval of the City Forester" (Appendix 1). That buffer zone includes a 10-12-foot-wide gravel walking trail that nearly encircles the lake. Erosion of shoreline areas encroaches upon the walking trail and compounds with water-quality concerns to make stabilization of these areas a high priority.

A shoreline study was also completed by Great River Greening in 2009 to identify priority areas for remediation. Bank stabilization projects have been conducted following that study. Success has been hampered by the wind-driven wave action that continues to undercut banks and erode installed plantings.

Photo (right) of undercut bank on Pleasant Lake from Kerber et al. 2017.

Shoreline stabilization projects in 2007 (left) and 2009 (right). Wave action has limited success of these projects. Photos by Tyler Thompson.

Conclusions of the Great River Greening study were supported by the UMN Sustainability study. The Great River Greening study identified priority areas for shoreline remediation. One map is included here. Additional maps can be found in the previous reports. Both studies identified a lack of shoreline vegetation and encroachment by invasive species (e.g., Common Buckthorn) in the buffer zone. These factors contribute to erosion problems on Pleasant Lake. Exacerbating issues include wind/wave action and rise and fall in lake surface elevation due to water pumping (Appendix 3).

Figure 17: Priority areas for shoreline stabilization. From Kerber et al 2017: "Notice that the shoreline shows signs of erosion around almost the entire lake; however, there is increased erosion priority areas on the SW tip of the lake, on the NE corner, and around the peninsula. It is possible that the increased erosion in these areas is due to the fetch across the lake causing an increase in wind and wave energy on the shoreline."

3.4 WATER QUALITY SUMMARY

SPRWS collects water quality (WQ) data on Pleasant Lake. Results are shared with partners as needed. Data include: water clarity (secchi disk), nutrients (TP, Chl-a, SRP, nitrogens), and chemistry (temperature, conductivity, dissolved oxygen, and potential hydrogen [pH]). Total Phosphorus (TP) and Chlorophyll A (Chl-a) analyses are conducted in the lab.

- TP is the primary cause of excessive plant and algae growth in lake systems. Phosphorus originates from a variety of sources, many of which are human related. Major sources include human and animal waste, soil erosion, detergents, septic systems, and stormwater runoff. Internal loading can also be present in a lake. Internal loading can result from P becoming re-suspended into the water column from the sediment. High amounts of P in sediments may occur as a result of historical land uses.

- Chl-a is a green pigment in algae. Measuring Chl-a concentration gives an indication of algae abundance.

- The MN Pollution Control Agency (MPCA) has impairment standards for deep lakes in Minnesota. These standards are: <40 µg/L for TP, <14 µg/L for Chl-a, and <1.4 m for secchi depth.

- Pleasant Lake was placed on the MPCA's 2014 303(d) List of Impaired Waters for nutrients/eutrophication (TP and Chl-a over state standards) and lists a TMDL target completion year of 2025. The Proposed 2014 303(d) List was approved by the USEPA in 2018.

Table 2: Pleasant Lake Monitoring Data 2009-2017

Pleasant Lake Historical Average TP/Chl-a/SDT/Chl			
Year	TP (µg/L)	Chl-a (µg/L)	Secchi (m)
2013	25	9.4	3.4
2014	35	11.2	3.0
2015	52	24.4	2.7
2016	66	13.3	2.4
2017	35	17.7	2.5

Table 2: Pleasant Lake Chemistry. The numbers in red indicate parameters that exceed State Standards. The Trophic State Index (TSI) for Pleasant Lake indicates the basin's nutrient levels combined with clarity levels qualify it as eutrophic.

Figure 18: Historical Water Quality Averages in Pleasant Lake 2013-2017

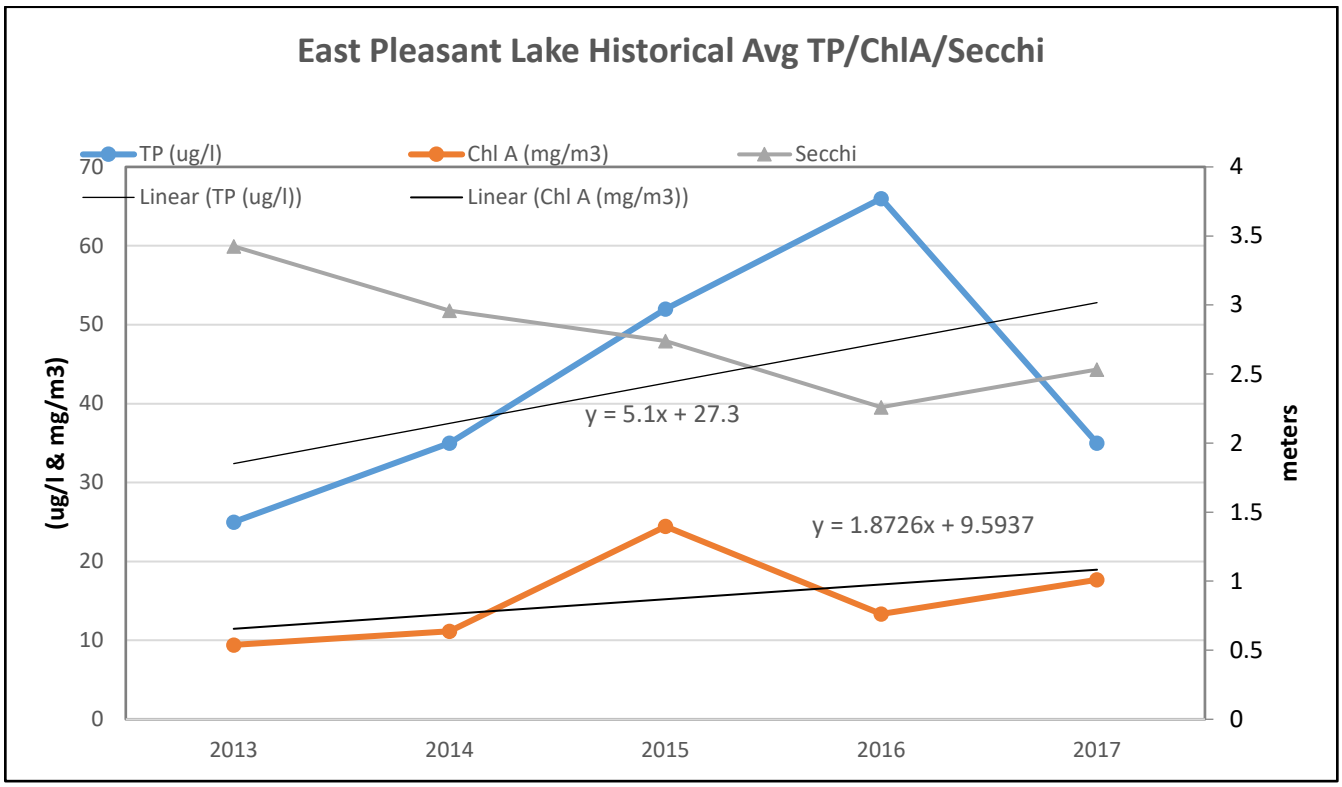


Figure 18: The graph shows results of TP, Chl-a, and secchi depth, with a linear trend through time for TP and Chl-a. TP levels frequently exceed the State Standard (40 µg/L). Chl-a has generally increased through time with a notable peak in 2015 and exceeds the State Standard (14 µg/L). Pleasant Lake was placed on the State Impaired Waters List for nutrients in 2014. It is considered impaired for aquatic recreation. Water in Pleasant Lake is dependent upon SPRWS pumping rates, so plans to improve nutrient levels need to consider the input of Mississippi River water.

4 MANAGEMENT PLAN

4.1 COMPLETED BPMS IN THE SUBWATERSHED

- A shoreline restoration was completed on the south end of Deep Lake Channel in 2015 at the inlet to Pleasant Lake. This restoration is in Pleasant's catchment and directly benefits the basin.
- At least 5 shoreline restorations have been completed since 2007 on Pleasant Lake, 2 of which were VLAWMO Cost Share Program-funded.
- VLAWMO Landscape Level 1 Cost Share grants: 6 native restorations, 3 rainbarrels, 2 raingardens, and 2 shoreline restorations. The 2 installed raingardens have combined annual reductions of .257 acre-feet of runoff, .209 lbs of total phosphorus (TP), and 38.1 lbs of total suspended solids (TSS).

4.2 RESULTS OF STAKEHOLDER SURVEY

Surveys were mailed to 303 residents who live along the Pleasant Lakeshore or very close (e.g., across the street) on November 19, 2018. The original survey is included in Appendix 4. 121 surveys (40%) were returned to VLAWMO and analyzed. These responses help us better understand concerns and priorities of residents. They also serve as a baseline from which we will continue to engage with stakeholders and adaptively manage water and habitat quality in Pleasant Lake.

Stakeholders were asked how important a list of 12 possible lake issues were to them (Q1). The top 4 concerns identified were, in order of importance: algae growth, other aquatic invasive species, invasive plants, and odor. Specific concerns mentioned in the comments section include a need for algae and weed control. Many people commented on declining water quality for swimming and boating. Other concerns include: keeping the lake private, a high fee for anchoring sailboats, requests for increased trail maintenance, concern about trees that block the view of the lake, pumping water from the lake for use in gardens, potential for contamination to private wells, quality of Mississippi River water pumped through the lake, and a desire for increased carp control. The graph below shows the full set of possible lake issues and importance assigned by stakeholders.

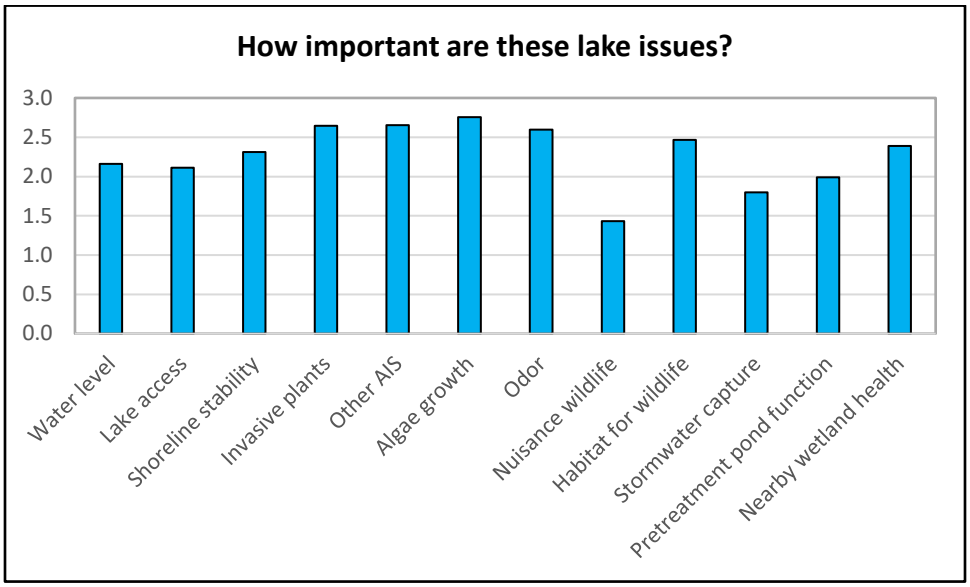


Figure 19: Survey Q1: How important are the following possible lake issues to you? (0 = Not Important, 1 = Fairly Important, 2 = Important, and 3 = Very Important).

Stakeholders were asked which activities they enjoy at Pleasant Lake and the quality of those activities at the lake (Q2-3). Activity choices included: aesthetics, wildlife viewing/birding, non-motorized boating, using trails, and outdoor grilling. Respondents were asked to choose all activities that apply. They identified trail use, aesthetics, and wildlife viewing/birding as top activities and felt that resources are in good shape for those activities (Mean = 2.6). Swimming and non-motorized boating ranked the lowest in current quality (2.2 and 1.6 respectively). Comments reflected that people feel water quality is declining, and that it has become unappealing to swim because of algae and weed growth. Respondents added skiing and ice skating to activities they enjoy, and many expressed a desire for increased trail maintenance. Respondents demonstrated high concern about water quality by adding comments and attaching separate letters about their experience living near the lake. Many people said that they used to swim but no longer do. They also do not allow children or grandchildren to swim in the lake anymore.

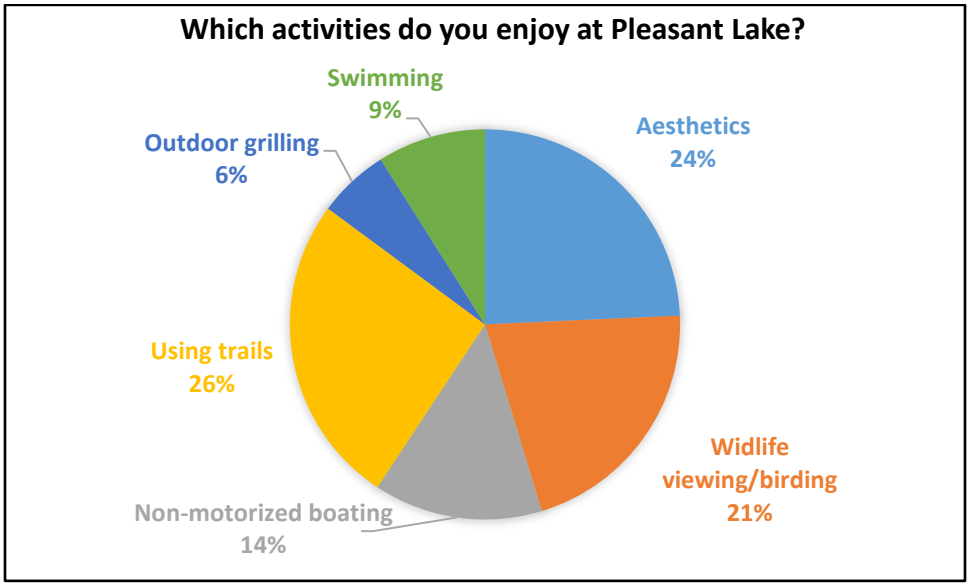


Figure 20: Survey Q2-3: Q2) Which activities do you enjoy at Pleasant Lake? (Check all that apply), and Q3) How do you feel about the current quality of Pleasant Lake for activities you enjoy? (1 = Poor, 2 = Average, and 3 = Excellent).

When asked which water-related priorities stakeholders feel are most important, they rated water pollution invasive species, and threatened or impaired groundwater as top concerns (Q4).

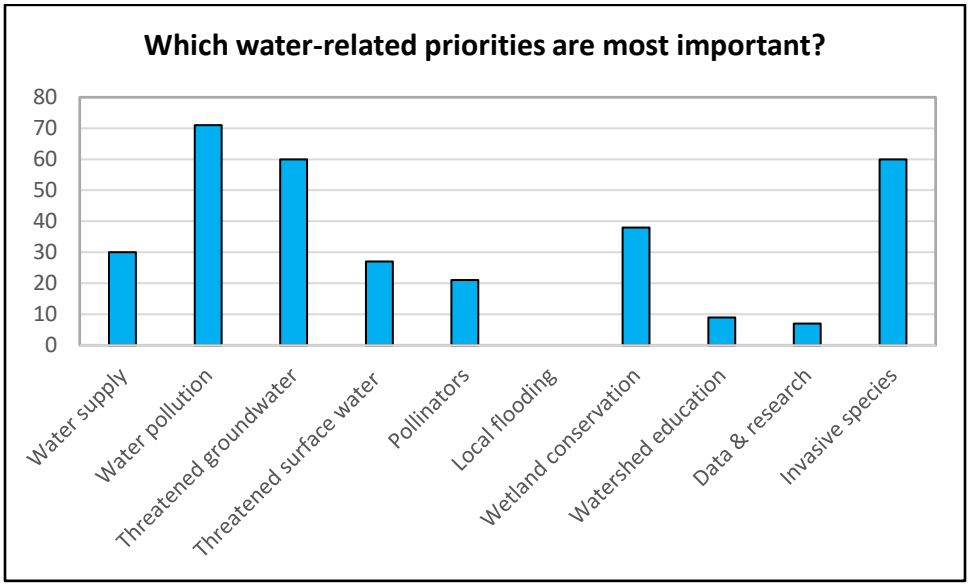


Figure 21: Survey Q4: Which water-related priorities are most important to you? (Check up to 3.)

Stakeholders identified wildlife habitat and clean drinking water as top reasons why water quality is important to them (Q5). Respondents were invited to choose as many of the 6 choices as they felt applied. Many respondents chose all options; most respondents chose multiple options. Respondents also added that property value and protecting the aquifer as important reasons why water matters to them.

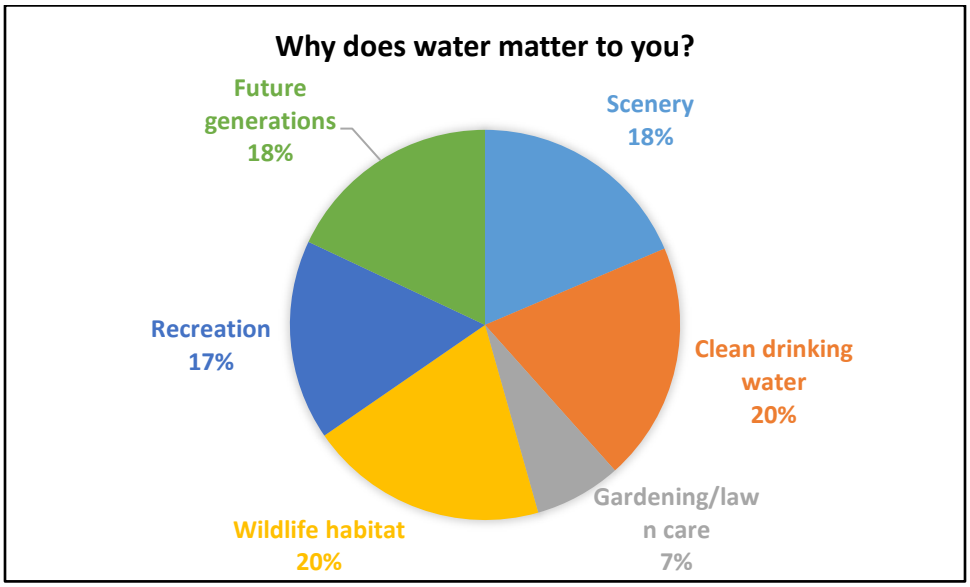


Figure 22: Survey Q5: Why does water matter to you? (Check all that apply).

Stakeholders identified how familiar and involved they currently are with local water issues (Q 6a-c). The majority of respondents felt they were familiar with local water issues at an average level (N = 51), that primary perceived barriers to involvement are time constraints and not enough experience, and that their current level of involvement is at a medium level as part within their normal daily routine (N = 44). These questions will help gauge the community response and educational effectiveness of future BMPs and VLAWMO's outreach efforts.

The survey itself served as a form of communication and information. At the end of the survey, we provided website links and volunteer information. Surveys were often returned with the bottom portion removed.

Additional concerns, comments, and questions by stakeholders include (Q8):

- Improving lake and water quality and responding specifically to climate change
- Timing and treatment for swimmers' itch should be more proactive
- Use of lawn chemicals (fertilizers and pesticides) should not be used near the lake
- Encourage homeowners to do more to remove buckthorn
- Illegal fishing (and one asked "Why no fishing?")
- Lack of results from the aeration system
- Consistent rules and enforcement for vegetation trimming within the buffer zone
- A request for more education to the community.

Quite a few respondents commented that they now call it "Unpleasant Lake" because of the declining water quality and algae growth. People are concerned about health of the lake, and some would like to be more involved in clean-up efforts.

Topics, themes, and priorities from the stakeholder survey will be part of an upcoming stakeholder meeting in 2019 and used to identify strategies and guide water-quality improvement in the watershed. One strategy that has been suggested is a joint lake association for Charley, Deep, and Pleasant Lakes. These lakes are located in North Oaks, part of the SPRWS chain of lakes for drinking water delivery, and the focus of current SLMPs by VLAWMO.

4.3 MANAGEMENT PLAN FOR PLEASANT LAKE

In 2015, the Ramsey Conservation District completed a Retrofit Report for the Pleasant-Charley-Deep subwatershed, assessing possible areas and locations for implementing BMPs for improving water quality (Appendix 5). The Report described the lake's land catchment area as having a low base load risk for contributing external loading due to buffering capacity of preserved and undeveloped land, low density residential in the south, the newest residential area's distance from the lake and higher-than-standard stormwater treatment.

The Report identified ~20 possible projects within the Pleasant Lake subcatchment and specified locations in urgent need for shoreline stabilization. These locations are supported by the earlier (2009) study that identified many of the same locations. Recommendations from the retrofit report should be considered as management steps continue forward for Pleasant Lake.

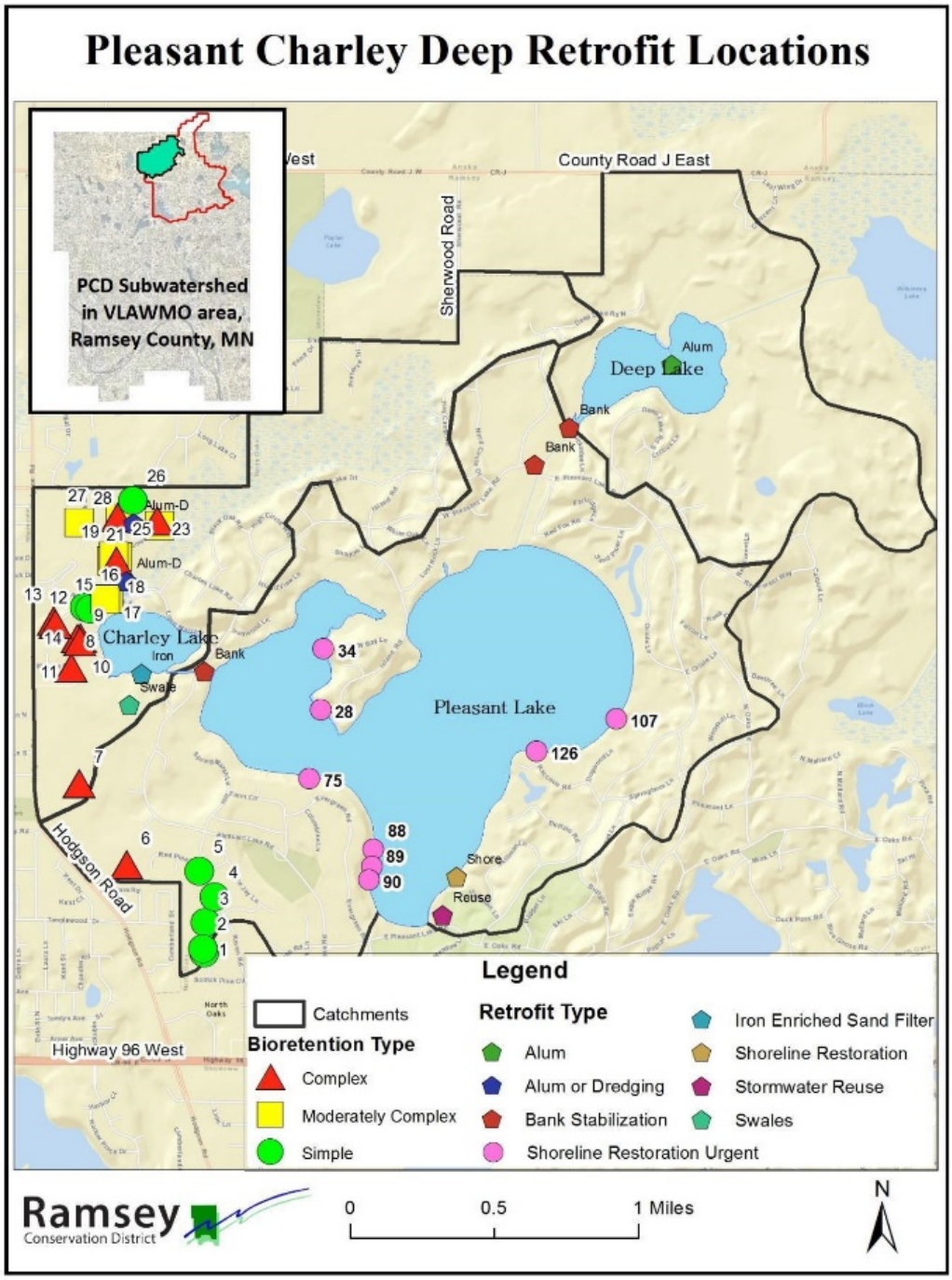


Figure 23: BMP retrofit locations identified in the 2015 Pleasant-Charley-Deep Retrofit Report.

The 2017-2026 VLAWMO Comprehensive Watershed Management Plan assessed lakes and water resources within its jurisdiction and set management classifications for each of the subwatersheds. Pleasant Lake is part of the Pleasant-Charley-Deep Subwatershed, which was given a classification of "Monitor/Restore". Producing this SLMP is a step towards determining which restoration activities are optimal. VLAWMO will consider adding BMPs to the landscape to reduce TP contributed to the system.

4 MANAGEMENT PLAN

Table 3: Action Items for Pleasant Lake

Action Item	Description	Leader	Potential Costs $ = $0-$5,000 $$ = $5,000-$25,000 $$$ = >$25,000
Continued Lake Monitoring	Continue current lake monitoring program to measure nutrient levels, dissolved oxygen, and temperature.	VLAWMO	$
Promote Landscape Grant Program	Reach out to property owners to promote the VLAWMO Landscape Grant Program to help reduce stormwater runoff into Pleasant Lake.	VLAWMO	$
Enhanced Studies	Partner and provide support with the City of North Oaks, North Oaks Homeowners' Association, and St. Paul Regional Water Service on possible future studies regarding the effects of decreased water pumping into Pleasant Lake, and other topics as VLAWMO continues working with stakeholders in the watershed.	VLAWMO, City, NOHOA, SPRWS	$$
Water Quality Improvement Projects	Meet with SPRWS, City, and NOHOA on regular basis to discuss upcoming water quality improvement projects, using 2015 Retrofit Analysis Report to aid in determining best opportunities.	VLAWMO, City, NOHOA, SPRWS	$ - $$$

5 LITERATURE CITED

5.1 Literature Cited

Brainard, J.C. and R.E. Leonard. 2007. *Three Bold Ventures: the history of North Oaks, Minnesota*. Beaver Pond Press, Edina, MN.

Kerber, R., K. Leadbetter, Y. Xu, and B. Albitz. 2017. *Pleasant Lake Sustainability Study for North Oaks Homeowners' Association*. Unpublished

UC-Davis SoilWeb. Downloaded Januray 1, 2019. *https://casoilresource.lawr.ucdavis.edu/soil_web/*

APPENDIX

Appendix 1: North Oaks Shoreland Ordinance, 2011
Appendix 2: Pleasant Lake Aquatic Plant Delineation for Pleasant Lake, 2015
Appendix 3: Pleasant Lake Sustainability Study, 2017
Appendix 4: Stakeholder Survey for Pleasant Lake, 2018
Appendix 5: Pleasant–Charley–Deep Subwatershed Urban Stormwater Retrofit Analysis, 2015