VLAWMO

VADNAIS LAKE AREA WATER MANAGEMENT ORGANIZATION

Tamarack and Fish Lake Review, Ramsey County, MN

2024

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1 INTRODUCTION

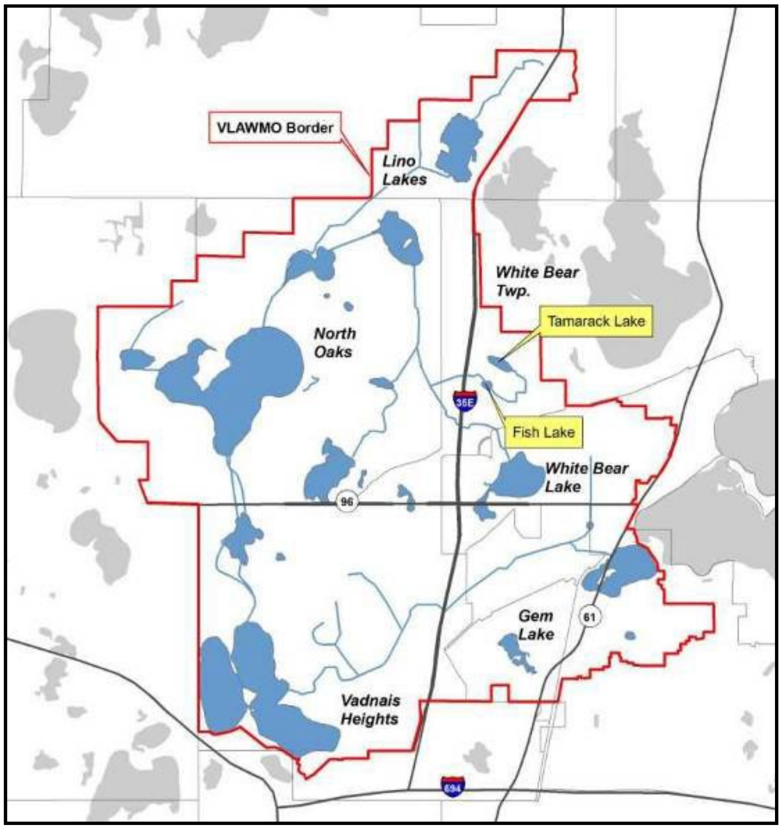
1.1 Introduction

This SLMR includes monitoring, surveys, planning, projects, and partnerships for Tamarack and Fish Lakes in White Bear Township. Information was originally compiled in 2009 and updated in 2023 to provide a synthesis of knowledge to date as we work to continue to protect these lakes and improve water quality. As part of VLAWMO's participation in the EPA funded/MPCA administered 319 small, priority watershed grant program that was awarded in 2019, the Tamarack Lake Subwatershed is a focal area of management for VLAWMO. Recent partnerships, including a pilot Wetland Health Evaluation Program (WHEP) that was conducted in partnership with Tamarack Nature Center in 2022. Feasibility investigations, including work toward a possible alum treatment, are underway to continue to identify and implement projects to improve Tamarack Lake, which is listed as impaired for nutrients.

Figure 1: Tamarack and Fish Lakes are located in Tamarack Nature Center, which is a 320-acre nature preserve in White Bear Township. Water flows into a ditch system that eventually empties into Wilkinson Lake in North Oaks.

Tamarack and Fish Lakes are located within the 320-acre Tamarack Nature Center (TNC) in White Bear Township, Ramsey County, and within the Vadnais Lake Area Watershed. The land has been a part of the Ramsey County Park system since 1974. Tamarack and Fish Lakes are connected by a stream and wetland system. Tamarack Lake is 15 acres, with a maximum depth of 10 feet, and Fish Lake is 5 acres, with a maximum depth of 20 feet.

Figure 2: Tamarack and Fish Lakes, location in the watershed



Tamarack Lake is impaired for nutrients (listed in 2014, Unnamed in the MPCA database, AUID: 62002200) and a priority to restore for VLAWMO's management efforts. Tamarack Lake has had water quality scores of 78 (2020), 76 (2021), 76 (2022), and 75 (2023). That is equivalent to "very green/hypereutrophic" according to the TSI (Trophic State Index, Carlson scale, MPCA). Tamarack Lake is protected by riparian buffers but still has very poor water quality.

Tamarack Nature Center is managed by Ramsey County Parks. There is no boating on Tamarack nor Fish Lakes. There is walk-up public access from nature center trails and a boardwalk to a viewing platform at Tamarack Lake.

Ramsey County, VLAWMO, and Tamarack Nature Center staff partner on habitat improvement projects and monitoring. Habitat improvement projects improve habitat for pollinators, increase resilience, and help to buffer water resources for climate change. Large-scale projects have been implemented in the past and continue to be a priority for implementation with partners. A large invasive species removal project was completed by Ramsey County during 2020, and inter-seeding occurred following that project in the woodland area. Additional invasive species treatment efforts were completed in 2020, followed by seeding and supplemental planting in 2021-2022. A wetland/pond planting project at Teal Pond was completed through a VLAWMO cost-share grant to Ramsey County Soil and Water Conservation Division (RCSWCD) in 2021, with partnership and volunteers from VLAWMO and Tamarack Nature Center.

Additional projects, including a possible alum treatment, being considered as part of feasibility study with Barr Engineering in 2023/2024, may have the potential to rapidly improve water quality in a lake that is highly accessible to residents and a valued resource within the nature center land area.

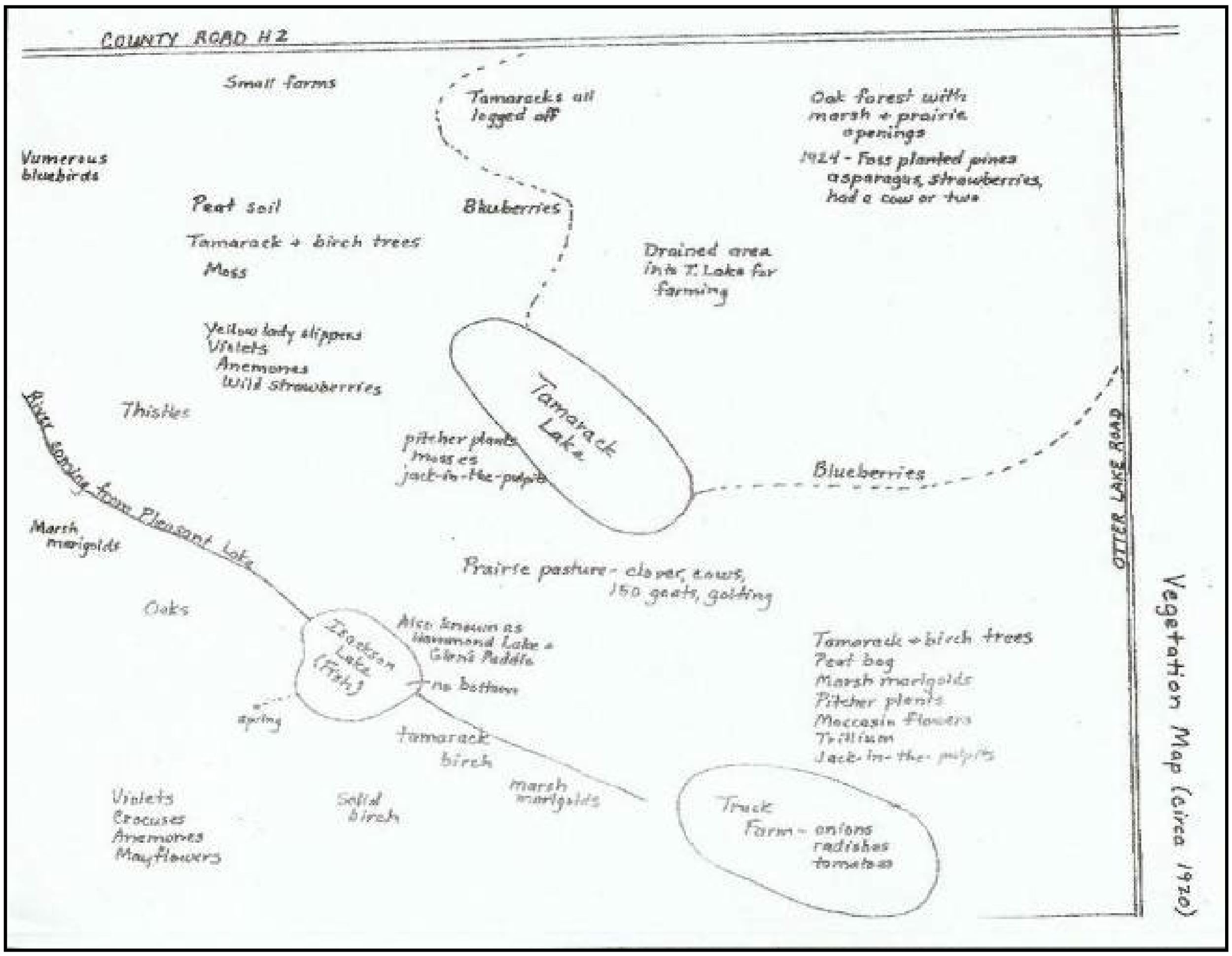
2 WATERSHED FEATURES

2.1 Aerial Photo History

The land that is now Tamarack Nature Center became inhabited by European settlers in 1861-1863. As settlement occurred, a large portion of the wetlands were tilled and drained for farmland.

Historically, vegetation surrounding the Nature Center was originally heavily wooded with elm; ash; black, white and burr oak; tamarack; and sugar maple. In the drier soils of the Tamarack Nature Center area, a forest of oak species and oak savanna existed. The swamps contained tamarack and paper birch. Under the tamaracks grew sphagnum moss, pink lady's slipper, jack-in-the-pulpit, trillium, pitcher plants, and marsh marigold. Original wildlife in the area included wolves, bear, grey fox, and sharp-tailed grouse. A hand-drawn map was provided by Tamarack Nature Center depicting the vegetation in the Tamarack Nature Center property from 1920. In 1924, Fish Lake (then called Isackson Lake) had sunfish and northern in it. At that time, the stream flowing out of it from the Hill Farm in North Oaks was described as larger and "like a river."

Figure 3: Map depicting vegetation and land use circa 1920



2 WATERSHED FEATURES

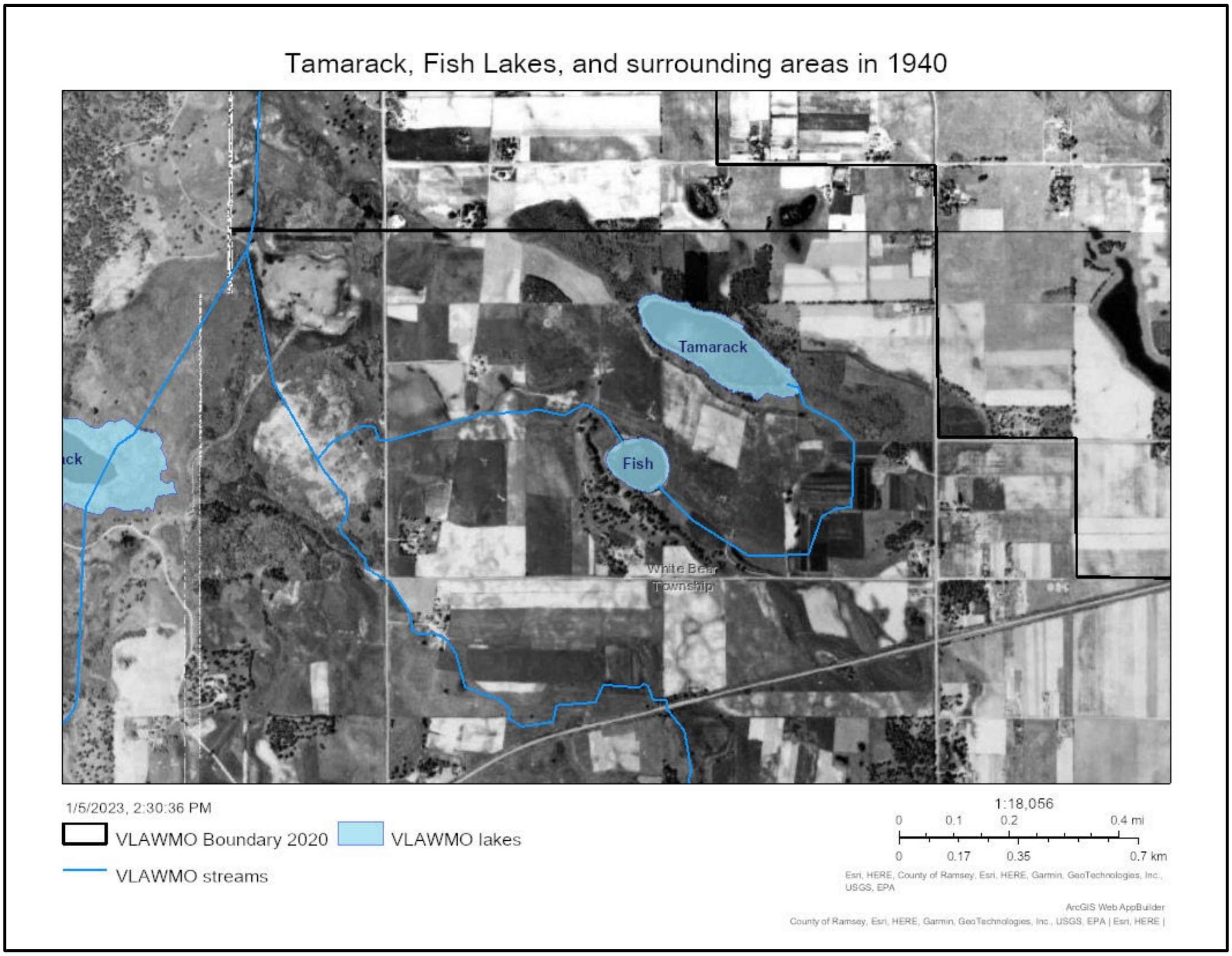
Development continued to be a driver of landscape change through the coming decades. When I-35E was constructed in 1970, drainage was altered, and less water flowed into the nature center property. Development and associated influences brought changes in the wildlife community as well. White-tailed deer became abundant in the 1980s. Red squirrels, mink and muskrats were common then and remain so today. The fish community remains changed from its earlier composition; currently, small bullheads and minnows are found in Fish Lake.

Tamarack was established as a nature center in the 1980s. A trailer served as the original office. The existing visit center was constructed in 1989, redeveloped beginning in 2009, and ongoing update plans are expected as allowed by annual funding. The land immediately surrounding Tamarack and Fish Lakes contains several ponds, extensive wetlands, mature oak and maple woodlands, young pine plantings, and restored prairie. Hiking trails were constructed in the 1980s, and a prairie restoration and prairie trail were completed in 1991. The habitats of TNC are being managed towards a mixture of prairie, oak woodland, and a variety of wetland types. The wetlands include tamarack swamps, alder swamps, and cattail marsh. A wetland restoration project was completed in an area in the southeast corner of the Nature Center property in 1996. Recent restoration efforts continue, maintaining, enhancing, and expanding upon these earlier projects.

The area surrounding TNC includes a major interstate on the western side, municipal, office, and industrial development to the south, residential to the east and north as well as a school and sport fields to the northeast. The larger region around TNC is dotted with numerous recreational lakes and wetlands.

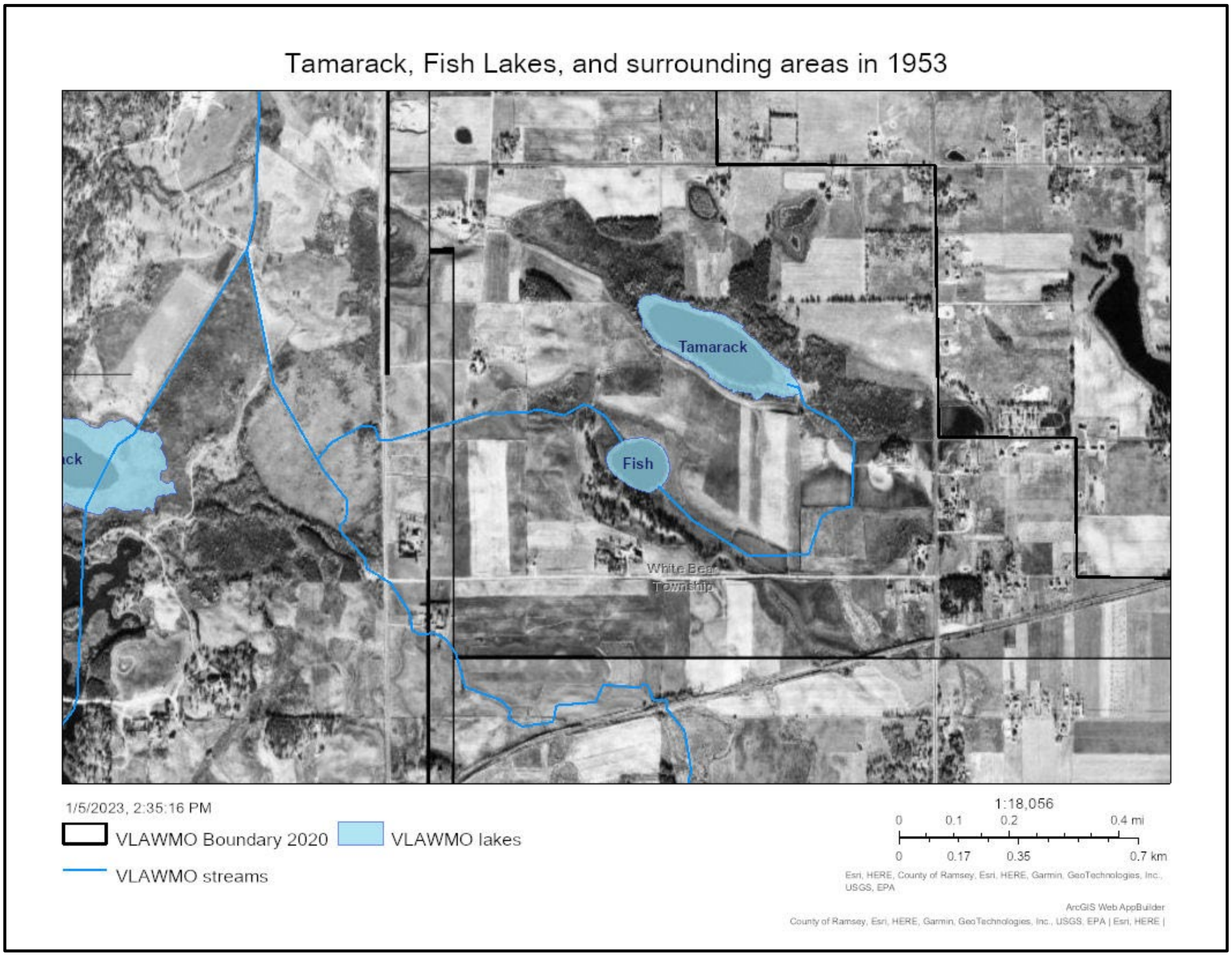
2 WATERSHED FEATURES

Figure 4: 1940 aerial photo of Tamarack and Fish Lakes



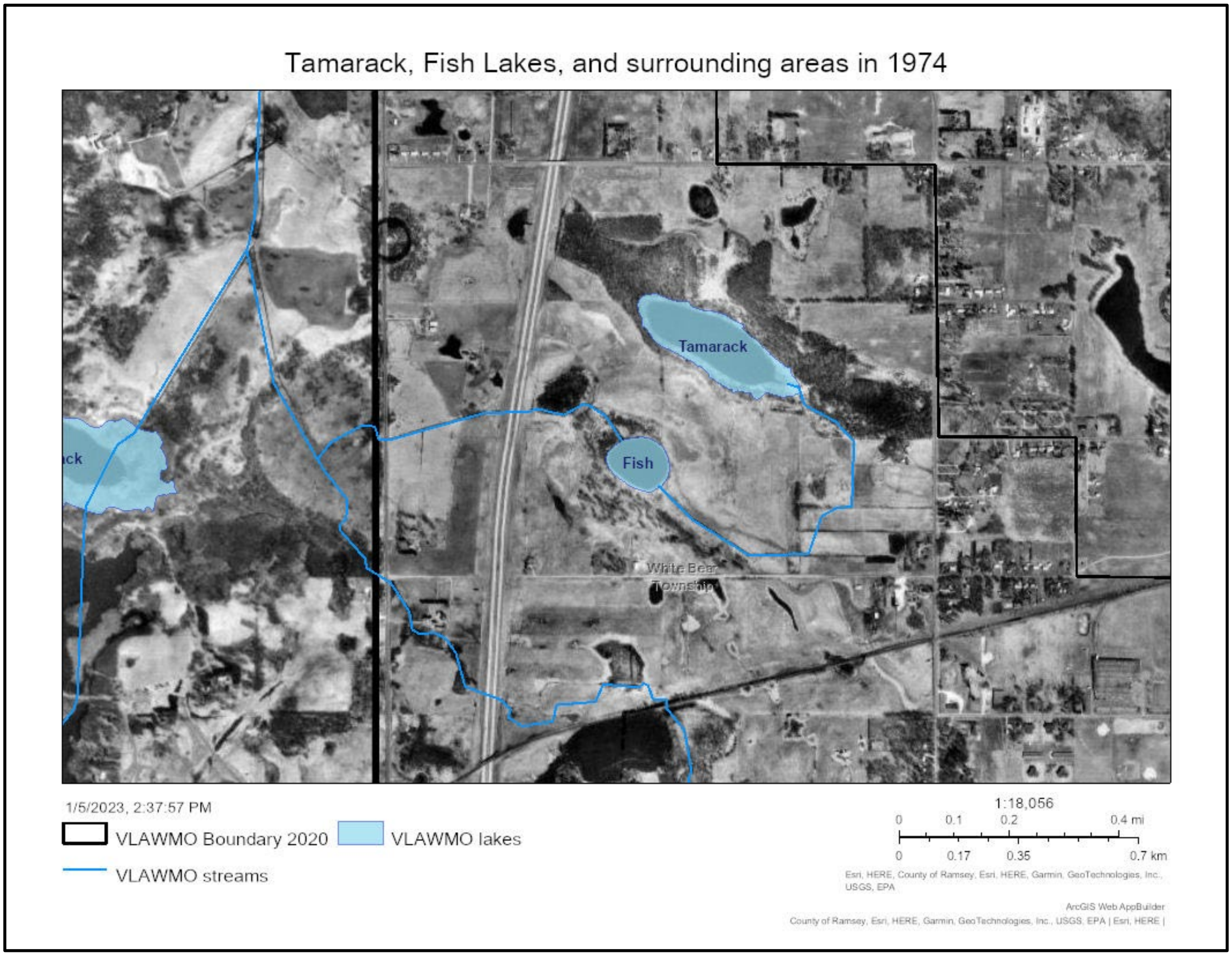
The aerial photo from 1940 shows primarily agricultural land use in the surrounding areas. It appears from the aerial photos, as well as discussion with nature center staff, that the landowner(s) did not grow crops on the land bordering the waterbodies.

Figure 5: 1953 aerial photo of Tamarack and Fish Lakes



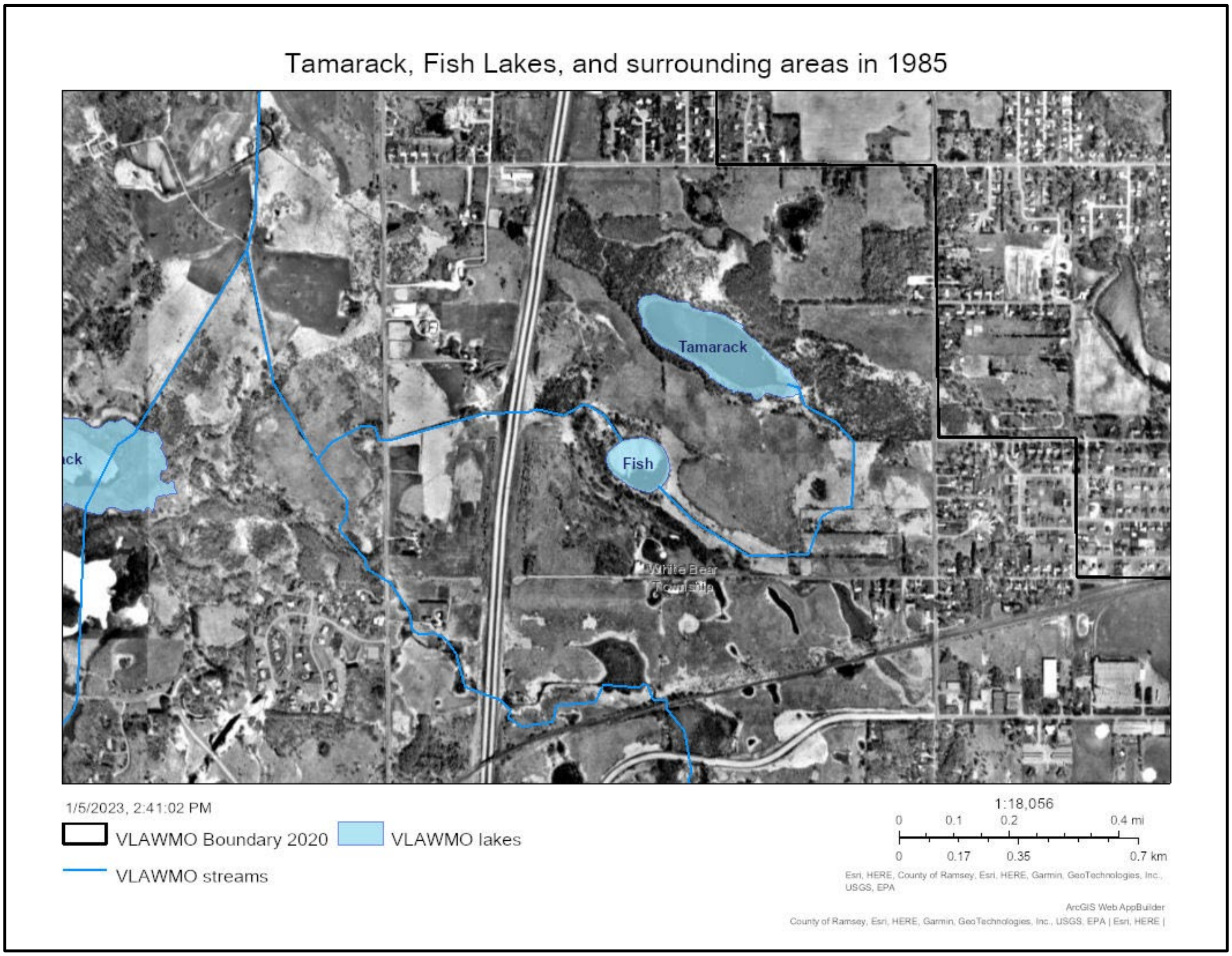
By 1953, a drainage ditch was dug in the southeast area of what is now Tamarack Nature Center property. A few homes had also been built in the area.

Figure 6: 1974 aerial photo of Tamarack and Fish Lakes



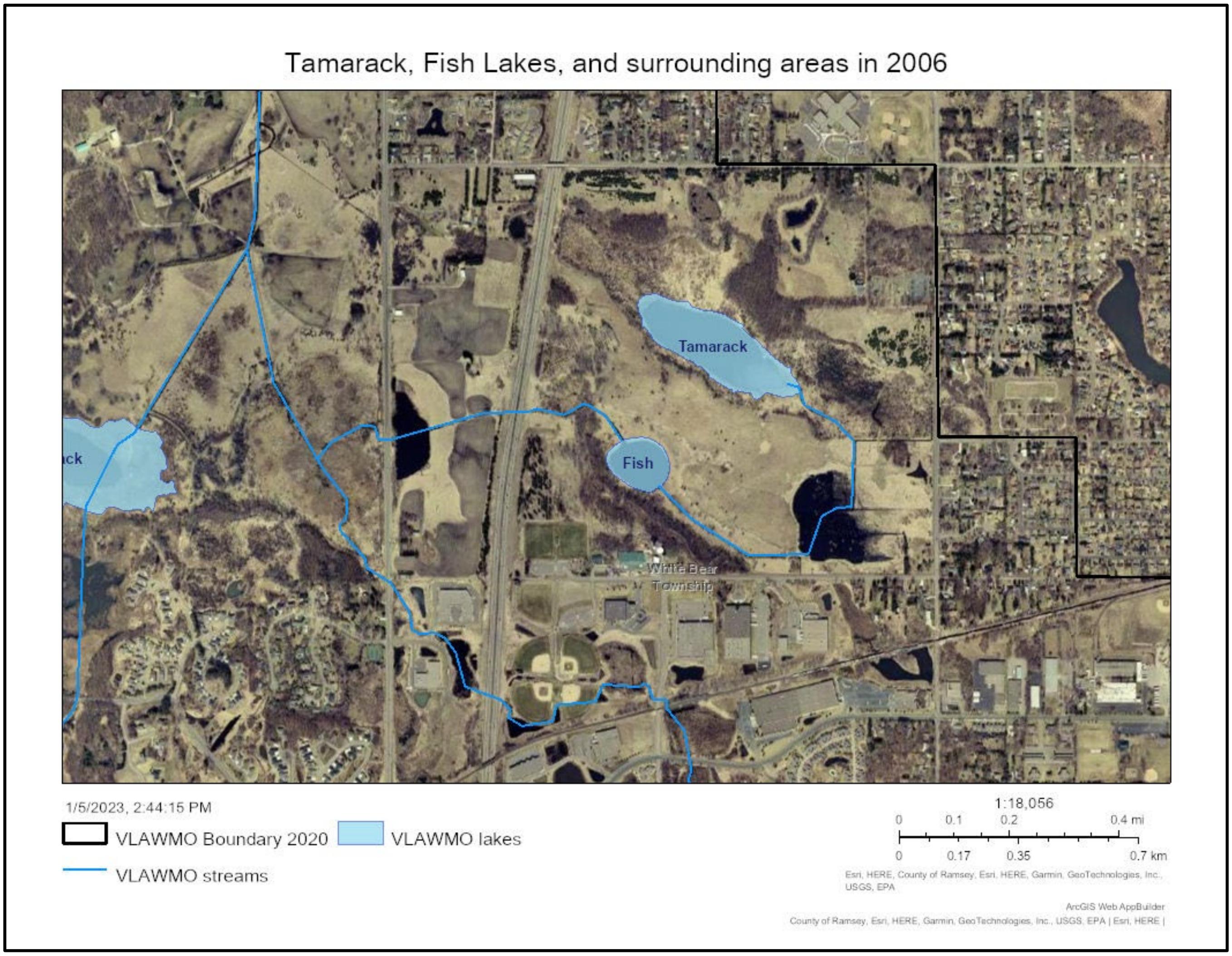
By 1974, residential development continued to expand, and Interstate 35E had been constructed.

Figure 7: 1985 aerial photo of Tamarack and Fish Lakes



By 1985, residential development increased, especially north of Tamarack Nature Center property.

Figure 8: 2006 aerial photo of Tamarack and Fish Lakes

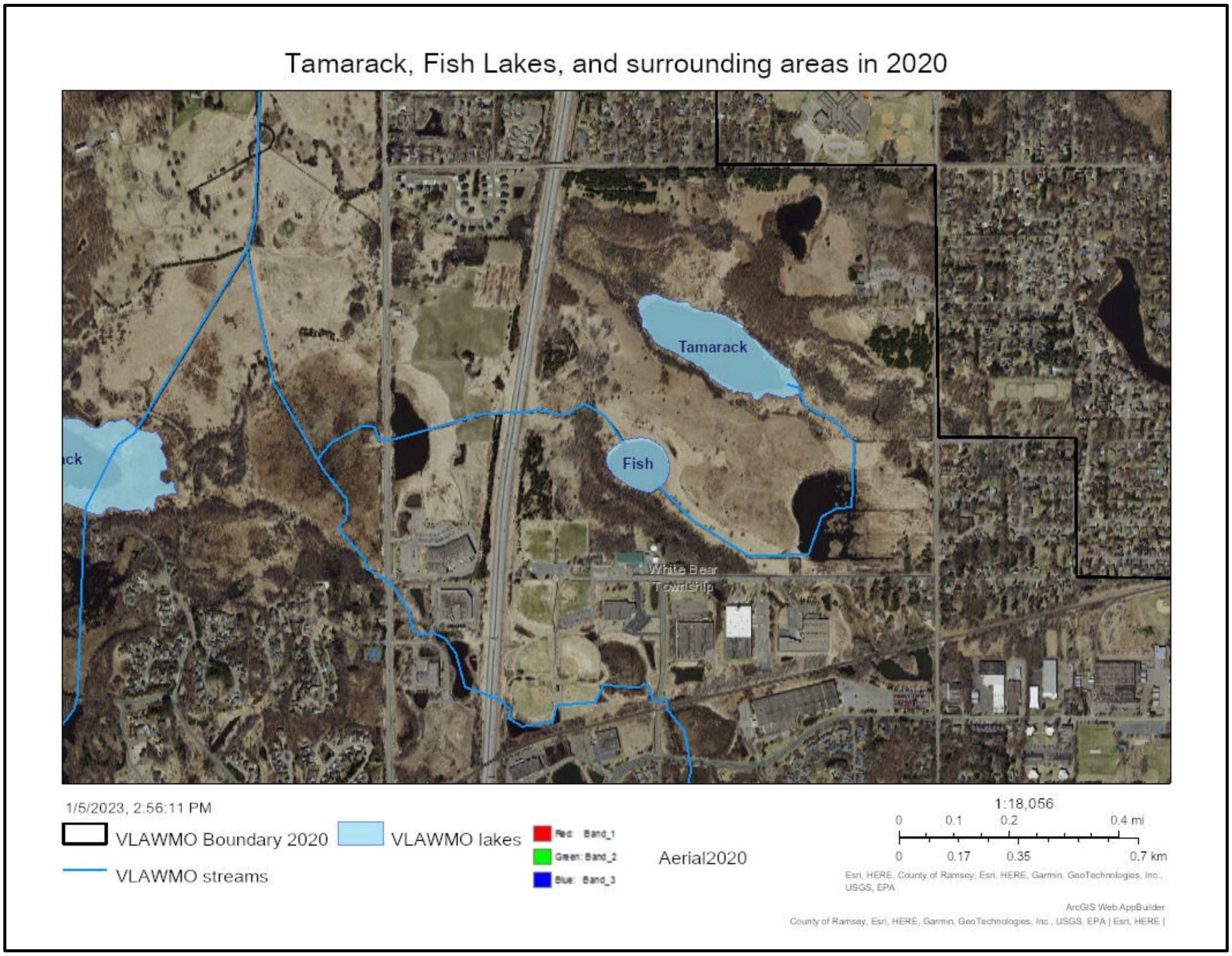


By 2006, the land south of the nature center was fully developed for industrial and municipal use, and residential development including a school surrounded the northern and eastern sides of the nature center.

Figure 9: Conceptual plans for Tamarack Nature Center from 2009

Ramsey County worked with contractors to implement changes to Tamarack Nature Center. Not all of the upgrades envisioned in the master plan were built. For example, the master plan included a Tamarack Lake Raft, which was a floating platform powered by paddles to move around the lake, allowing visitors increased access to the lake. A boardwalk was also planned for and built around Teal Pond. As of 2023, site upgrades are still planned for future implementation.

Figure 10: 2020 aerial photo of Tamarack and Fish Lakes

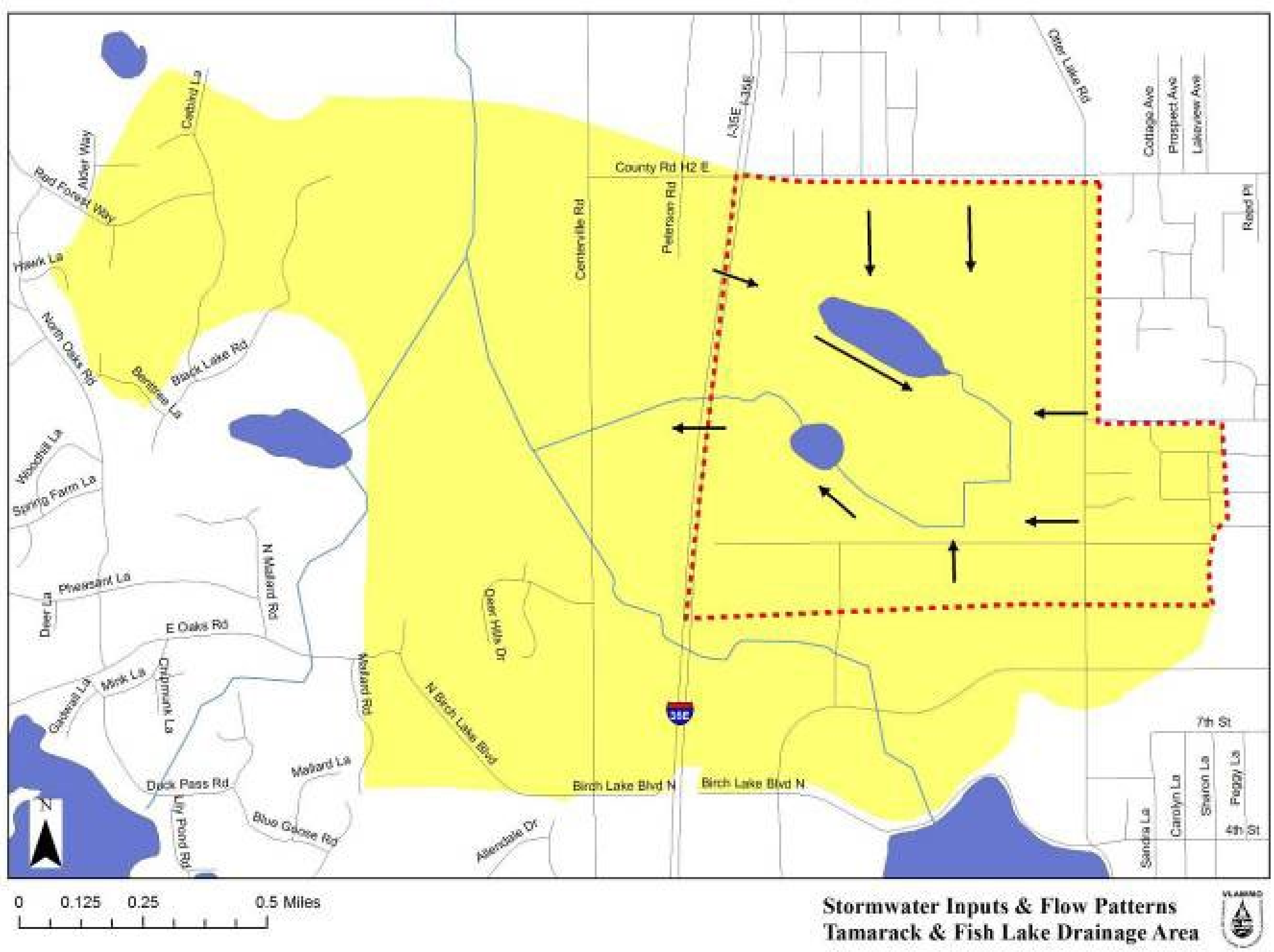


In 2020, the current land uses and development extent are visible, some nature center upgrades had been built, and additional upgrades are considered for the future.

2.2 Tamarack and Fish Lake Drainage Areas

Tamarack and Fish Lakes are within the Wilkinson Stream Subwatershed (yellow area in Figure 11). The area that drains into the lakes is marked by the red dashed line. The drainage area is approximately 500 acres, which is over 30 times larger than the surface area of the lakes. Lakes with a large drainage area (over 10:1 ratio) tend to have lower water quality. Land use is primarily parkland onsite, with industrial land use on the southern end and residential on southeastern side. Interstate 35E is on the western border of the drainage area. Water flows into the area via storm sewers and ditches, and it flows out through a creek that goes under 35E. Observation well #62039 is located near Tamarack Nature Center and shows a depth to groundwater range of 6.5–9.5 feet. This high water table could indicate groundwater recharge in addition to stormwater runoff.

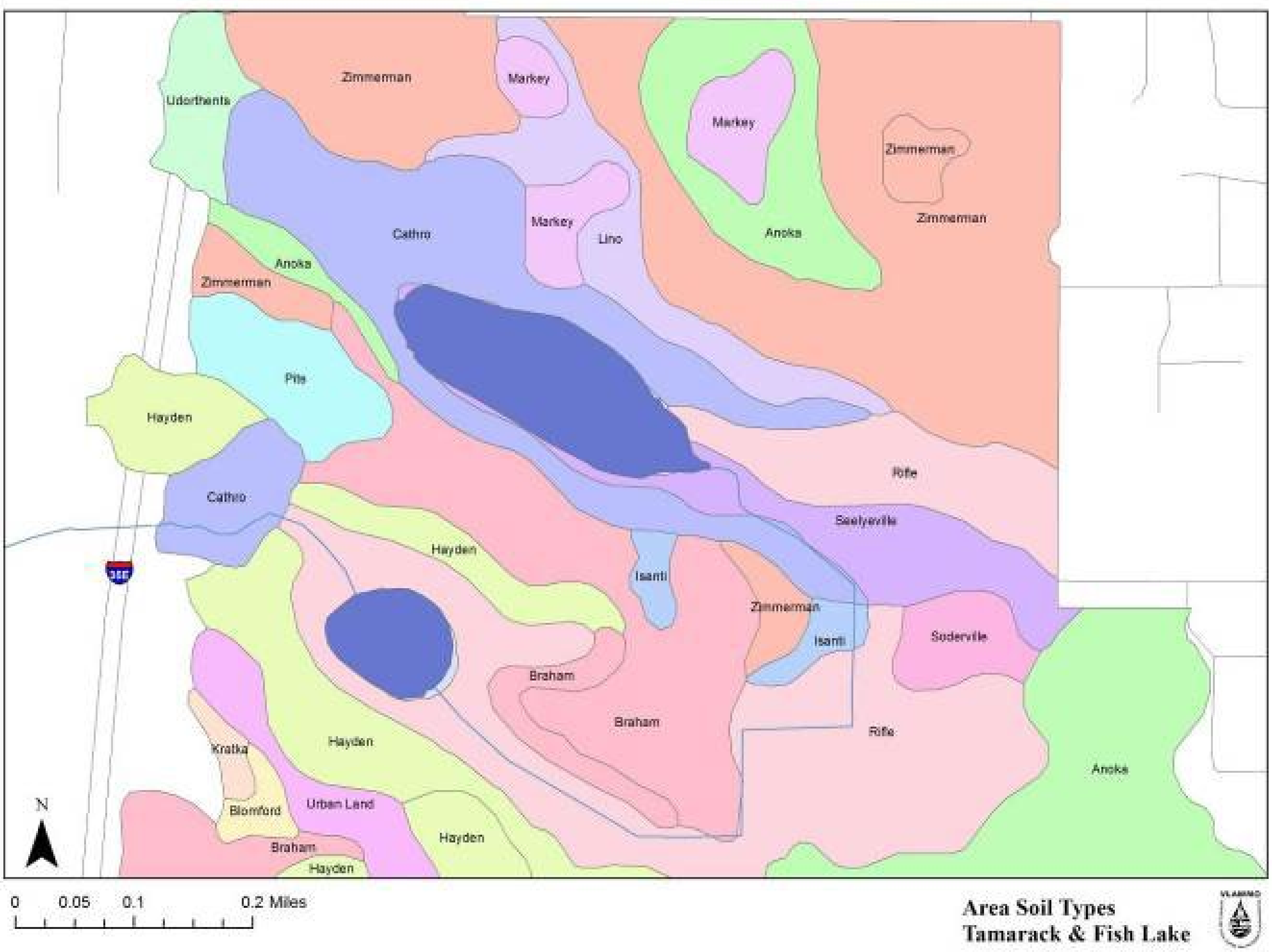
Figure 11: Tamarack & Fish Lakes Drainage Area and Flow Patterns



2.3 Tamarack and Fish Lake Soils

The soils around Tamarack and Fish Lakes vary from sandy loams to muck; primarily based on the topography of the land. The soils in the lower areas and near the lakes are muck types (Rifle, Markey, Cathro). Soils on the upland areas are fine, sandy loams (Hayden, Zimmerman, Isanti, and Anoka).

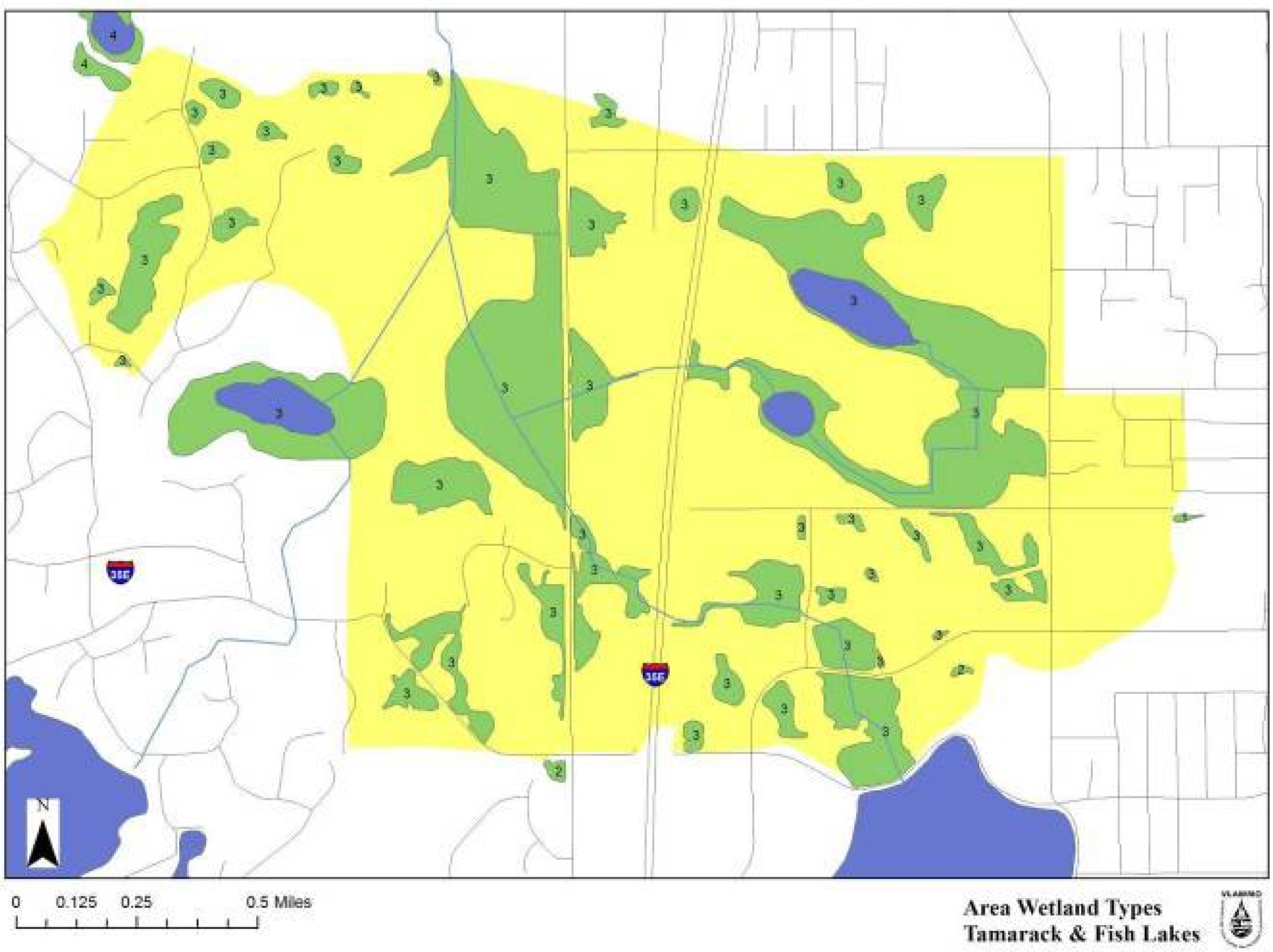
Figure 12: Tamarack and Fish Lake area soils



2.4 Tamarack and Fish Lake Wetlands

Area wetlands are primarily Type 3 – Shallow Marsh. The soil is generally waterlogged early in the growing season and is often covered in 6 inches or more of water.

Figure 13: Wetlands surrounding Tamarack & Fish Lakes



Lake Features

During 2008, the shorelines of Tamarack and Fish Lakes were photographed to provide an overview of what the lakes look like onsite. The land surrounding both Tamarack and Fish Lakes is part of the Tamarack Nature Center. No development is present along the shorelines of either lake.

Figure 14: Shoreline snapshots

Tamarack Lake and shoreline		
		
Fish Lake and shoreline		
		

3 LAKE FEATURES

3.1 Tamarack Lake Depth

Minnesota Department of Natural Resources (MN DNR) has baseline depth information available from historical monitoring. Tamarack's Lake ID number is 62002200. Fish Lake does not have an ID number in the MN DNR database.

This information was obtained from the MN DNR Lake Finder website.

Water Level Data was checked 5 times between 07/07/2008 to 08/06/2008:

Highest recorded: 917.92 ft (07/22/2008)
Lowest recorded: 917.72 ft (08/06/2008)
Recorded range: 0.02 ft
Last reading: 917.72 ft (08/06/2008)
Ordinary High Water Level (OHW) elevation: N/A

In 2008, as part of SLMP discussions, Ramsey County staff stated that the water level in Tamarack does not fluctuate, which could indicate a groundwater water source for the lakes. Groundwater levels in a nearby monitoring well indicate that water is found between 5.5 -9.5 feet below the surface.

A bathymetry survey was completed by Ramsey County Soil and Water Conservation Division (RCSWCD) on August 2, 2022, to develop a map of the bottom and determine lake depths. The deepest location detected by sonar was 2.5 m (8.2 ft), and the average was 1.5 m (5.0 ft). Bottom hardness is represented as soft, medium, or hard; with soft bottoms characterized as muck, loose silt or sand, and medium to harder bottoms characterized as compacted sand, gravel, or rock. Tamarack has a primarily medium bottom with softer areas in the deeper pools toward the middle of the lake.

Figure 15: Tamarack Lake depths with 1-meter contours

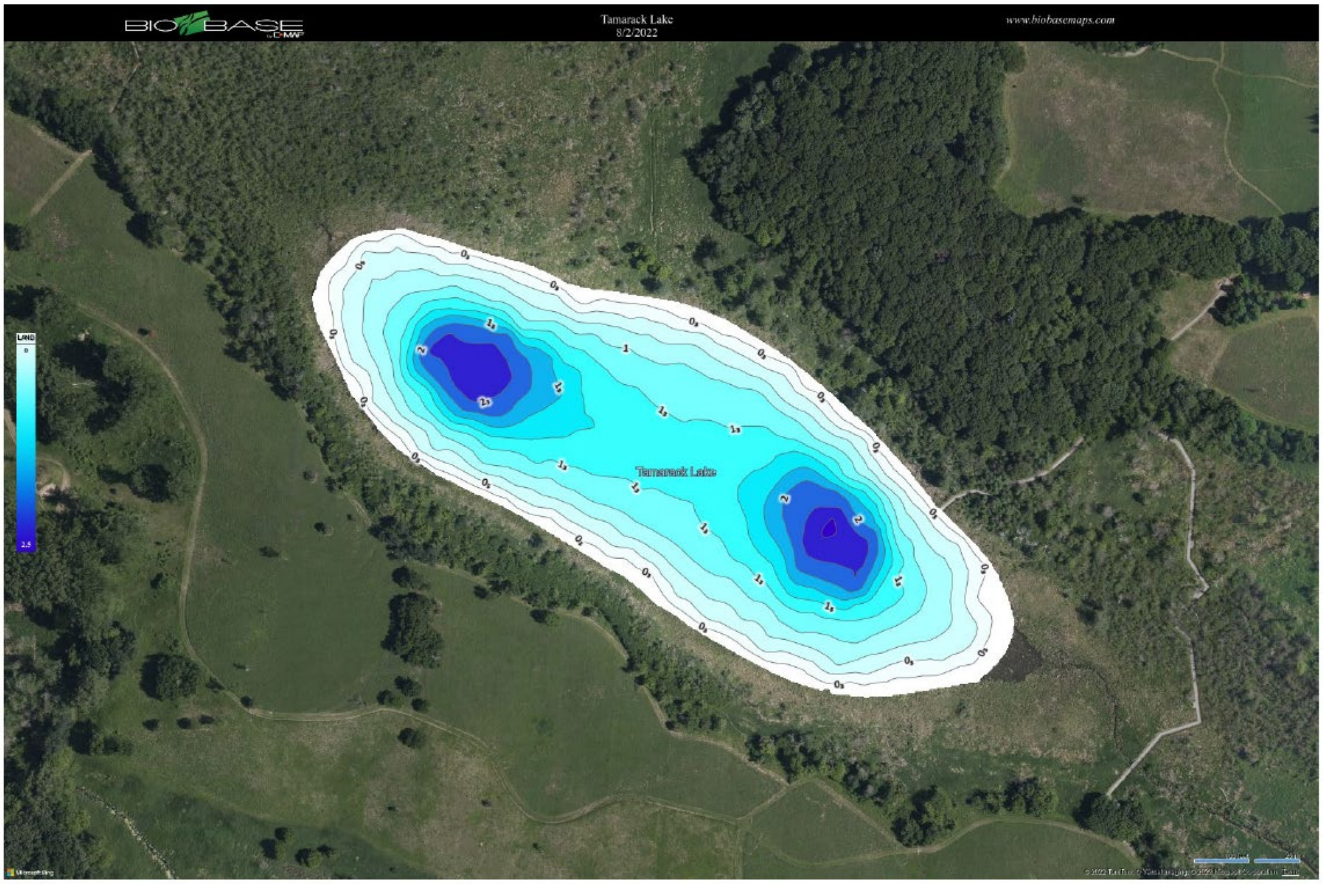


Figure 5. Tamarack Lake 0.3-m contours with depth in meters taken on August 2, 2022.

Macrophyte, Contour, Biovolume and Bottom Composition Survey 5

Figure 16: Tamarack Lake bottom hardness

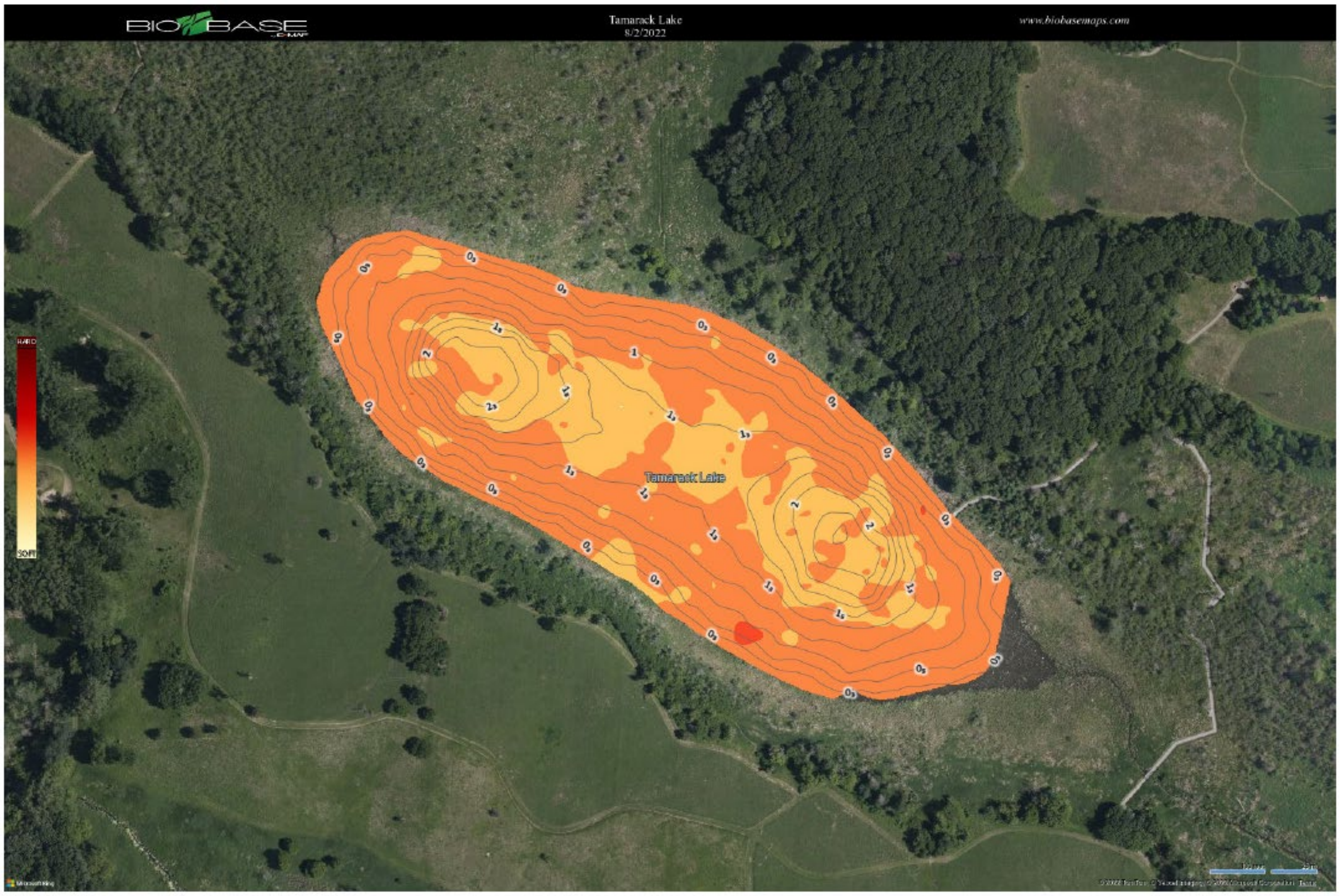


Figure 7. Tamarack Lake bottom composition values with 0.3-m contours taken on August 2, 2022.

Macrophyte, Contour, Biovolume and Bottom Composition Survey 7

3.2 Lake Sediments

A survey was conducted by VLAWMO staff and Steve McComas of Blue Water Science in 2008 to study the lake sediments of Tamarack and Fish Lakes. The report by McComas, *Predicting Curlyleaf Pondweed and Eurasian Watermilfoil Growth Based on Tamarack and Fish Lake Sediment Characteristics* is linked on the VLAWMO website. Sediment samples were collected on March 27, 2008; 5 samples were collected on Tamarack and 4 on Fish Lake.

The report detected low lake sediment phosphorus concentrations in Tamarack Lake and moderate to high phosphorus concentrations in Fish Lake. It hypothesized that, according to a possible relationship between sediment composition and invasive species colonization, there may be a medium potential for nuisance Curly-leaf pondweed plant growth and a low potential for Eurasian watermilfoil on both lakes for most of each waterbody. There was also a smaller area on Fish Lake with a low potential for Curly-leaf pondweed and high potential for milfoil.

Sediment characteristics are only one possible hypothesized factor in potential aquatic invasive species infestations. Continued vigilance and periodic plant surveys should be used to rapidly detect infestations, should they occur.

To better understand phosphorus concentrations and possible internal loading to Tamarack Lake, a study is planned for 2023 to update the analysis done in 2008 and to identify possible strategies for addressing internal load.

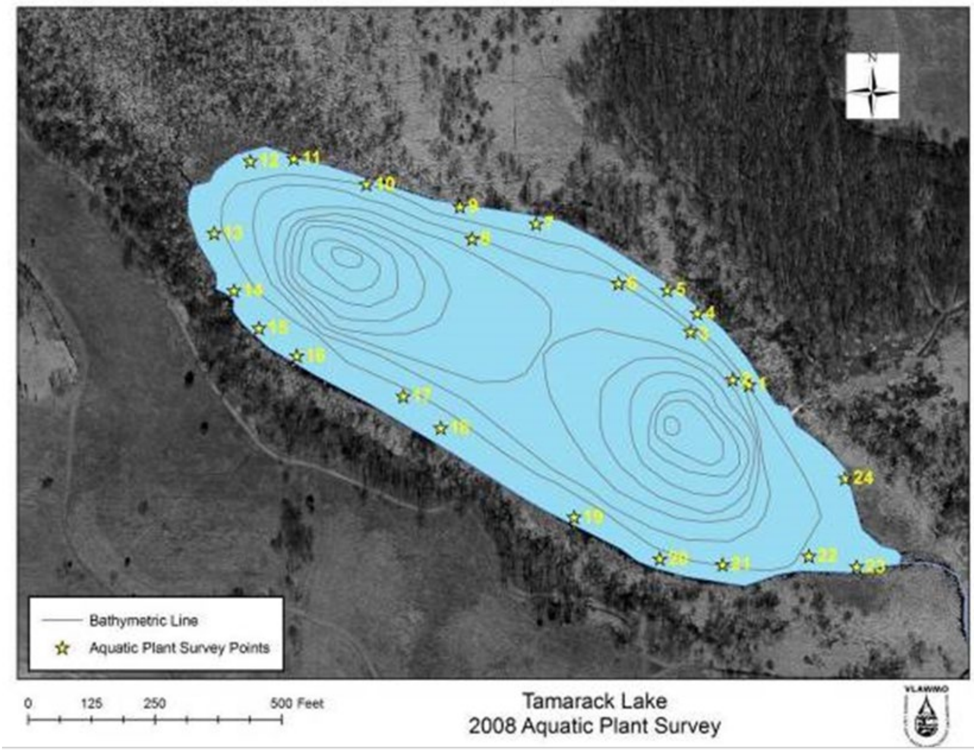
3.3 TAMARACK LAKE BIOVOLUME AND AQUATIC VEGETATION

Biovolume and Aquatic Vegetation (2008 and 2022)

2008

VLAWMO staff worked with Lorin Hatch, HDR Inc. in July to identify aquatic macrophytes in Tamarack Lake. Water clarity was low, so light was determined to not support plant growth past a depth of 4 feet. Therefore, the survey was conducted around the perimeter of the lake. At 24 points, a rake was dragged from the lake bottom up through the water column, and the identification and abundance of plants was recorded.

Figure 17: Sample points for aquatic macrophyte survey in 2008



4 plant species were recorded. They included:

- Sago pondweed
- Coontail
- *Najas* spp.
- Water lily (species not specified)

Sago Pondweed was found at nearly every survey point around the lake and was thickest at points 12-15 and 20-23. Coontail was found at many survey points but was only dominant at point 24. Water lily was mainly found between points 11-18. *Najas flexilus* was most prominent from points 13-21. The plants documented in this survey are native to Minnesota. According to the MN DNR, Sago pondweed provides food for waterfowl and supports aquatic insects. Coontail is tolerant of nutrient-rich water and provides food for waterfowl. Water lilies grow in mucky bottoms of lakes and are an excellent habitat component for largemouth bass and sunfish and provide food for waterfowl. *Najas flexilus* generally grows in clear water and starts from seed each year. This plant is eaten by waterfowl, especially mallards, and provides cover for bass, pike, small bluegills and perch.

2022

Ramsey County Soil and Water Conservation Division (RCSWCD) conducted a biovolume and aquatic vegetation survey on August 2, 2022, in Tamarack Lake. Biovolume measures the density of plant life within the lake. Blue signifies 0% plant life, and red signifies 100% plant life. At depths greater than 4-6 feet, there is commonly no plant life in Minnesota lakes. Plant growth is limited because the sun does not penetrate into the water column below those depths enough to allow photosynthesis to occur.

For the aquatic macrophyte survey, 21 evenly spaced (50 m) georeferenced points were surveyed using the metal portion of a rake/tines tied to a rope. Aquatic macrophytes were found at 6 of 21 points surveyed. The four species found on Tamarack Lake were Coontail (*Ceratophyllum demersum*), Flat-stem pondweed (*Potamogeton zosterformis*), Naiad (*Najas* spp.), and Sago pondweed (*Stuckenia pectinata*). No aquatic invasive plant species were detected.

Figure 18: Macrophyte sampling with RCSWCD and VLAWMO staff.

Flat-stem pondweed at Tamarack Lake	Sago pondweed at Tamarack Lake	Duckweed was not detected on the survey but has been noted in other checks at Tamarack Lake
		

Figure 19: Tamarack Lake survey points with depths

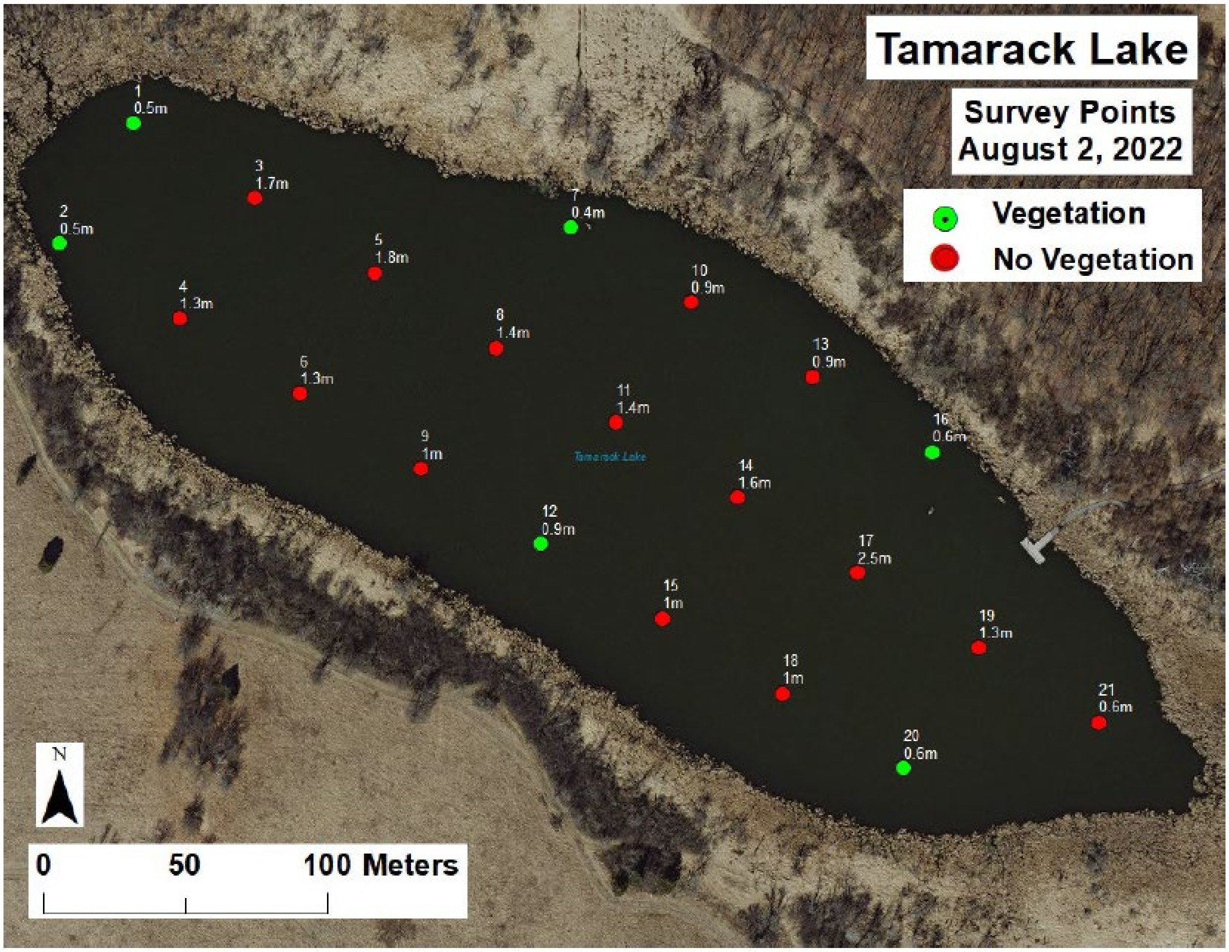


Figure 2. Tamarack Lake vegetation point intercept survey locations. N=21.

Macrophyte, Contour, Biovolume and Bottom Composition Survey 3

Figure 20: Tamarack Lake biovolume

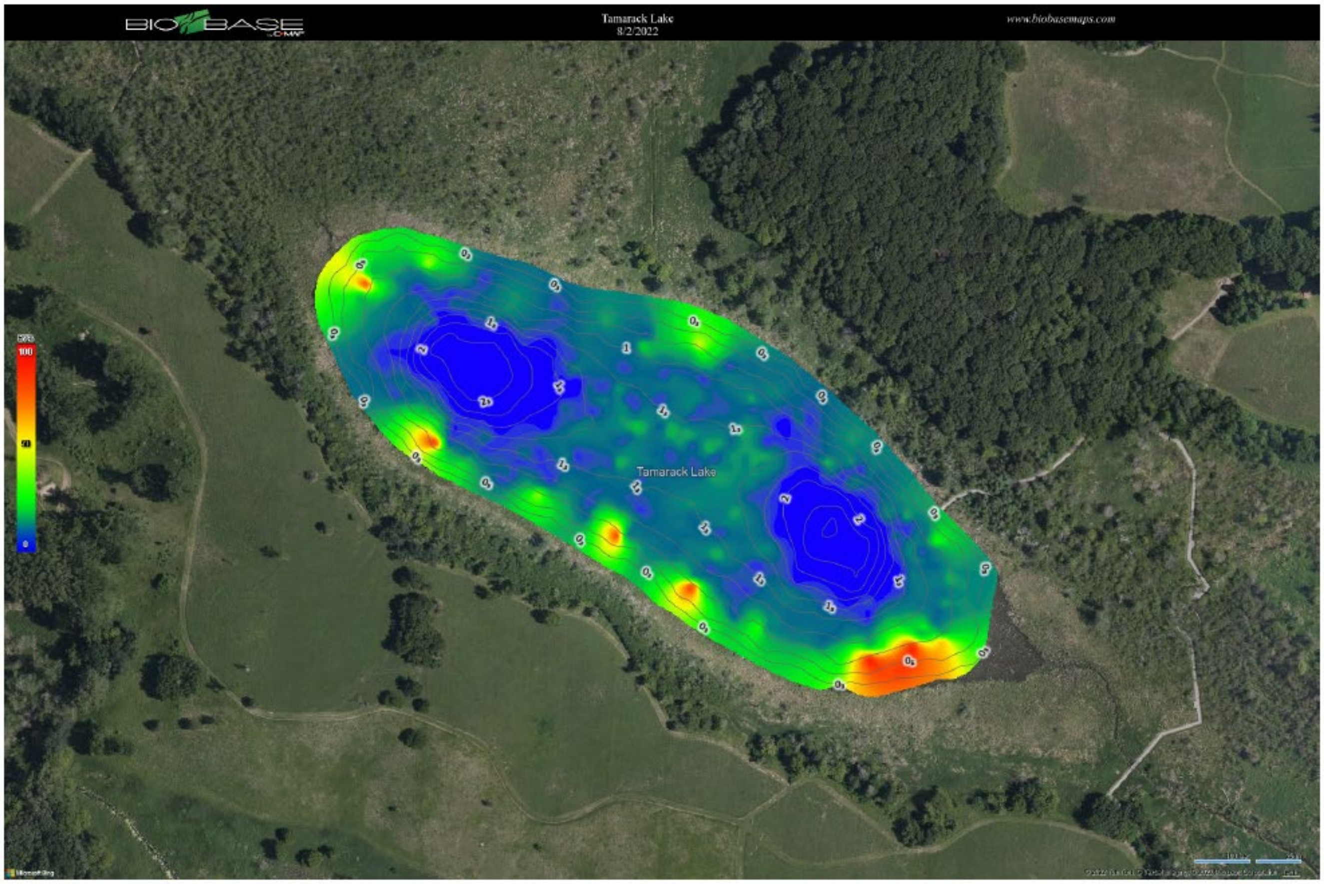


Figure 6. Tamarack Lake vegetation biovolume with 0.3-m contours taken on August 2, 2022. Percent values range from zero to one hundred; Blue = 0%, Yellow = 50% and Red = 100%.

Macrophyte, Contour, Biovolume and Bottom Composition Survey 6

3.4 Bio-Blitz Surveys, Wildlife Monitoring, and Fishery Notes

Bio-Blitz Surveys

In 2004, Ramsey County conducted a series of surveys within a 24-hour period to document birds, mammals, amphibians, reptiles and fungi found within the Tamarack Nature Center property. Detailed results are described in the separate Bio-Blitz reports linked on the VLAWMO webpage (Reports -> Environmental Surveys and Biological Monitoring). Notable species documented included Bobolinks (which is a bird species identified to be in greatest conservation need by the MN DNR and is associated with prairies) and Spring Peepers (which is a frog species that has been documented to be declining in the Twin Cities Metro area). There were also multiple new genus and species of fungi reported for Ramsey County.

Wildlife Monitoring

Wildlife monitoring was a recommended management action in the 2009 SLMP. Wildlife monitoring has since been conducted through:

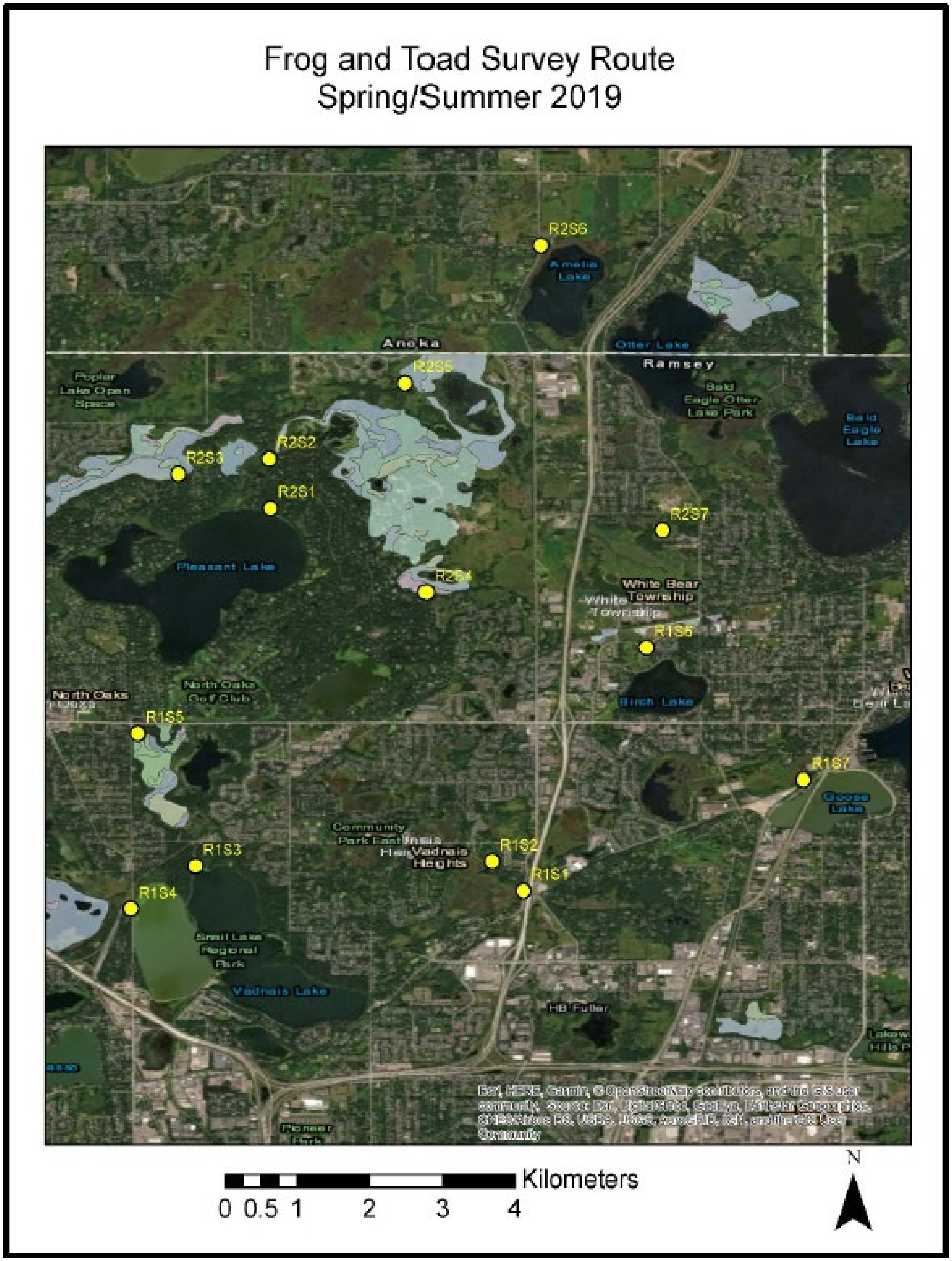
1. Frog and toad call surveys
2. Remote-camera monitoring
3. Macroinvertebrate surveys

Each of these techniques and relevant results within the park are described in this section. Full information and reports are available that include more detailed information on the VLAWMO website.

1. Frog and Toad Call Surveys

During 2019-2020, VLAWMO conducted frog and toad call surveys in representative locations throughout the watershed. Eight species were detected in the watershed; all 8 species were detected at Tamarack Nature Center. Species included: Spring peepers, Wood frogs, Northern leopard frogs, Boreal chorus frogs, American toads, Gray tree frogs, Cope's gray tree frogs, and Green frogs. A full report from these surveys is available on the VLAWMO website and as a StoryMap.

Figure 21: Frog and toad call sampling locations watershed-wide



2. Remote-camera Monitoring

During 2018-2020, VLAWMO conducted remote-camera monitoring in representative locations throughout the watershed. Tamarack and Fish Lake remote cameras captured visits by mammals including: Coyote, White-tailed deer, Virginia opossum, Short-tailed weasel, Eastern cottontail, Muskrat, Gray squirrel, Red squirrel, Peromyscus (either White-footed or Deer mouse), and Red-backed vole. The full remote-camera monitoring report and the remote camera StoryMap are available on the website.

Table 1: An excerpt from a summary table in the remote-camera monitoring report that shows monitoring at Tamarack and Fish Lakes

Site	Locations	Total cameras	Dates	Weeks	Trapnights
Tamarack Nature Center	5	5	Oct. 19-Nov. 21, 2018	~5	165

Figure 22: Remote-camera monitoring locations watershed-wide

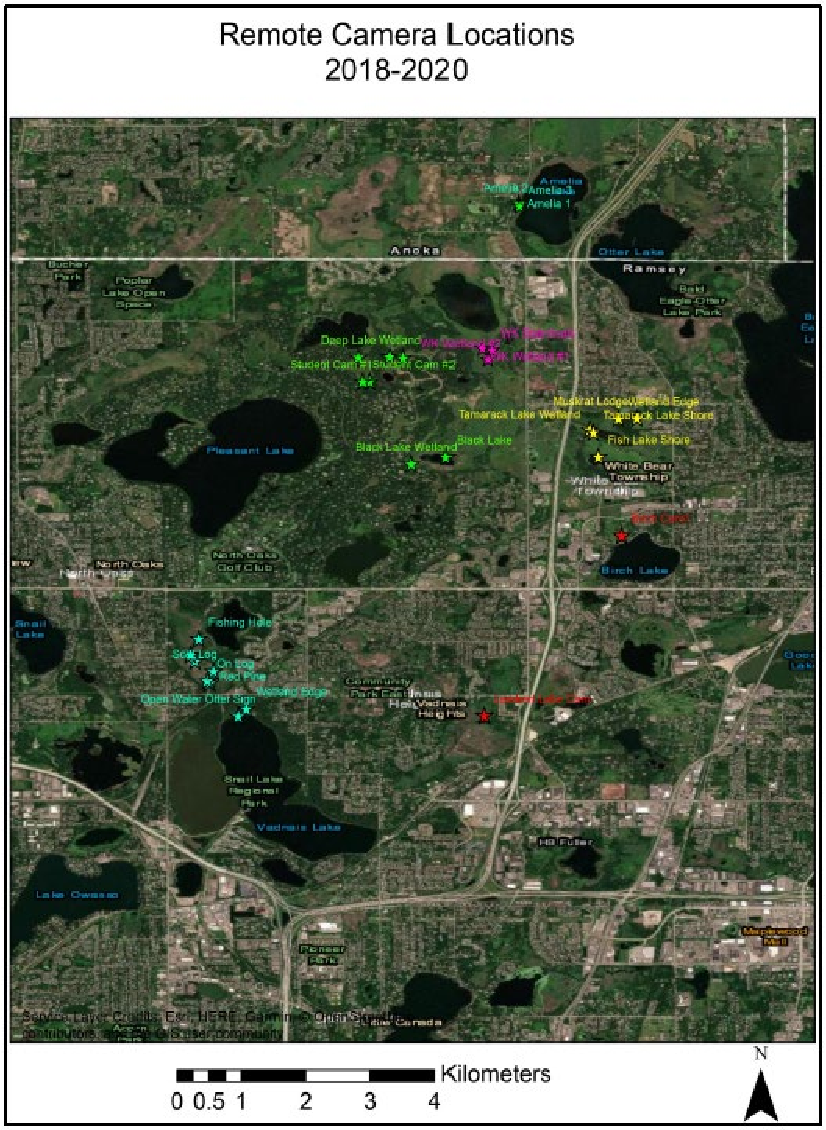


Figure 23: Photos from remote cameras at Tamarack and Fish Lakes

Tamarack Nature Center Sample Photos

Pileated woodpecker

Short-tailed weasel

White-tailed deer

Red-backed vole

Virginia opossum

Muskrats

3. Macroinvertebrate Survey

Three surveys were conducted, primarily by Rebecca Dahlin, a student from Northwestern University during the summer of 2008. Surveys were completed on Tamarack Lake, Fish Lake, and Teal Pond. Using specialized nets, dips were made throughout each waterbody. Macroinvertebrates were identified and quantified. The types of macroinvertebrates found correlate to different sensitivities of pollution. A data sheet is filled out which allocates the macroinvertebrates into different Pollution Tolerance Groups. A calculation results in a Pollution Tolerance Index (PTI) rating.

Macroinvertebrate sampling was also done with volunteers in 2022 on Teal Pond. This 2022 sampling was part of a Wetland Health Evaluation Program (WHEP) pilot program in partnership between VLAWMO and Tamarack Nature Center. Results of sampling in 2008 and 2022 is shown in this section, with full recognition that these samples are anecdotal and provide only a snapshot glimpse into an area. The 2022 WHEP sampling was designed with guidance and assistance from staff at the MPCA and Dakota County, entities that coordinate the Dakota and Hennepin County WHEP programs. A part of this effort included reassessing pollution tolerance levels to better fit wetlands, as opposed to standard PTI ratings developed for lakes and streams.

A uniform, standardized protocol would be necessary to draw scientifically relevant comparisons and a clear indication of possible pollutant levels. Sampling results here are anecdotal.

Pollution Tolerance Index ratings:
23 or More = Excellent, 17 – 22 = Good, 11 – 16 = Fair, 10 or Less = Poor

Table 2: 2008 Tamarack Lake Macroinvertebrate Findings (10 dip sites/15 dips per site)

PT Group 1 Intolerant		**PT Group 2 Moderately Intolerant**		**PT Group 3 Fairly Tolerant**		**PT Group 4 Very Tolerant**	
Stonefly Nymph		Damselfly Nymph	27	Midge Larvae		Left-Handed Snail	10
Mayfly Larvae/Nymph	13	Dragonfly Nymph	13	Black Fly Larvae		Aquatic Worms	3
Caddis Fly Larvae/Nymph	7	Sowbug		Planaria		Blood Midge	
Dobsonfly Nymph		Scud	27	Leech	1	Rat-tailed Maggot	
Riffle Beetle	3	Crane Fly Larvae	3	Water Mite	40	Orb Snail	3
Water Penny	1	Clams/Mussels					
Right-Handed Snail	1	Crayfish					
# of Taxa	5	**# of Taxa**	4	**# of Taxa**	2	**# of Taxa**	3
weighting factor (x 4)	**20**	**(x 3)**	**12**	**(x 2)**	**4**	**(x 1)**	**3**
						Total PTI	**39**

Table 3: 2008 Fish Lake Macroinvertebrate Findings (10 dip sites/6 dips per site)

PT Group 1 Intolerant		PT Group 2 Moderately Intolerant		PT Group 3 Fairly Tolerant		PT Group 4 Very Tolerant	
Stonefly Nymph		Damselfly Nymph		Midge Larvae		Left-Handed Snail	
Mayfly Larvae/Nymph		Dragonfly Nymph	1	Black Fly Larvae		Aquatic Worms	1
Caddis Fly Larvae/Nymph		Sowbug		Planaria		Blood Midge	
Dobsonfly Nymph		Scud		Leech	11	Rat-tailed Maggot	
Riffle Beetle		Crane Fly Larvae		Water Mite	4	Orb Snail	
Water Penny		Clams/Mussels	1				
Right-Handed Snail		Crayfish					
# of Taxa		**# of Taxa**	2	**# of Taxa**	2	**# of Taxa**	1
weighting factor (x 4)		**(x 3)**	**6**	**(x 2)**	**4**	**(x 1)**	**1**
						Total PTI	**11**

Table 4: 2008 Teal Pond Macroinvertebrate Findings (6 dip sites on north end of pond/6 dips per site)

PT Group 1 Intolerant		PT Group 2 Moderately Intolerant		PT Group 3 Fairly Tolerant		PT Group 4 Very Tolerant	
Stonefly Nymph		Damselfly Nymph	1	Midge Larvae	1	Left-Handed Snail	
Mayfly Larvae/Nymph		Dragonfly Nymph		Black Fly Larvae		Aquatic Worms	
Caddis Fly Larvae/Nymph		Sowbug		Planaria		Blood Midge	
Dobsonfly Nymph		Scud		Leech	6	Rat-tailed Maggot	
Riffle Beetle		Crane Fly Larvae	3	Water Mite	1	Orb Snail	
Water Penny		Clams/Mussels	3				
Right-Handed Snail		Crayfish					
# of Taxa		**# of Taxa**	3	**# of Taxa**	3	**# of Taxa**	
weighting factor (x 4)		**(x 3)**	**9**	**(x 2)**	**6**	**(x 1)**	

Total PTI	**15**

Table 5: 2022 Teal Pond Macroinvertebrate Findings (6 Leaf Packs and 2 dip sites/3 dips per site)

Group 1 Intolerant		Group 2 Moderately Intolerant		Group 3 Fairly Tolerant		Group 4 Very Tolerant	
Mayfly Larvae/Nymph	2	Cranefly	8	Right-Handed Snail	11	Midges	37
Dobsonfly, Fishfly, Alderfly Larvae/Nympth	3	Clams/Mussels	7	Limpet	12	Aquatic Worm	111
		Dragonfly Nymph	3	Scud	29		
		Diving Beetles	5	Leech	16		
				Mosquito Larvae	1		
				Marsh Treader	1		
				Water Strider	10		
# of Taxa	2	# of Taxa	4	# of Taxa	7	# of Taxa	2
weighting factor (x 4)	**8**	**(x 3)**	**12**	**(x 2)**	**14**	**(x 1)**	2

Total PTI	**36**

Macroinvertebrate collection at the nature center has a primary goal of education and experiential learning as opposed to quantitative environmental monitoring. Any comparisons made here should be considered anecdotal and could inform implementation of a standardized protocol that could accurately capture macroinvertebrate responses to pollutant levels.

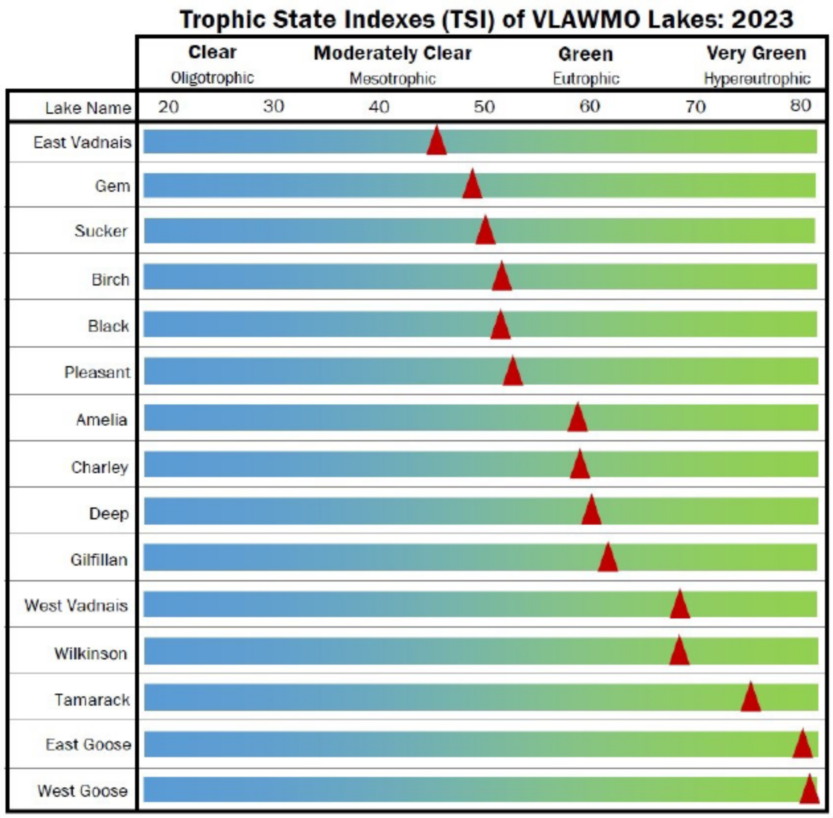
4. Fishery Notes

While conducting the surveys in 2008, VLAWMO staff noted the presence of many bullheads and minnows in Tamarack Lake. Bullhead stir up lake bottoms, resuspend nutrients in the sediment, and may be contributing to high turbidity. An official fish survey has not been conducted by VLAWMO nor MN DNR. Fish surveys may be considered in the future.

3.5 Water Quality Summary

Tamarack Lake is shallow and falls in the area of very green/hypereutrophic on the Trophic State Index (TSI) (shown below using the Carlson scale, MPCA). Fish Lake is not monitored, so history and trends are unknown. Tamarack Lake had a scores of 78 (2020), 76 (2021), 76 (2022), and 75 (2023) (a lower number translates to better water quality).

Figure 24: TSI scores for VLAWMO lakes



VLAWMO has collected water quality (WQ) data on Tamarack Lake since 1997. VLAWMO staff collects WQ data and water samples biweekly, May-September, for water clarity (secchi disk), nutrients (TP, Chl-a, SRP, nitrogen), and chemistry (temperature, conductivity, dissolved oxygen, and potential hydrogen [pH]). Total Phosphorus (TP) and Chlorophyll A (Chl-a) analyses are conducted by a contracted lab.

Monitoring is essential in understanding the status of the lake and establishing progress over time. Seasonal average TP (micrograms/L) has fluctuated over the years. TP has ranged from an outlier in 1997 of 17 to a high of 187 (2016). In 2021, the average was 177. A summary graph of the trends through time is shown below. This graph was taken from the annual monitoring report that is prepared by VLAWMO and available on the VLAWMO website.

- 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 resuspended into the water column from the sediment. High amounts of P in sediments may occur as a result of historical land uses including, but not limited to, waste disposal into the lake.

- 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 the levels of TP and Chl-a. For shallow lakes in Minnesota, the impaired water quality standard levels are: <60µg/L for TP, <20µg/L for Chl-a, and <230 mg/L for Chloride.

- Red numbers indicate values that exceed MN State Standards.

Table 6: Tamarack Lake monitoring data 1997-2023

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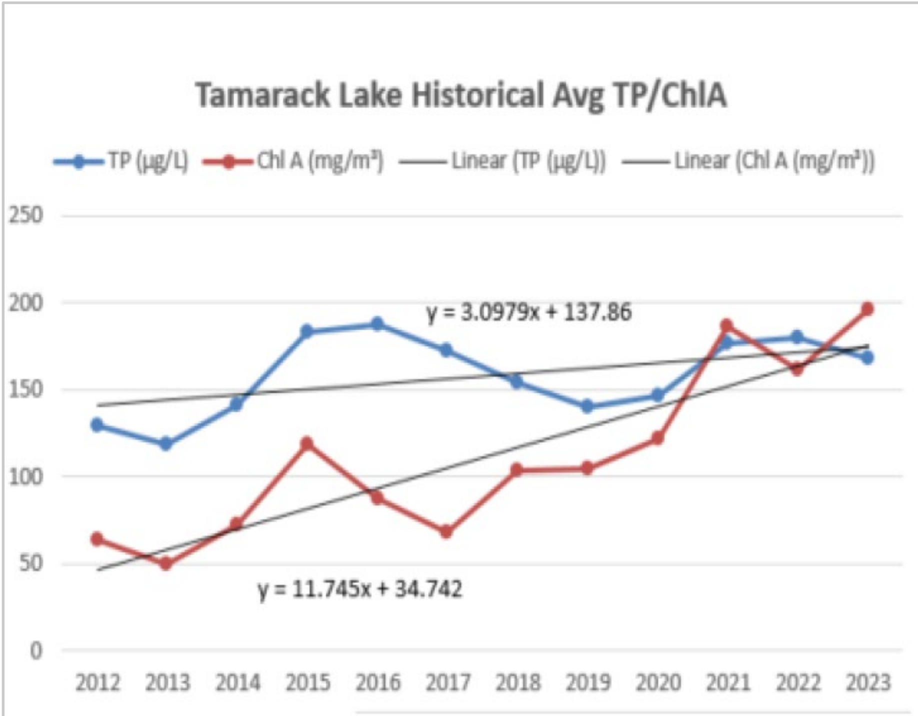
Tamarack Lake Historical Avg TP/Chl A/ SDT			
Year	TP (µg/L)	Chl A (µg/L)	Secchi (m)
1997	17	180	0.2
1998	54	32	0.5
1999	90	26	0.4
2000	60	27	0.4
2001	132	37	0.4
2002	164	120	0.4
2003	168	95	0.3
2004	96	-	0.8
2005	143	65	-
2006	136	38	-
2007	148	109	0.5
2008	115	99	0.3
2009	161	161	0.2
2010	157	96	0.2
2011	120	28	0.6
2012	129	64	0.4
2013	119	50	0.5
2014	141	72	0.5
2015	183	119	0.4
2016	187	87	0.4
2017	172	68	0.4
2018	154	103	0.4
2019	140	104	0.4
2020	146	122	0.3
2021	177	186	0.3
2022	180	162	0.6
2023	168	196	0.7

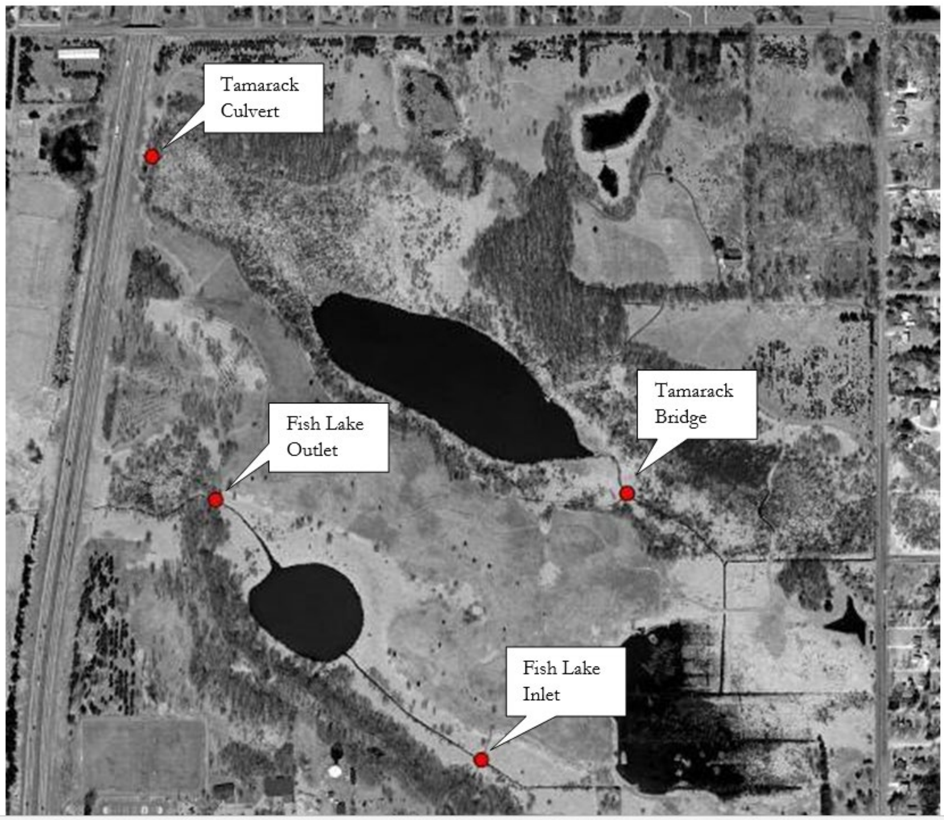
Figure 25: Water quality trends in Tamarack Lake



Additional automated storm samplers and data collected (2008-2009)

Four storm samplers were installed within the drainage area to study the change in pollutants and nutrients as water enters the Nature Center property, flows through Tamarack Lake, through the wetland banking area, and as it leaves Fish Lake. Table 7 shows results of sampling (2008-2009).

Figure 26: Storm sampler locations in Tamarack Nature Center



Samples were collected in March 2008 at the Tamarack Culvert and Tamarack Bridge sites to determine how much salt is coming off the roads from snowmelt runoff. The results were 600 mg/L at the culvert and 26 mg/L at the bridge. This indicates a high level of salt in the runoff from 35E but that it is not at a high level by the time water reaches the bridge. In 2009, 2 samples were collected at the culvert. On 2/10/09, chloride was 779 mg/L and on 3/6/2009 it was 528 mg/L. VLAWMO will continue collecting chloride samples.

The storm samples were tested for the following: TP, Total Kjehdahl Nitrogen (TKN), Nitrates (NO_3), Ammonia (NH_3), and Total Suspended Solids (TSS).

TKN is the sum of organic nitrogen and Ammonia (NH_3). High measurements of TKN typically results from sewage and manure discharges to water bodies. The average TKN for a lake in this ecoregion is 600-1200 ug/L. High NO_3 levels are often caused by over application of fertilizers that leach into waterbodies. Unused NO_3 turns into NO_2, which is poisonous to fish (75ug/L will stress fish; over 500 ug/L can be toxic). Typical levels of NO_3 in this ecoregion less than 100 ug/L. NH_3 is a form of nitrogen contained in fertilizers, septic system effluent and animal waste. It is also a product of bacterial decomposition of organic matter. Typical levels of NH3 could not be found for this report. However, high levels of unionized NH3 can be toxic to aquatic organisms. TSS indicates the presence of very small particles in the water column. TSS interferes with light penetration, buildup of sediment, and the solids could carry nutrients that cause algal blooms and other toxic pollutants that are harmful to fish. Typical TSS in this ecoregion is 2-6 mg/L.

Table 7: Tamarack and Fish Lake Storm Sampler Results (2008-2009)

	4/22/2008	6/6/2008	7/8/2008	7/21/2008	7/24/2009	8/20/2009	8/25/2009
TP (ug/L)							
Tamarack Culvert	109	255	414	267	318	254	242
Tamarack Bridge	357	630	83	480			
Fish Lake Inlet				408	343	259	291
Fish Lake Outlet				198			
TKN (ug/L)							
Tamarack Culvert	2660	3150	2630	1760	2794	1143	3151
Tamarack Bridge	4560	7980	2020	3280			
Fish Lake Inlet				11300	1595	3152	3075
Fish Lake Outlet				3630			
NO3 (ug/L)							
Tamarack Culvert	2120	369	926	452	836	243	460
Tamarack Bridge	10	9	9	75			
Fish Lake Inlet				9	961	425	234
Fish Lake Outlet				80			
NH3 (ug/L)							
Tamarack Culvert	434	226	328	72	235	149	216
Tamarack Bridge	1420	5240	50	4580			
Fish Lake Inlet				7360	424	65	436
Fish Lake Outlet				1330			
TSS (mg/L)							
Tamarack Culvert	17.8	8.8		19.3	28.2	115.8	85.6
Tamarack Bridge	25.1	20.6		10.7			
Fish Lake Inlet				24	14.3	10.1	21.1
Fish Lake Outlet				11.8			

VLAWMO does not plan to conduct ongoing storm sampling unless it is required to inform a specific project. These data provide a glimpse of water quality as water flows through Tamarack Nature Center.

Table 8 shows 4 years of nutrient analysis on Tamarack Lake, the MPCA nutrient standards for lakes, and the results of predicted lake nutrient status derived from the MNLeap modeling software. The model was first run based on typical conditions of the Central Hardwood Forest Ecoregion which uses an average TP inflow of 150 ug/L. The model was run again using a TP inflow of 265 ug/L based on results from storm sample collections at the 35E culvert.

Consideration could be given to installing measures that would reduce the amount of TP inflow into the Nature Center at the 35E culvert which may result in lower TP levels in Tamarack Lake itself.

Table 8: MNLeap Nutrient Analysis for Tamarack Lake

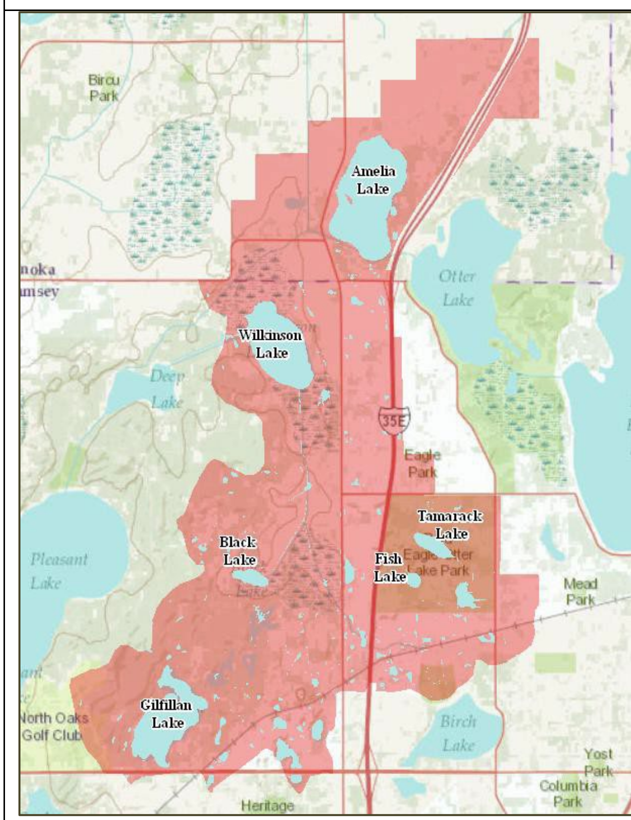
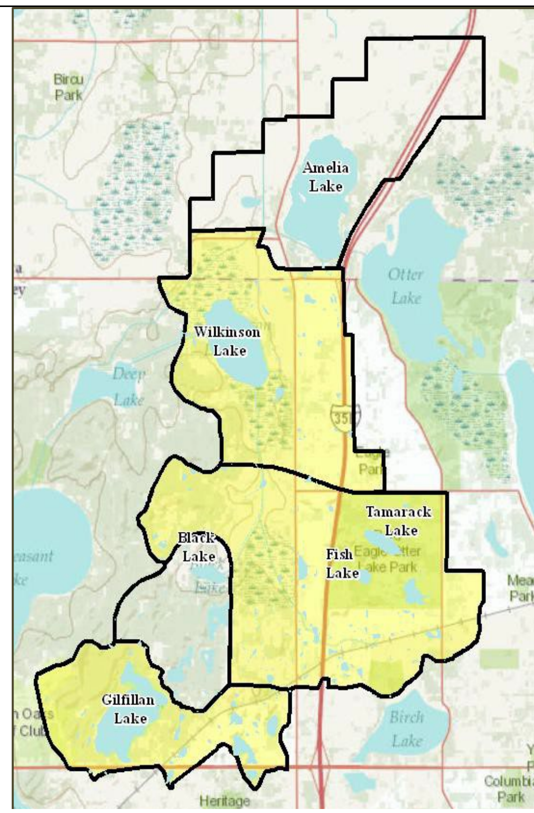
Tamarack Nutrient Analysis			
Average Conditions	**TP (µg/L)**	**Chl A (µg/L)**	**SDT (m)**
2006	136	38	
2007	148	104.4	0.5
2008	114.6	98.6	0.3
2009	161	161	0.2
MPCA Nutrient Criteria (shallow lakes)	60	20	1.1
Predicted Conditions (MnLEAP Model - CHF Avg – 148 ug/L inflow)	81	40.5	0.9
Predicted Conditions (MnLEAP Model - 265 ug/L TP inflow)	125	76.6	0.6

4.1 RETROFIT REPORT

Retrofit Report (2012)

In 2012, the Ramsey Conservation District (RCD), now Ramsey County Soil and Water Conservation Division (RCSWCD), completed a Retrofit Report for the Gilfillan, Black, Wilkinson, Amelia, Fish, and Tamarack Lake chain of waterbodies. This was part of a larger effort to assess the full watershed and subwatershed scales and identify optimal locations for BMPs. Amelia and Black Lakes were excluded from the final area because these subwatersheds consisted of primarily open space.

Figure 28: Initial and final areas considered for retrofit analysis

Initial area considered in 2012	Final area included in analysis; excluding Amelia and Black Lakes due to low need for retrofits
	

The Tamarack and Fish Lake subwatershed areas were grouped into a catchment called “Wilkinson Stream” for this analysis. A large portion of this catchment is open space consisting of lowlands, wetlands, and buffers. The southern portion of the catchment consists of low to medium-density residential single-family housing, commercial, and light industrial land use. A series of wetlands, ditches, and stormwater ponds exist within this catchment, contributing runoff to Tamarack and Fish Lake. The soils within the area where retrofit opportunities were identified consist of Urban land-Zimmerman complex and Anoka and Lino loamy, fine sand which would allow for simple bioretention practices, if found to not be compacted or polluted.

Three localized areas for this 1399-acre area were identified with total possible reductions of 681 lb/yr of Total Phosphorus.

Figure 29: Bioretention and permeable asphalt BMP locations identified to reduce pollutant loads to Tamarack and Fish Lakes.

Gilfillan Tamarack Wilkinson Subwatershed: Urban Stormwater Retrofit Analysis

4.2 Completed BMPs and project partnerships in the subwatershed

Best Management Practices (BMPs) are implemented to improve and protect water quality. Common small-scale examples of BMPs include raingardens, infiltration basins, shoreline restorations, rain barrels, and native restorations and plantings. Larger BMPs include stormwater retention basins, iron-enhanced sand filters, weirs and stormwater conveyance retrofits, and in-lake treatments such an alum treatment, rough fish management, or aquatic vegetation management.

Completed BMPs for Tamarack and Fish Lakes include:

- Raingarden and bioswale planting in the parking area at Tamarack Nature Center (2017)
- Teal Pond restoration planting with RCSWCD and Tamarack Nature Center (2021)
- Native plant pollinator garden at the Historic White Bear Town Hall (2022)

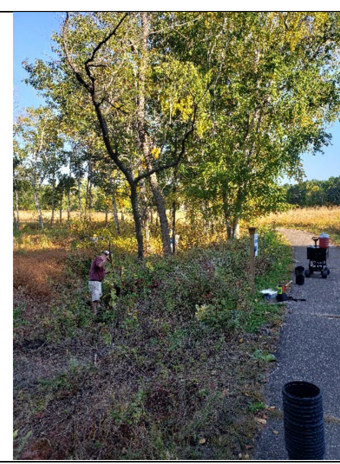
Figure 30: Tamarack Nature Center volunteer raingarden and bioswale planting (2017) and Teal Pond restoration volunteer planting (2021).

Raingarden and bioswale planting (2017)



Teal Pond restoration planting (2021)





Residential Grant Projects

As one of VLAWMO's core program areas, VLAWMO's grant programs work to implement in-ground BMPs within VLAWMO's boundaries, for the improvement and preservation of water quality. For more information, visit www.vlawmo.org/grants/. Within the Tamarack and Fish Lake subwatershed, 11 VLAWMO grant projects have been implemented since 2007.

Figure 31: Tamarack and Fish Lake subwatershed implemented projects and BMPs. Note that 2 of the rain barrel grants appear overlapping on the map below.