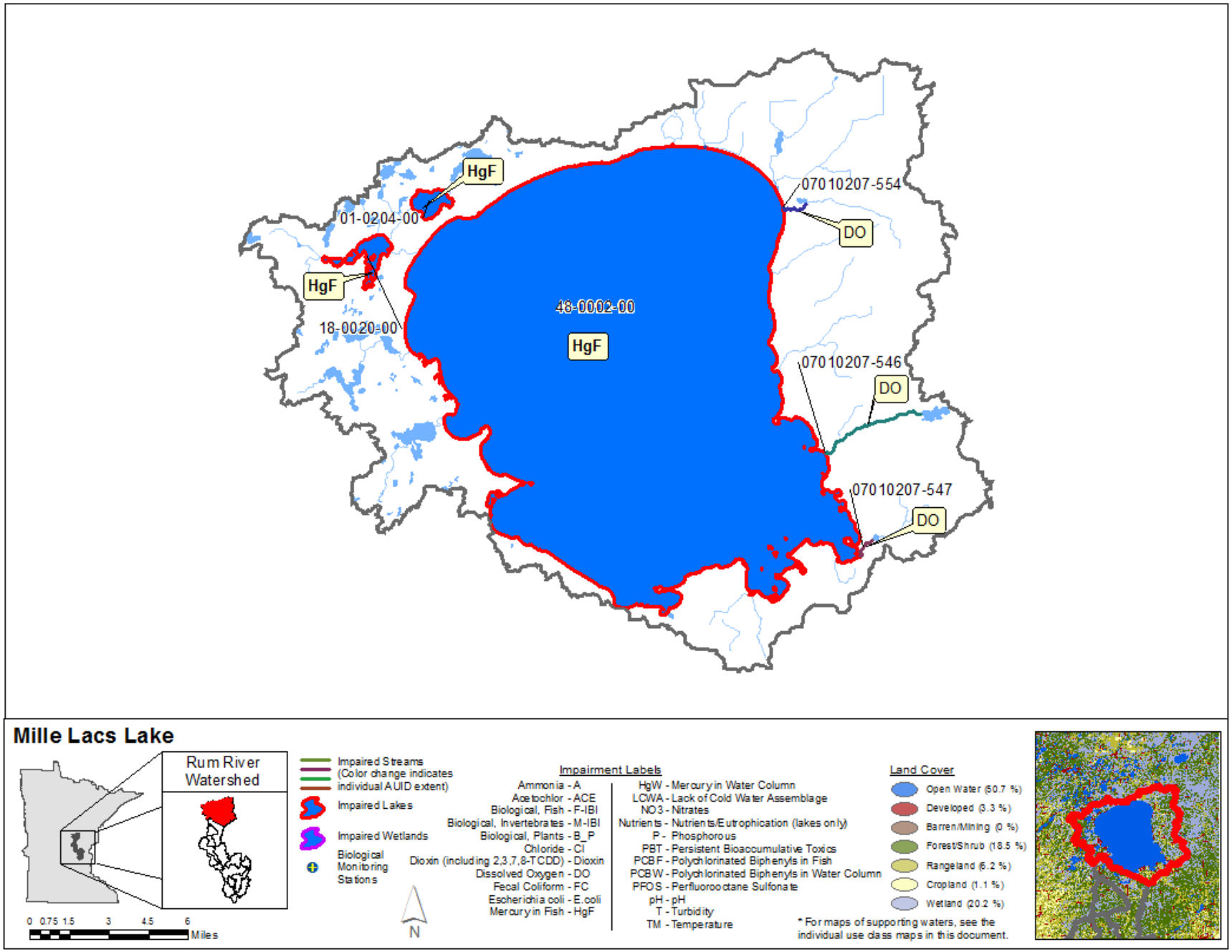
Mille Lacs Lake Aggregated 12-HUC HUC 0701020701-01 *Summary report prepared by Bonnie Finnerty, MPCA project manager 5/10/18*

The Mille Lacs Lake subwatershed is the largest subwatershed in the Rum River Watershed, draining 416 mi_2 of the southeast corner of Crow Wing County, the northwest corner of Mille Lacs County, and the southwest corner of Aitkin County. The Mille Lacs Lake subwatershed is dominated by Mille Lacs Lake, which is the second largest lake in Minnesota. Mille Lacs Lake itself is 207 mi_2. There are a handful of very small tributaries that flow into Mille Lacs Lake none of which are larger than 5 mi_2 so no biological sampling was conducted. Mille Lacs Lake is the origin of the Rum River, which flows out of its southwest corner. Land in the watershed is primarily open water (50.7 %) and wetland (20.4 %). Developed areas in the watershed (3.2 %) are mainly limited to the shores of Mille Lacs Lake consisting of cabins, houses, and resorts. The largest communities along the lake are Garrison, Isle, and Wahkon. Outside of the small cities and he development of the shoreline there is are large forested areas (18.5 %) mostly consisting hardwoods. No intensive water chemistry was taken in the subwatershed because Mille Lacs Lake is the origin of the Rum River and the outlet of the 12 HUC is a lake and would not act like a riverine system.

The following pages provides a summary of the assessment data as well as other reports that were prepared during the 2013 MPCA watershed approach cycle. These detailed documents can be found on the MPCA website at: https://www.pca.state.mn.us/water/watersheds/rum-river

The following specific reports found on the above webpage include:

- The Rum River Monitoring and Assessment Report (summary of monitoring data) https://www.pca.state.mn.us/sites/default/files/wq-ws3-07010207b.pdf
- The Rum River Groundwater Report (summary of groundwater information) https://www.pca.state.mn.us/sites/default/files/wq-ws1-11.pdf
- The Rum River TMDL Report (summary report addressing waters within the Rum River that don't meet state standards) https://www.pca.state.mn.us/sites/default/files/wq-iw8-56e.pdf
- The Rum River Watershed Restoration and Protection Strategy (WRAPS) report that provides recommended strategies to protect and improve waterbodies within the watershed https://www.pca.state.mn.us/sites/default/files/wq-ws4-34a.pdf


HgF
01-0204-00
HgF
18-0020-00
48-0002-00
HgF
07010207-554
DO
07010207-546
DO
07010207-547
DO
Mille Lacs Lake
Rum River Watershed
0 0.75 1.5 3 4.5 6
Miles
N
Impaired Streams
(Color change indicates individual AUID extent)
Impaired Lakes
Impaired Wetlands
Biological Monitoring Stations
Impairment Labels
Ammonia - A
Acetochlor - ACE
Biological, Fish - F-IBI
Biological, Invertebrates - M-IBI
Biological, Plants - B_P
Chloride - Cl
Dioxin (including 2,3,7,8-TCDD) - Dioxin
Dissolved Oxygen - DO
Fecal Coliform - FC
Escherichia coli - E.coli
Mercury in Fish - HgF
HgW - Mercury in Water Column
LCWA - Lack of Cold Water Assemblage
NO3 - Nitrates
Nutrients - Nutrients/Eutrophication (lakes only)
P - Phosphorous
PBT - Persistent Bioaccumulative Toxics
PCBF - Polychlorinated Biphenyls in Fish
PCBW - Polychlorinated Biphenyls in Water Column
PFOS - Perfluorooctane Sulfonate
pH - pH
T - Turbidity
TM - Temperature
* For maps of supporting waters, see the individual use class maps in this document.
Land Cover
Open Water (50.7 %)
Developed (3.3 %)
Barren/Mining (0 %)
Forest/Shrub (18.5 %)
Rangeland (6.2 %)
Cropland (1.1 %)
Wetland (20.2 %)

Stream Assessment Summary

There are 28 stream reaches in the Mille Lacs Lake Aggregated 12-HUC. For aquatic recreation, 1 of the 28 stream reaches has been assessed. The remaining stream reaches are dominated by small tributaries directly to Lake Mille Lacs and either have insufficient information or no data. Malone Creek (Thains Creek, 07010207-547) is meeting the aquatic recreation standard. Malone Creek is less than a mile and is a tributary to Mille Lace Lake. It is predominately surrounded by wetland characteristics and some development.

For aquatic life, 3 of the 28 stream reaches have been assessed. The remaining stream reaches are heavily impacted by lake influences and either have insufficient information or no data. Reddy Creek (Marmon Creek, 07010207-544) was listed as impaired for dissolved oxygen in 2010; upon closer review, it was determined that wetland conditions are present at the sampling site and the data was not representative of stream conditions; the impairment will be removed. Cedar Creek (Little River, 07010207-546), Borden Creek (07010207-554), and Malone Creek (Thains Creek, 07010207-547) were listed as impaired for dissolved oxygen in 2010 and 2012; the current data supports the previous listings. Many of the stream reaches are surrounded by wetlands and forested areas.

Table 1. Aquatic life and recreation assessments on stream reaches: Mille Lacs Lake Aggregated 12-HUC. Reaches are organized upstream to downstream in the table

AUID ***Reach Name*,** *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:**												**Aquatic Life**	**Aquatic Rec. (Bacteria)**
													Eutrophication				
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator			
07010207-544 **Reddy Creek (Marmon Creek),** Unnamed cr to Lk Mille Lacs		0.04	WWg			IF	IF	IF	MTS	MTS			IF			IF	IF
07010207-546 **Cedar Creek (Little River),** Cedar Lk to Lk Mille Lacs		4.55	WWg			EXS	IF	MTS	MTS	MTS			IF			NS	NA
07010207-547 **Malone Creek (Thains Creek),** Anderson Lk to Lk Mille Lacs		0.98	WWg			EXS	MTS	MTS	MTS	MTS			IF			NS	FS
07010207-554 **Borden Creek,** Deer Lk to Lk Mille Lacs		1.27	WWg			EXS	MTS	MTS	MTS	IF			IF			NS	NA

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information

Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support, Impaired (Fails Standards)

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Abbreviations for Use Class: **WWg**= warm water general, **WWm**= Warm water modified, **WWe** = Warm water exceptional, **CWg**= Coldwater general, **CWe** = Coldwater exceptional, **LRVW**= limited resource value water

*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

The Watershed Restoration and Protection Strategy (WRAPS) document provided the following goals and strategies to help restore and protect the following streams within this sub-watershed.

Table 2. Restoration and Protection Strategies for Streams within the Mille Lacs Lake Subwatershed

Waterbody and Location		Parameter	Water Quality		Strategies	Strategy Type	Estimated Scale of Adoption Needed	Primary Responsibility							Time-line to reach WQ goal	Inter 10-y Mile ston
Waterbody ID	Location & Counties		Current Conditions	Goals/Targets				Wshd. Distt.	SWCD	MPCA	MS4	County	DNR	Other		
Borden Creek 07010207-554	Aitkin	DO	DO exceeds standards and elevated TP	DO at or above 5mg/L	See general strategies below											
Peterson Creek 07010207-559	Aitkin, Mille Lacs	NA	Not Assessed	Reduce TP												
Seastade Creek 07010207-558	Aitkin	NA	Not Assessed	Assessment												
Seventeen Creek 07010207-553	Aitkin	NA	IF for Aquatic Live and NA for Aquatic Recreation.	Assessment												
Cedar Creek 07010207-558	Aitkin, Mille Lacs	DO	Low DO	Assessment												
General Protection Strategies for Above Streams					Streambank or Shoreline Protection	50-ft buffers on all streams and all buffer requirements met	Buffers installed		x						45 years	50% done
						Restore/Maintain riparian wetlands	1 restoration		x			x				1 site
						Streambank stabilization	2 sites fixed						x			1 site
						Address ditching impacts	2 sites fixed		X			X				1 site
					Forestry Practices	Implement forestry BMPs that control runoff and minimize sediment loading to surface waters	80% of shoreline owners		x			x	x			60%
					Monitoring /Data Collection	Collect additional data to develop TMDL	2 years data		x	x						N/A
					Inventory/Mapping	Inventory problem crossing areas	All crossings						x			50%
					Special Projects	Remove beaver dams where appropriate	Dams removed.							x		ID da sites
					Livestock Waste Management	Livestock exclusion on streams	2 sites		x	x						1 site
						All MN R. Ch. 7020 manure spreading setbacks are met	All sites meet standards.		x	x						Inver ry com ted.
						Winter manure spreading reduced			x	x						
						Total containment of manure storage			x	x						
						Inject or immediately incorporate manure where currently surface applied			x	x						
Malone Creek 07010207-558	Mille Lacs	DO	Low DO	Assessment	Monitoring /Data Collection	Collect additional data to develop a TMDL	2 years data		x	x					10 years	N/A

Lake Assessment Summary

For aquatic recreation, 17 of the 48 lake basins >10 acres in size have been assessed (Table 3). The remaining stream reaches have either insufficient information or no data. The majority (15) of the lakes have characteristics of deep basin lakes and are considered mesotrophic. Round Lake is small and deep, surrounded by forest and wetland it is the only lake in the Mille Lacs Lake watershed that is oligotrophic. There are few lakes (Cedar, Twenty, Deer, and Mille Lacs) that with right conditions in the summer could experience algal blooms. There are 12 lakes that meet the water quality aquatic recreation standards. There are 11 lakes that have long term transparency records which can be calculated into a transparency trend. The majority (6) of them have no trend. A few of the lakes (Round, Whitefish, Borden, and Mille Lacs) have an increasing transparency trend. Turtle Lake has a decreasing transparency trend. Overall, where lakes have enough data for an assessment those lakes are meeting the aquatic recreation standard. For aquatic life, 5 of the 48 lake basins >10 acres in size have been assessed (Table 3). The overall theme of the five lakes were that gillnets were dominated by northern pike and the trap nets collected mainly bluegill. The lakes also had a number of other species that were collected including cisco. Round and Smith Lake both contain cisco which would indicate an oxygen rich cold-water habitat Borden's fish survey did not collect any cisco for the first time since 1972 (7 surveys form 1972-2008, 20 cisco collect each survey); it is possible that increased temperature and reduced oxygen concentrations at depth are occurring to reduce habitat available. Overall, the five lakes meet the aquatic life standard. There are 11 lakes with aquatic plant surveys, all with exceptional quality plant communities. This indicates that eutrophication is not affecting the aquatic plan community. Table 3 provides a summary of the assessment data for the Mille Lacs Lake subwatershed of the Rum River watershed.

There are many lakes that should be a priority for protection in the Mille Lacs Lake subwatershed. All of the following lakes are susceptible to increases o phosphorus in multiple ways. These increases could cause any of the lakes to become impaired. Mille Lac Lake (48-0002-00) has a large surface area and the phosphorus average is close the ecoregion standard. Cedar Lake (01-0065-00) is also close to the Northern Lakes and Forest ecoregion standard. Big Pine Lake (01-0157-00), Round Lake (01-0204-00), Camp Lake (18-0018-00), and Smith Lake (18-0028-00) all have larger watersheds where the land use could be changed in which an increase of phosphorus could cause impairment. Additional strategies can be found in Table 4.

Table 3. Lake assessments: Mille Lacs Lake Aggregated 12-HUC.

Name	MNDNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Cedar	01-0065-00	253	E	92.7	5.5	2.4		28	1	2	FS	
Twenty	01-0085-00	128	E	100	0.9			57		0.8	IF	
Deer	01-0086-00	45	E		1.8			69		0.9	IF	
Big Pine	01-0157-00	617	M	42.2	23.8	6.4	NT	14	3.5	3.8	FS	FS
Round	01-0204-00	719	O	42	38.1	13.1	I	11	2.8	3.7	FS	FS
Whitefish	18-0001-00	710	M	61.5	18.9		I	19	6.6	3.9	FS	
Camp	18-0018-00	514	M	43.7	12.8		NT	15	8.9	2.4	FS	FS
Kenney	18-0019-00	105	M	33.3	16.8		NT	16	9.6	3.1	FS	
Borden	18-0020-00	990	M	32	25.6	6.7	I	19	7	3.	FS	FS
Miller	18-0021-00	124	M	34.8	14.6		NT	17	9.6	3.5	FS	
Smith	18-0028-00	455	M	47.2	16.5		NT	16	7.5	3.5	FS	FS
Holt	18-0029-00	167	M	58.9	8.5		NT	21	10	2.7	FS	
Barbour	18-0030-00	63	M	26.2	16.5						IF	
Scott	18-0033-00	164	M	79.2	14.3			21	6	4.1	FS	
Turtle	18-0047-00	104	M	82.1	10.1		D			2.8	IF	
Partridge	18-0048-00	183	M	62.5	12.8	3.9					IF	
Mille Lacs	48-0002-00	128167	E		10.7	8.8	I	30	7.7	3.3	FS	

Abbreviations: D -- Decreasing/Declining Trend **H** – Hypereutrophic **FS** – Full Support
I -- Increasing/Improving Trends **E** – Eutrophic **NS** – Non-Support
NT –No Trend **M**–Mesotrophic I**F** – Insufficient Information
O -Oligotrophic
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

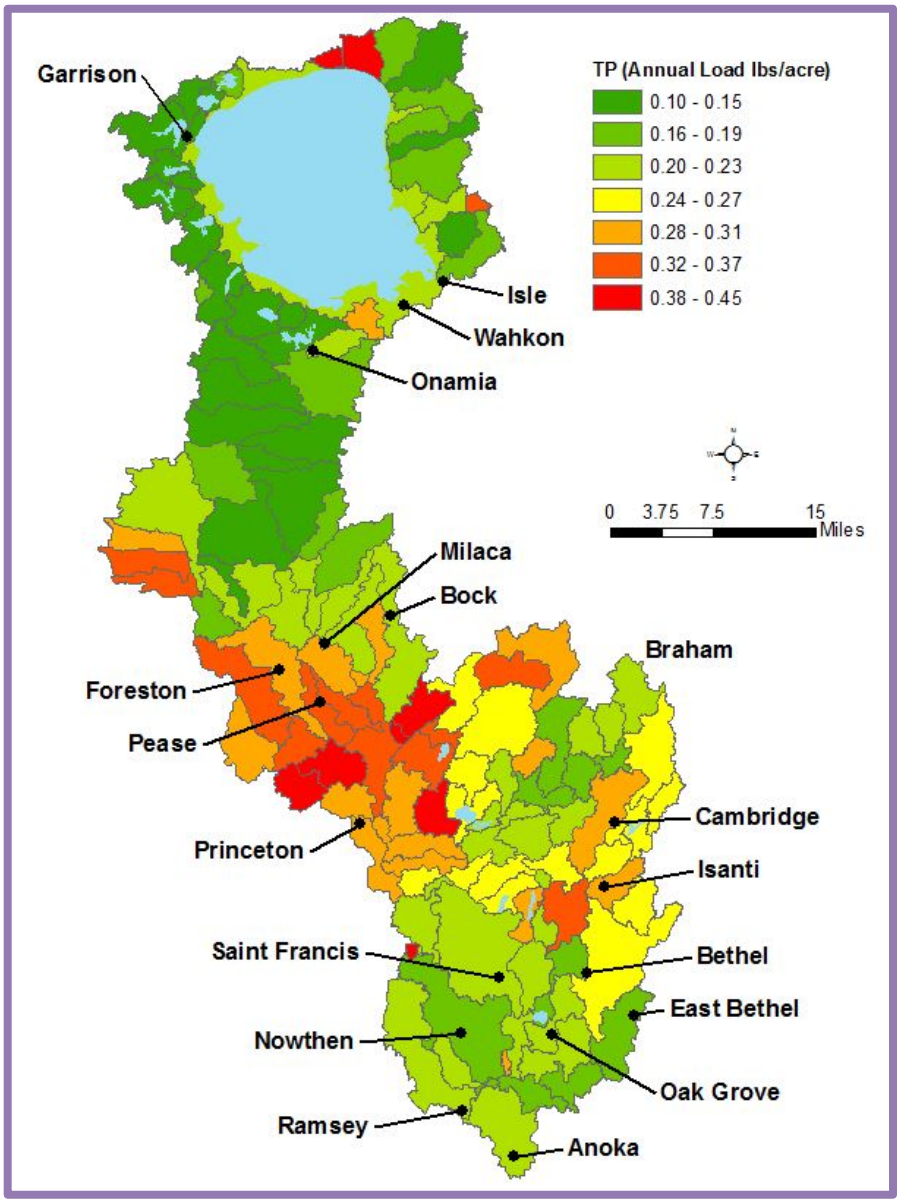
Table 4. Strategy Table for the Mille Lacs Lake HUC10 Subwatershed.

Waterbody and Location		Parameter	Water Quality		Strategies	Strategy Type	Estimated Scale of Adoption Needed	Primary Responsibility							Time-line to reach WQ goal	Inter 10-y Mile ston
Waterbody ID	Location & Counties		Current Conditions	Goals/Targets				Wshd. Distt.	SWCD	MPCA	MS4	County	DNR	Other		
Big Pine 01-0157	Aitkin	TP	TP: 13.5 mg/L	TP: 11.7 mg/L	See general protection strategies below											
Borden 18-0020	Crow Wing	TP	TP: 20.6 mg/L	TP: 17.5 mg/L												
Camp 18-0018	Crow Wing	TP	TP: 14.5 mg/L	TP: 11.2 mg/L												
Cedar 01-0065	Aitkin	TP	TP: 28 mg/L	TP: 26.9 mg/L												
Mille Lacs Lake 48-0002	Aitkin, Crow Wing Mille Lacs	TP	TP: 29.4 mg/L	TP: 24.7 mg/L												
Round 01-0204	Aitkin	TP	TP: 11 mg/L	TP: 9.9 mg/L												
Smith Lake 18-0028	Crow Wing	TP	TP: 17.5 mg/L	TP: 15.1 mg/L												
Whitefish Lake 18-0001	Crow Wing	TP	TP: 19.2 mg/L	TP: 16.3mg/L												
General Protection Strategies for Above Lakes					Urban Stormwater Management Practices	Combination of practices such as raingardens, rain barrels, filter strips.	60% of shoreline owners		x						45 years	35%
					Streambank or Shoreline Protection	Implement erosion stabilization practices	75% of shoreline owners		x				x			40%
						Est. 50' native buffer on shoreline except where shoreline ordinance allows other.	75% of shoreline owners		x							30%
						Easements for priority sites – wild rice habitat & cisco lakes	5% property owners		x							3%
					Subsurface Sewage Treatment Systems	Replace systems deemed Imminent Threat to Public Health & encourage proper maintenance	100% of shoreline owners		x			x				50%
					Forestry Practices	Implement forestry BMPs to control runoff & sediment loading (managed timber harvest, stewardship, etc.)	80% of shoreline owners		x			x	x			60%
					Outreach/CE	Promote active citizenship in lake health BMPs	60% of shoreline owners		x					x		40%

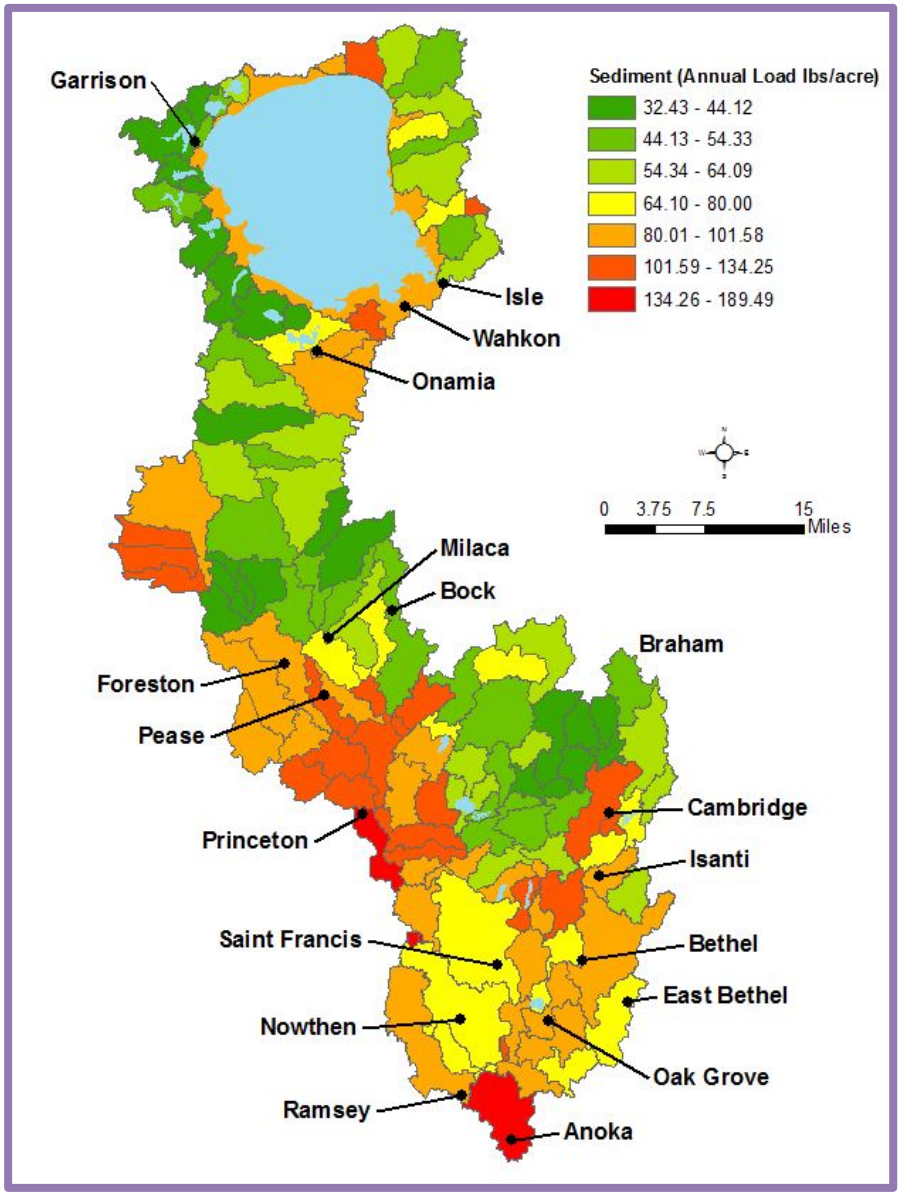
HSPF Modeling

HSPF modeling was used to estimate total phosphorus, total nitrogen, total suspended sediment and runoff throughout the watershed shown in the figures below.

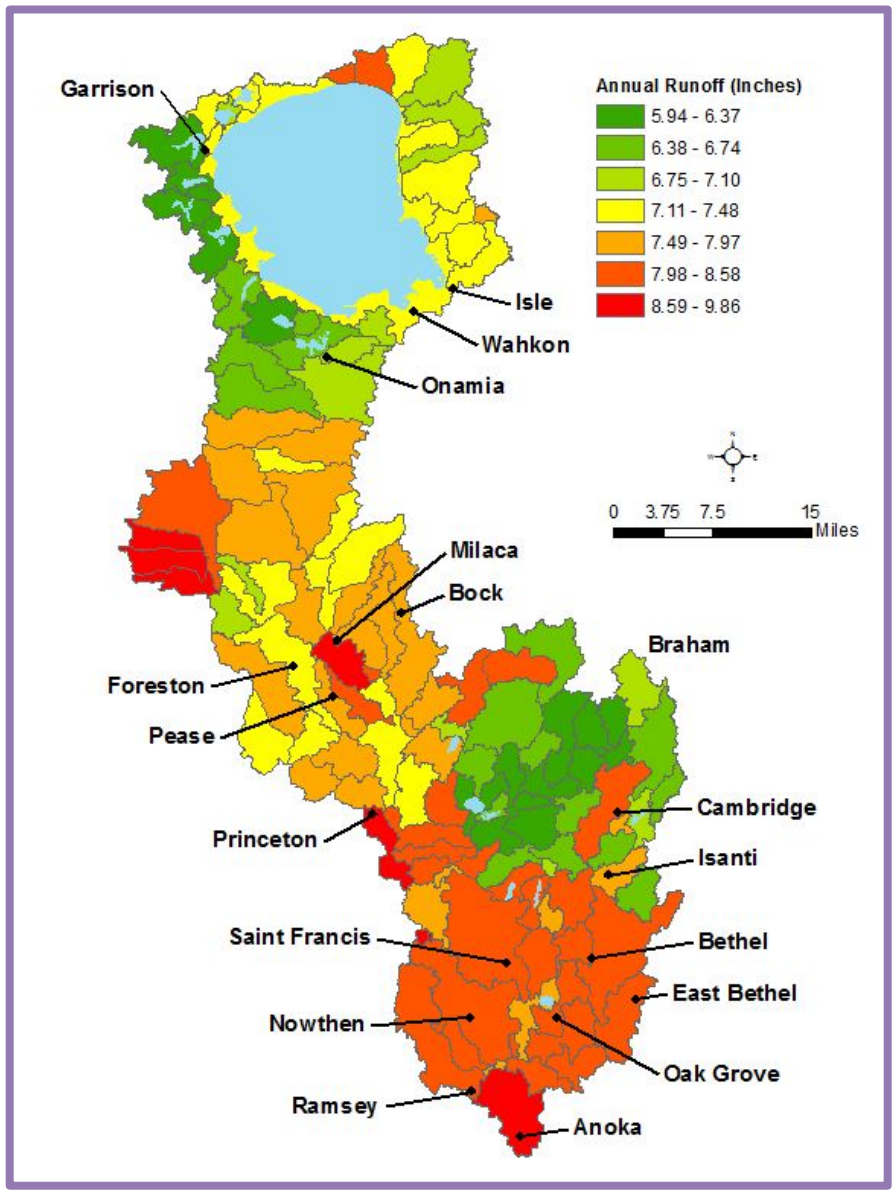
Annual Runoff (Inches)



Sediment (Annual Load lbs./acre)



Total Phosphorus (Annual Load lbs./acre)



Total Nitrogen (Annual Load lbs./acre)