Final Report and Recommendations of the Mille Lacs Lake Watershed Management Group Phase I Clean Water Partnership Watershed Management Project

April 2003

Dick Osgood
Project Facilitator

THE OSGOOD GROUP

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Shorewood, MN 55331

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April 21, 2003

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Dear Friends of Mille Lacs Lake:

We are pleased to transmit to you our Watershed Management Plan of April 21, 2003.

The Mille Lacs Lake Watershed Management Group held it's first meeting in August of 1997 with the purpose of organizing to develop a management plan for protection of the lake. Actual development of the plan was made possible by award of a Clean Water Partnership Grant in April, 1999.

The Plan includes a summary of a diagnostic study of the water quality of the lake and it's tributary streams, an analysis of that data, and recommendations for future action. The recommended future actions are presented in the form of an implementation plan.

April 21, 2003

Friends of Mille Lacs Lake
- page two -

Mille Lacs Lake presently enjoys relatively good water quality and supports excellent recreational opportunities including a magnificent walleye fishery. Under such conditions, it becomes a difficult task to interest people in additional measures to protect Mille Lacs.

Mille Lacs Lake is vulnerable. Although some of the results from the diagnostic study are conflicting, fertilization of the lake continues from natural and causes associated with development. Unless measures are taken to reduce the amount of Phosphorous being added to the lake, water quality will begin to deteriorate at a more rapid rate and recreational value of the resource could be greatly impaired.

The Mille Lacs Lake Watershed Management Group solicits your continuing support in it's efforts to protect the lake and it's watershed in order that it continue to be available for the enjoyment of generations to come.

Sincerely yours,

Paul L. Andrews
Chair, Steering Committee
Mille Lacs Lake Watershed Management Group

PROLOGUE

by Paul Andrews, chair
Mille Lacs Lake Watershed Management Group

Archeologists have found evidence that humankind has resided along the shores of Mille Lacs Lake for 4,000 years. During this period of time, flora and fauna of the area were probably much as they are today, although the areas occupied by prairies, savanna and wetlands advanced and retreated with periods of drought and more abundant rainfall.

The first residents following the last period of glaciation were undoubtedly attracted to the Lake first by its size, and second, by the abundant harvest available in its waters and watershed, much as today's occupants and visitors.

Because of the gathering/hunting culture of the first residents and their relatively small number, aging of the Lake probably progressed at the same rate as before humankind's arrival in the watershed. With the arrival of European settlers and the introduction of agricultural practices and lakeshore settlement, fertilization of the Lake increased and aging progressed at a more rapid rate. Additional sources of fertilizer were introduced as residential and recreational facilities and their supporting infrastructure were developed around Mill Lacs and elsewhere in its watershed.

We are very fortunate that, unlike many smaller lakes in the state, Mille Lacs can still be classified as a mesotrophic Lake and indeed enjoys relatively good water quality.

It is the fervent wish of many individuals who contributed to the production of this management plan that all stakeholders will avail themselves of the information available herein and work to ensure that the water quality of Mile Lacs Lake will not become further degraded. This magnificent resource deserves to be protected for the enjoyment of generations to come.

EXECUTIVE SUMMARY

Diagnostic Study

A three year field study monitored and evaluated tributary pollution inputs to Mille Lacs Lake. Various pollution parameters were measured in runoff entering Mille Lacs Lake, but phosphorus was the main focus of the diagnostic study. During a normal year, 6,348 kilograms of phosphorus (about 13,967 pounds) enter the lake via runoff. There are other sources of phosphorus too. Rainfall contributes 10,891 kg (23,960 pounds), septic systems contribute 1,500 kg (3,300 pounds) and minor sources contribute 628 kg (1,382 pounds). The total input is 19,367 kg (42,607 pounds).

Lake water quality was also measured during this study. The current condition of Mille Lacs Lake is 'mesotrophic,' meaning it has yet to show significant signs of degradation. This condition falls in an optimal range for walleye production. Past water quality studies of the lake, dating back to 1971, seem to show the lake's water quality has improved over the past three decades. However, due to inconsistent sampling and analytical methods, comments on water quality trends are not conclusive.

A sediment core was taken from the lake bottom in the winter of 2002. Because lake sediments are deposited in layers, the core can be evaluated for historic water quality indicator information. The procedure is much like evaluating tree rings. From this evaluation, it was determined that phosphorus inputs to Mille Lacs Lake have actually been increasing over the past five decades.

On the basis of the study, it is concluded that the current good water quality in Mille Lacs Lake cannot be assured. The trend of increasing phosphorus inputs continues and at some point, the lake's quality will degrade.

Goal

The Mille Lacs Lake Watershed Management Group has identified this goal statement:

> *The water quality of Mille Lacs Lake will be preserved at its 2000-2001 levels through an ongoing program of advocacy, education, protective actions, planning and monitoring.*

To support this goal, the MLLWMG has identified these phosphorus reduction targets:

Source	Annual Phosphorus Reduction
Tributary	2,265 kg (4,983 pounds)
Septic Systems	1,000 kg (2,200 pounds)
Winter & Summer Recreation	228 kg (502 pounds)
Mitigating future increases	undetermined

These reductions represent an 18% reduction of the total phosphorus inputs to the lake. This is a significant reduction, especially considering that rainfall, which cannot be controlled, accounts for 56% of the total inputs.

Implementation Plan

The implementation plan emphasizes a high level of oversight and coordination by a Project Coordinator plus the continuation of a comprehensive monitoring program. The MLLWMG has identified six objectives and 14 management actions to support the project's goals and objectives.

Management Objective 1: Increase the awareness and knowledge of watershed residents, lakeshore owners, recreational users, resort owners, local elected officials and state regulators with regard to the need for lake and watershed protection.

Management Actions

1. Develop and maintain a database of stakeholder and media contacts.
2. Develop educational and information materials for frequent distribution through various media.
3. Develop and facilitate quarterly public official forums.
4. Build and maintain an engaging web site.

Management Objective 2: The MLLWMG must be effective advocates for the protection of Mille Lacs Lake.

Management Action

5. The MLLWMG should be active participants in and be a visible presence at all appropriate opportunities where protection of Mille Lacs Lake can occur.

Management Objective 3: Implement watershed protection to mitigate excessive phosphorus loading and offset the anticipated increases in nutrient inputs as well as other kinds of pollution.

Management Actions

6. Implement appropriate watershed projects. Before specific BMPs can be evaluated, it is necessary to conduct a comprehensive subwatershed analysis. Pending that analysis, a re-check of the feasibility of the target phosphorus reductions should also be done.
7. Design and implement demonstration projects. Demonstration projects in the shoreline subwatershed should be implemented in coordination with the education actions. These projects should focus on phosphorus reduction and shoreline stabilization BMPs.
8. Develop programs and actions to reduce recreation-related sanitary pollution to the lake.
9. Identify, upgrade and replace failing or non-compliant septic systems.
10. The MLLWMG should oversee lake and watershed management activities to facilitate timely and appropriate protection or mitigation actions. Specifically, target reductions for future phosphorus loading increases will be fully mitigated (see section B.3.d).

Management Objective 4: Minimize future increases in nonpoint source pollution through appropriate local planning and zoning controls.

Management Action

11. The MLLWMG should be an active participant in the comprehensive planning project.

Management Objective 5: Implement an ongoing monitoring and evaluation program.

Management Action

12. Continue a comprehensive lake and stream monitoring program.

Management Objective 6: Program administration.

Management Actions

13. Representation on the MLLWMG should be expanded to include resort owners.
14. Hire a full-time advocate and program coordinator.

The implementation plan budget is $346,831, excluding in-kind services and costs yet to be determined.

Conclusions

The implementation plan for Phase II of the Mille Lacs Lake Clean Water Partnership Watershed Management Project continues with monitoring and evaluation as well as implementing education, advocacy and demonstration projects. The main emphasis of Phase II is to retain a Project Coordinator who will direct, coordinate and oversee all aspects of the implementation plan. In addition, continued monitoring is a significant and essential element of the implementation plan. The Mille Lacs Band of Ojibwe DNRE will conduct the monitoring program. Together, the budget for the Project Coordinator (staff costs plus office support) and the monitoring program comprise 83% of the proposed Phase II budget. However, in-kind and costs yet to be determined for watershed projects have not been included in the overall budget.

Recommendations

The MLLWMG recommends the MN Pollution Control Agency accept this report in satisfaction of the requirements of the Phase I study and that it becomes the basis for a Phase II implementation application. Further, the MLLWMG recommends the project partners continue to support the proposed management actions by their participation and by providing in-kind and financial support.

ACKNOWLEDGEMENTS

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Numerous people have been involved with and contributed to the success of this project. All contributors and participants are appreciated - we apologize if we have missed anyone.

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A. OVERALL INFORMATION

A.1 Study Area

The Mille Lacs Lake Watershed Management Group (MLLWMG) was formed in August 1997 to "provide a citizen driven forum encouraging a partnership of stakeholders participating as equals in protecting and enhancing the aesthetic, economic and recreational value of lakes, streams, shoreland and all land classifications in the Mille Lacs Lake Watershed." Following an unsuccessful attempt in 1998, the group obtained a Clean Water Partnership Grant (this project) in 1999 to assist in the development of a Watershed Management Plan.

A.1.a Geology

There were four major glacial advances in Minnesota during the Pleistocene Ice Age (Zumberge 1952). Deposits left by the glaciers reflect the rocks over which they passed. Mille Lacs Lake is an example of a moraine-dam lake, meaning it pooled behind this elevated feature left by a retreating glacier. The Mille Lacs moraine rises about 130 above the lake level and is wrapped around the southwestern half of the lake from Garrison to Isle. The northern and eastern areas around the lake are swampy remnants of the former lake level, which was about 15 feet above the present level.

Mile Lacs Lake is underlain by Precambrian crystalline bedrock, which is exposed in some areas south and east of the lake. The surficial geology consists mainly of coarse-grained glacial sediments. These strata may be confined or overlain by glacial till material. The coarse- and fine-grained materials are found in the Mill Lacs moraine, which has a hilly topography (see Trotta and Cowdery 1998).

A.1.b History (compiled by Joe Fellegy, Mille Lacs Historian)

Non-native settlement and development in the Mille Lacs Lake watershed was seeded in the 1870s. That decade preceded the peak 20 years of pine logging at Mille Lacs, and predated establishment of lake towns, farms, autos and roads, a 30-year steamboat era, railroad connections to Mille Lacs, lakeshore alteration and shoreland development, and the start of a sportfishing and tourism industry. Nevertheless, as pine harvests crept northward up the Rum River and its tributaries in the 1860s and 1870s, large stands of towering white pine within a few miles of the big lake beckoned the timber interests. And Mille Lacs as a potential "summer resort" began drawing notice among would-be boomers and investors - especially after the establishment of towns in the greater Mille Lacs region.

Intersections of the new Northern Pacific Railroad and the Mississippi River spawned Aitkin (1871), 14 miles north of Mille Lacs; and Brainerd (1870), 20 miles west of the lake. The rise of other towns similarly brought people and commerce to the lake, which in turn encouraged better roads and trails, economic activity, and population growth. These included Mora (1882) to the southeast, and Milaca (1892) and its forerunner "Oak City" (1882) to the south. Prior to the 1870s and 1880s, the more distant communities of Little Falls and Princeton, both dating to the 1850s and about 50 miles from the lake, were the nearest trading centers. Their historic contributions to Mille Lacs development aside, all these towns lie outside the Mille Lacs Lake watershed.

The small lake towns - including Garrison, Isle, Malmo, and Wahkon - trace their histories to the 1880s. Also beginning in the 1880s, settlements evolved at Nichols and Wealthwood on the north shore, and Cove on the south shore - sometimes called "ghost towns" now. There were other small settlement-era (circa 1900) trading places - often with a store and post office, and maybe a blacksmith shop and sawmill - located in or near the watershed within several miles of Mille Lacs Lake. Glory and Bennettville in Aitkin County; Dykeman, Flak, and Neutral in Crow Wing County; and Opstead and Redtop east of the lake in Mille Lacs County, are examples of such short-lived "towns."

Onamia, 4 miles south of Mille Lacs Lake, is situated near the Rum River's exit from Onamia Lake, one of three "rice lakes" (also including Ogechie and Shakopee) downstream from the outlet of Mille Lacs. Onamia grew as a "gateway to Mille Lacs" following the arrival of the Soo Line railroad in 1908, and with successive improvements on Highway 169 and its forerunners.

The Mille Lacs Band of Ojibwe Indian community on the west shore has seen marked growth in buildings and infrastructure since the 1960s, and especially after the start of Grand Casino Mille Lacs in 1990.

Pine logging era. A timber industry in the lake region continues, but "logging" in Mille Lacs history most often refers to the peak era of pine logging operations at the lake beginning about 1885. Much of the pine harvest within several miles of the lake was landed on the ice and later boomed and towed by steamer to the Rum River outlet for drives to sawmills at Anoka and the Twin Cities, and later to the large Foley-Bean mill at Milaca. This large plant closed in 1907, the symbolic end date for major harvesting of the Mille Lacs pineries. Local sawmills inland from Mille Lacs have continued to process hardwoods and other species.

Roads, railroads, and resorts. Article 3 of the 1855 Treaty, which created the original 61,000 acre Mille Lacs Indian Reservation that later included the present Kathio, South Harbor, and Isle Harbor townships, provided that $5,000 be spent on a road from the mouth of the Rum River (at Anoka) to Mille Lacs. In 1861, the federal government built a "military road" to facilitate the movement of troops and supplies between Fort Ripley (on the Mississippi River between Brainerd and Little Falls) and Lake Superior - via Mille Lacs' north shore.

From the 1870s forward, as settlement in the Mille Lacs region grew, foot trails became wagonroads, some of which transformed into roads and highways capable of carrying auto traffic. The first automobiles reached Mille Lacs before 1910, and road upgrades became essential during the transition from horse-and-buggy to autos and trucks. The Soo Line (Minneapolis, St. Paul, and Sault Ste. Marie Railway) was completed between Brooten and Duluth in late 1909, reaching the south Mille Lacs area in 1908. The Soo Line connected the lake to the outside world like never before, ending years of speculation about which part of Mille Lacs would most directly benefit from rail service. Over the next several years, depots were built at Onamia, Wahkon, Isle, and Redtop. The railroad contributed to commerce, development, settlement, and tourism at Mille Lacs before auto traffic blossomed, and for several more decades.

As part of the Babcock Plan for Minnesota roads, the Scenic Highway (forerunner of present #169) project reached Mille Lacs about 1920. A resort-building boom followed. Places like Bay View, the Blue Goose Inn, Izatys, Rocky Reef, and Shore Acres date to the 1920s. The next several decades brought more resorts. But since the 1960s, the development trend has been towards fewer resorts and more lakeshore cabins and permanent homes. Now, there are fewer active resorts on the entire west shore than there once were on Wigwam Bay alone!

There is less "main highway" presently hugging the lake than in the early days. Highway 18 on the north shore, built in 1937-38, has fewer close-to-the-lake stretches than the old primitive "lake road." The post-1950s trend is similar for Highway 169 on the west shore.

In the early 1990s, several modern hotel/resort complexes were built, including Eddy's Lake Mille Lacs Resort (southwest shore), and McQuoid's Inn & Conference Center (Isle). Izatys Golf & Yacht Club (south shore) evolved from one of the earliest resorts on Mille Lacs into a large modern resort complex with inland marina, town homes, golf courses, and convention accommodations. The Econolodge (southwest shore) and Garrison Inn & Suites (originally Country Inn & Suites) were built in the 1990s.

Lake traffic. Steamboats - sidewheelers and propeller-driven craft - operated on Mille Lacs between 1885 and 1915. There were never more than several steamers in business at a time. These were mainly work boats intended to tow booms of pine logs, landed on the ice in winter, across the lake to the Rum River outlet for downriver drives. The 101-foot Queen Anne, the largest of these steamboats, burned cordwood for fuel. In 1909, envisioning steamboat links between the lake towns and the new Soo Line Railroad at Wahkon, the Mille Lacs Transportation Company built steamboat piers at points around the lake. The scheme soon fizzled because of docking and navigation problems due to severe drought and low water in 1910, and also because of rapid growth in overland transportation. Aside from logging work, Mille Lacs steamers also carried cream, building and household supplies, passengers, and even cows.

The first gasoline-powered launches appeared shortly after 1900. These were private boats, often owned by investors and real estate agents. During the 1910s, at least one party, headquartered at Wahkon, towed a barge for hauling freight. Prior to the later 1920s, much of the "launch service" on Mille Lacs was for excursionists and "joy riders."

Open-water fishing. In the pre-1920s, a few places rented rowboats, usually homemade flat bottoms, to sport anglers. By the end of the '20s dozens of fishing resorts maintained fleets of rental boats. Some outboard motors were in evidence, especially among resorters who towed strings of rowboats to and from the walleye fishing grounds, mainly in May and June. Group fishing on gasoline-powered wooden launches gained popularity in the 1930s and 1940s. Launches provided visiting anglers, who lacked seaworthy boats and knowledge about the lake, offshore "deep water" fishing opportunities with a guide. Boat construction has changed from wood to fiberglass and metal. Launch fishing remains popular. Night launch trips increased dramatically in the 1980s and 1990s.

A key trend during a century of sport fishing at Mille Lacs includes angler use of more of the lake. Even for guides, prior to the 1930s, the "fishing season" meant mainly the mid-May through June inshore fishing period. Now, with navigational aids and improved boats, anglers fish anywhere on the lake. Since the 1930s, anglers have become increasingly familiar with offshore mud flats in the north half of the lake and deep gravel structure in the south portion, thus creating a summer walleye fishery. A summer-fall shallow reef-top fishery, night trolling with artificial lures, slip bobbering deep and shallow with leeches, and other methods, have combined to equip the Mille Lacs devotee with a season-long fishing repertoire. Nevertheless, May, June, and early July remain the busiest, while mid-July through fall see far less lake traffic.

Mille Lacs experienced two periods of market fishing. From the 1880s until 1912, settlers participated in a spring commercial fishery (often with hook and line) which saw barrels of iced down fish hauled by team and wagon to railroad connections in Aitkin, Brainerd, Milaca, and other towns. For several years at the end of World War I, a state fish-buying agent, located at Wahkon, facilitated the sale of Mille Lacs fish as a wartime public health measure.

Ice fishing. Prior to 1950, much of the "ice fishing" on Mille Lacs was really spearing for northern pike, typically within walking distance of shore. Winter angling for walleyes - with resorters plowing lake roads, renting fish houses, and storing fish houses for private parties - mushroomed in the 1950s. Annual fish house counts rose from about 500 in 1950 to 5,000 a decade later. Since then, the annual counts have typically fluctuated from 2,500 to 6,000 - about 3,500 in the 2002-03 season. The first resort roads to the mud flats, with fish house rentals on the flats, date to about 1970. Increased use of snowmobiles in the 1970s, 4-wheel-drive pickups in the 1980s, and ATVs and navigational aids in the 1990s, have spread out the ice-fishing effort.

Miscellaneous. Small-scale farming and livestock-raising in all directions from Mille Lacs date to the pre-1900 settlement era, but with no large "operations" right at the lake. A trend over the past 50 or 60 years includes a diminishment of farming directly adjacent to the lake and its intermittent feeder streams. Cattle ranching on the Mille Lacs meadows, north of the lake and in the watershed, is a development of recent decades.

Light industries have variously come, gone, and survived at Mille Lacs. These have included the manufacture of fishing tackle, wild-rice processing, and even a short-lived "pickle factory" at Wahkon. Most local boat-building ceased around 1970. Fort Mille Lacs Village, a popular tourist attraction for almost 50 years, closed in 2000.

The annual mid-summer tullibee die-offs have trended downward since 1970. The tullibee or lake cisco (*coregonus artedii*) is a cold-water species and a relative of the whitefish. Mille Lacs is at the southern extreme of this fish's range. Years ago, summer kills of tullibee at Mille Lacs (and at other central Minnesota walleye lakes) were taken for granted. Thousands of them dotted the lake surface and lined the beaches during July and August hot spells. It still happens, but mainly on a lesser scale.

A MILLE LACS TIMELINE

1870s	A handful of settlers at Mille Lacs, some pine logging south of the lake
1880s	Lake towns spring up - including settlements at present Garrison, Isle, Malmo, and Wahkon
1885-1915	Steamboats work on Mille Lacs
1880s-1907	Pine logging heyday in the Mille Lacs region
1890s	Original Mille Lacs Indian reservation opened to homesteaders and logging operations
1890s-1912; 1918-21	Commercial fishing and "state fishing" for market, mainly in spring
1900s	Early gasoline launches appear; first autos reach Mille Lacs
1908	Soo Line railroad complete through Onamia, Wahkon, and Isle, with spur and dock at Wahkon
1910s	Roads begin transition from wagon trails to highways
1920s	Scenic Highway (forerunner of #169) brings more traffic to Mille Lacs, launching modern resort era; beginnings of outboard motor use
1925-1930s	Electric service comes to Mille Lacs
1930s	Start of offshore summer walleye fishery, mainly with launches; local boat building industry develops
1935	Lake level hits modern record low
1940s	More resorts and private cabins
1943, 1972, 2002	Modern record-high water levels on Mille Lacs
1950s	Annual winter fish house counts rise from about 500 to 5,000

1950s-1970s Private inland harbors are developed at some resorts and private places; construction of Garrison Creek Marina
1980s-1990s In-the-lake breakwater/marinas built at some resorts
1960s-1970s Fiberglass and metal boats replace wooden rowboats; private boat ownership soars; more resort and public access boat launching ramps
1970s Minnesota enacts lakeshore development guidelines, adopted by counties; more regulation of shoreland use and septic systems
1970s-1980s Traditional annual tullibee summer kills become less noticeable
1980s Mille Lacs Lake Advisory Association (MLLAA) launches "Keep Mille Lacs Clean" campaign, resorts conduct on-lake clean-ups after ice fishing seasons; dumpsters and on-lake restrooms more available for winter anglers.
1990 Start of Grand Casino Mille Lacs complex at Vineland, north of Rum River outlet
1990s Loran-C and GPS navigational aids, plus to-scale map of Mille Lacs fishing grounds, encourage more offshore fishing
1990s "Clearer water" is a major discussion point among anglers and DNR fisheries biologists
1990s Several large hotel/resorts built in early 1990s

A.1.c 'The Lake'

Mille Lacs Lake is the second largest lake in Minnesota with a surface area of 207 square miles. The lake is shallow, with a maximum depth of 43 feet and a mean depth of 21 feet. This means the lake does not stratify (polymictic). The lake's sandy shores and good water quality make it ideally suited for walleye production. Indeed, Mille Lacs Lake is the premier walleye lake in Minnesota.

A.1.d The Watershed

Mille Lacs Lake watershed is 182 square miles, or 88% of the lake's surface area. A detailed land use inventory has not been completed as part of this study. MPCA (1982) indicates land use in the watershed is 20% agricultural and 80% hardwood-coniferous forest and marsh. This study has identified 13 subwatershed streams in addition to the direct drainage from the shoreline area. The lake has one surface outlet, the Rum River.

A.1.e Existing and Potential Problems

Mille Lacs Lake is one of Minnesota's crown jewels. Mille Lacs is recognized as one of the premier walleye producing lakes in the world. The watershed land area is 116,480 acres (182 square miles) and the lake area is 132,516 acres (207 square miles). Mille Lacs Lake is shallow for its size, having a maximum depth of 43 feet and an average depth of 21 feet. The current water quality is good, although some water quality problems could develop in the future.

Mille Lacs is the headwaters of the Rum River, which joins the Mississippi River in Anoka. The Rum River is designated as one of Minnesota's 'Wild and Scenic Rivers,' and currently has high water quality. There are thirteen subwatersheds, plus direct drainage, that drain into the lake.

Development around Mille Lacs Lake is continuing at a rapid pace. The shore length is 76 miles with more than 70% being developed with seasonal and year-round homes, businesses and other commercial interests. The majority of these parcels use on-site sewage treatment systems.

It has been estimated the lake contributes $150 to $200 million dollars to the regional and state economies each year. More than 2,000 recreational-based jobs are maintained by the continued excellence of the area's resources. There is a local desire to promote the further development of this recreation-based economy. Long-term sustainable development of the lake will only be possible if local units of government create a cohesive watershed development plan detailing issues of management such as setbacks and septic regulation, and wetland protection.

While the lake has been studied by many agencies, the available information is incomplete. There have been three main studies. The first report was completed in 1976 by Adams V. Grover and Associates; the second in 1980 by the East Central Regional Development Commission (ECRDC); and the last in 1994 by the MPCA. All of these studies are summarized in Heiskary et al. (1994). On the basis of these studies, the lake's water quality appears to have improved. Unfortunately, due to the incomplete nature of the studies and their different methodologies, it is difficult to draw meaningful conclusions regarding the causes of improved water quality. Nonetheless, watershed-wide reduction in agricultural lands as well as the improved design and maintenance of on-site septic systems has probably been important in this regard.

The potential water quality problems facing Mille Lacs Lake are similar to those of other popular lakes with high development and usage pressure. The ECRDC developed a sampling plan for Mille Lacs Lake tributaries to track fecal coliform, an indicator of septic contamination. The results of the study showed that all but three of the sites were within acceptable limits for body contact recreation. The 1994 MPCA study did not measure fecal coliforms.

According to the 1994 MPCA report, phosphorus levels have decreased by 25% since 1971. While the significance of this finding is unclear, it underscores the need for a comprehensive, long-term monitoring program to document water quality trends in the lake as well as provide appropriate protection strategies.

Mille Lacs Lake may be in jeopardy. There are many political entities, local citizen interests, economic groups, sports groups, state and federal agencies having interest in the health and well-being of the lake. However, there is no one entity charged with overseeing or coordinating the management of Mille Lacs Lake and its watershed.

This project has given all involved in the watershed the unique ability to take a proactive approach to maintain and improve the quality of Mille Lacs Lake.

A.1.f Who Was Involved in Carrying Out the Project

The Mille Lacs Lake Watershed Management Project was initiated by the MLLWMG and included these project sponsors:

- Aitkin County Soil & Water Conservation District

- Aitkin, Crow Wing and Mille Lacs County Water Plan Task Force
- Board of Water & Soil Resources
- Crow Wing County Soil Water Plan Task Force
- Lake Mille Lacs Association
- Mille Lacs Band of Ojibwe, DENR
- Mille County Board of Commissioners
- Mille Lacs Lake Watershed Management Group
- Mille Lacs Soil & Water Conservation District
- Minnesota Department of Natural Resources
- Minnesota Pollution Control Agency

Individual representatives are listed in Appendix F.2.

A.2 The Status Quo

A.2.a Jurisdictions

Local governmental units in the Mille Lacs Lake watershed include numerous cities, towns, counties as well as the Mille Lac Band of Ojibwe. Table A.2.a.1 lists the cities, towns and counties included in the watershed.

Table A.2.a.1
Cities, Towns & Counties in the Mille Lacs Lake Watershed

County	Cities	Townships
Aitkin		Idun, Hazelton, Lakeside Malmo, Seavey, Wealthwood
Crow Wing	Garrison	Bay Lake, Garrison, Roosevelt
Kanabec		Hay Brook
Mille Lacs	Isle Wahkon	Bradbury, East Side, Isle Harbor Kathio, South Harbor
Morrison		Richardson

The Mille Lacs Reservation was established by the 1855 Treaty. The tribal headquarters is near Onamia. The Tribe administers approximately 16,000 acres of trust and fee land located within three townships on the south end of Mille Lacs Lake. Mille Lacs tribal government consists of executive, judicial and legislative branches. Mille Lacs is a member of the Minnesota Chippewa Tribe.

A.2.b Population

Population statistics are unavailable for the portions of the cities and towns only within the Mille Lacs Lake tributary watershed. Table A.2.b.1 summarizes the population changes in those cities and towns with areas in the watershed.

The population around Mille Lacs Lake grew by 44% between 1990 and 2000. This compares to the statewide population increase of 12%.

Table A.2.b.1
Mille Lacs Lake Area Population

		Population		
County	Town/City	2000	1990	% change
Aitkin	Hazelton	712	440	62%
	Idun	235	182	29%
	Lakeside	495	337	47%
	Malmo	332	214	55%
	Seavey	64	64	0%
	Wealthwood	262	163	61%
Crow Wing	Bay Lake	923	657	40%
	Garrison City	213	138	54%
	Garrison	796	488	54%
	Roosevelt	534	342	56%
Kanabec	Hay Brook	218	165	32%
Mille Lacs	Bradbury	203	144	41%
	East Side	731	543	35%
	Isle City	707	566	25%
	Isle Harbor	590	416	42%
	Kathio	1309	930	41%
	South Harbor	885	563	57%
	Wahkon City	314	197	59%
Morrison	Richardson	485	412	18%
TOTAL		**10008**	**6961**	**44%**

The Mille Lacs Band of Ojibwe reports these census numbers from their members on and off reservation lands around Mille Lacs Lake:

1990	526 members
2000	4,704 members

A.2.c Economics/Development

The Minnesota Department of Trade and Economic Development reports growth statistics for the Central (includes Crow wing and Mille Lacs Counties) and Northeast (includes Aitkin County) Regions as follows:

1990-1998 Growth	Central	Northeast
Employment Growth	30%	16%
Growth in Wages	40%	21%
Business Start-Ups	8.3%	5.9%
Personal Income	43.9%	44.4%
Property Values		
Commercial/Industrial	79%	55%
Residential	96%	83%
Farm	43%	35%

The resort, hospitality and fishing industries have attracted jobs and new residents to the area in recent years. The highway 169 expansion and the Garrison Kathio West Mille Lake Sanitary District are necessary are a result of the rapidly expanding growth on the Mille Lacs watershed. The Milles Casino has brought 1,200 jobs, along with $275,000,000 in annual revenues.

It is clear, the economic development in the area is proceeding rapidly.

A.3 Project Cost by Program Element

Program Element	Cash[1]	Volunteer[2]	LGU[2]	Total
1. Development of Project Workplan	$ 4,171	$ 541	$ 4,946	$ 9,658
2. Watershed Monitoring Plan	$ 4,196	$ 533	$ 1,081	$ 5,810
3. Fiscal & Administration	$67,481	$6,923	$ 54,912	$129,316
4. Data Collections & Equipment	$51,487	$2,846	$ 70,392	$124,725
5. Consolidate Data	$ 9,368	$ 0	$198,050	$207,418
6. Planning & Zoning Issues	$20,504	$ 341	$ 3,808	$ 24,652
7. Information & Education	$22,180	$2,573	$ 856	$ 25,609
8. Future Funding	$ 1,790	$ 0	$ 0	$ 1,790
9. Implementation Plan & Demonstration	$ 1,430	$ 0	$ 6,258	$ 7,688
10. Long Term Management Plan	$16,100	$1,597	$ 462	$ 18,159
TOTALS	$198,708	$15,354	$340,765	**$554,826**

1. Cash expenses are reported through February 28, 2003
2. In-kind contributions reported through December 31, 2002

A.4 Chronology of the Plan

The MLLWMG received a Minnesota Board of Water and Soil Resources (BWSR) Challenge Grant in 1997 in the amount of $34,070 for administration and implementation projects in the Mille Lacs Lake Watershed. The administrative portion was $14,070, with $20,000 slated for project implementation. Projects funded included riprap lakeshore protection near Garrison, riprap lakeshore protection on a residential property on Big Pine Lake, and a livestock exclusion project within 1,000 feet of Mille Lacs Lake. Additional funds were contributed by the Crow Wing County Lakes and Rivers Alliance, EQUIP program, and Mille Lacs Electric Community Trust.

In 1997 the MLLWMG applied for a Clean Water Partnership Grant (Phase I) from the MPCA. This funding request was unsuccessful. The MLLWMG applied again the November of 1998; this grant request was awarded on February 16, 1999. The grant agreement was executed on April 27, 1999

Actions and accomplishments of the MLLWMG during the Clean Water Partnership Grant Period are listed below

1999

- GIS analysis of the watershed begun
- Adopt- A-Watershed volunteers trained and organized
- Historic data collected from various sources
- Acquired silt curtains for loan to resorts during harbor clean out
- Portable display developed
- Erickson livestock exclusion fencing project completed (July)
- Educational classes for 5th graders in Isle and Onamia (Sept.)
- Workplan completed and accepted by the MLLWMG and MPCA (Oct.)
- Coordinator sent to NALMS Conference, Reno Nevada (Nov.)

2000

- Hired a facilitator to conduct Planning and Zoning meeting (Feb)
- Distributed a press release explaining the goals of the watershed project (Feb)
- Booth staffed at Milaca and Princeton Expos (March)
- Sampling of tributaries and lake begins
- Developed website (April)
- Planning and Zoning Officials meeting (May 3rd)
- Hosted 3 workshops, dealing with basic water quality, septic systems, and lakescaping, in Onamia, Isle, and Garrison (June/July)
- Newsletter on Shoreland Management distributed in The Bargain Hunter (June)
- Booth staffed at Aitkin County Rivers and Lakes Fair (June)
- Native plants and information sign installed at the North Garrison Landing sediment basin (July)
- Recreation Pollution Study survey sent out, Launch operator surveys summarized (Oct)
- Educational classes for 5th grade students in Onamia
- Assist with development of the Aitkin County Comprehensive Wetland Plan (Dec)

2001

- Booth staffed at the Princeton Business Expo (March)

- Planning and Zoning Task Force meetings begun (April)
- Sponsored the first of three lakescaping training workshops (April 21)
- Coordinator sent to the National Conference on Nonpoint Source Pollution (April)
- Booth staffed at the Aitkin County Rivers and Lakes Fair (June)
- Booth staffed at the Aitkin and Mille Lacs County Fairs (August)
- Educational Program for 5th graders at Aitkin Elementary School (Nov)
- Participate in Aitkin Fishhouse Parade (Nov)
- Crow Wing County septic system inventory completed (Nov)

2002

- Begin working with Minnesota Planning Office on Comprehensive Planning for the Watershed (Feb)
- Booth staffed at the Princeton Expo (March)
- Sediment Core sample taken (March)
- Conduct Recreation Pollution Survey (May/June)
- Last meeting of the Planning and Zoning Task Force (May)
- Booth staffed at the Aitkin County Rivers and Lakes Fair (June)
- Consultant hired to complete final report
- Shoreline erosion sites in Mille Lacs County inventories (Aug)
- Nitrate testing clinic held in Malmo (Oct)
- Aitkin County septic system inventory completed (Nov)

2003

- Committee member sent to Small Community Wastewater Education Seminar (Jan)
- Mille Lacs County septic system inventory completed (Feb)
- Mille Lacs Lake and Ice Fishing Brochure printed/distributed (March)
- Sediment Core sample analysis completed (March)
- Nonpoint Source Pollution Education for Municipal Officials meeting hosted (March)

Throughout the Grant Period, members of the MLLWMG have also been involved in the following watershed issues: The Highway 169 Expansion and Garrison Kathio West Mille Lacs Lake Sanitary Sewer District.

B. DIAGNOSTIC STUDY

B.1. Methods

B.1.a Water Quality Monitoring

Lake Monitoring

Water quality samples were collected from four primary sites (Figure 1) on Mille Lacs Lake (ML-1, 6, 20 and 24). Lake sampling occurred from May through October, 2000 (five dates) and from May through September, 2001 (six dates). For water analyses, surface samples consisted of a 0-2 meter integrated sample. Discrete subsurface samples were also collected. Profiles for various parameters were collected using a Hydrolab Scout 2 with H2O Multiparameter Water Quality Data transmitter.

Parameters and analytical methods are as follows:

Parameter	Method
Ortho Phosphorus	365.1 (EPA)
Total Phosphorus	365.3 (EPA)
Nitrate/Nitrite-Nitrogen	353.2 (EPA)
Total Kjeldahl Nitrogen	351.2 (EPA)
Chloride	325.1 (EPA)
Chlorophyll	Std. Md. 10200H, 18 th Ed.
Color	110.3 (EPA)
Alkalinity	310.1 (EPA)
Dissolved Oxygen	Hydrolab
Temperature	Hydrolab
pH	Hydrolab
Specific Conductance	Hydrolab
Redox	Hydrolab

Secchi disk transparency was measured at each site on each date.

Lake water quality sampling was conducted by the Mille Lacs Band DNRE with citizen volunteers assisting in sample collection.

Watershed Monitoring

Tributary water quality samples were collected from thirteen tributary streams plus the lake's outlet (Figure 1). Three of the streams (Garrison, Seguchie, Thaines) and the outlet had automatic flow staging gauges (Campbell Scientific, Inc. CR10X) that provided continuous stage data. Instantaneous flows were measured using a pygmy flow meter at the time of sample collection in the streams lacking automatic monitors.

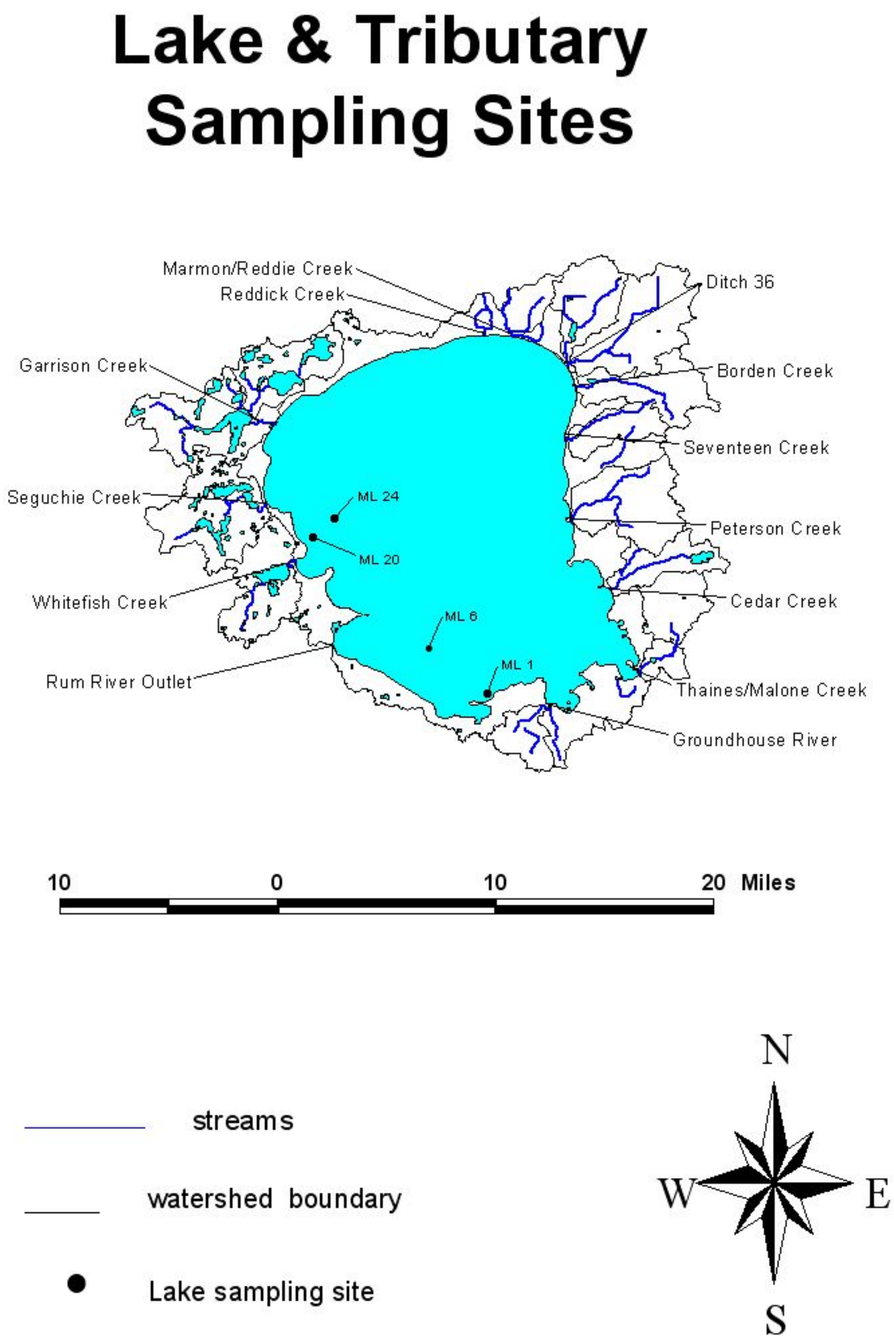

Figure 1. Lake & Tributary Monitoring Locations

Water samples for lab analysis were collected in 1000-ml container and delivered to the lab. In addition, water quality parameters were measured using a Hydrolab meter.

Parameters and analytical methods are as follows:

Parameter	Method
Ortho Phosphorus (2000 only)	365.1 (EPA)
Total Phosphorus	365.3 (EPA)
Chloride	325.1 (EPA)
Nitrate/Nitrite (2000 only)	353.2 (EPA)
Total Kjeldahl Nitrogen	351.2 (EPA)
Total Suspended Solids	160.2 (EPA)
Dissolved Oxygen	Hydro lab
Temperature	Hydro lab
pH	Hydrolab
Specific Conductance	Hydrolab
Flows	Stream Gauging

Water Quality Analysis

The lake and tributary samples were analyzed by the Mille Lacs Band of Ojibwe DNRE Water Quality Lab. Quality assurance and control was conducted in accordance with the Quality Assurance Project Plan (see B.1.d.).

Water quality parameter methods, method detection limits (MDL) and units are as follows:

Parameters	Method	MDL	Measuring Unit
Total Alkalinity	Hach-Titration	3.0 mg/l	mg/l as $CaCO_3$
Color, true	Hach, Alpha	1	Units as Pt-Co
Turbidity	EPA 180.1	0.01	NTU
Ortho- Phosphorus	EPA 365.1	0.76 ug/l	ug/l
Total-Phosphorus	EPA 365.3	2.0 ug/l	ug/l
Nitrate/Nitrite	EPA 353.2	0.17 ug/l	ug/l
Total Kjeldahl	EPA 351.2	0.018 mg/l	mg/l
Chloride	EPA 325.1	0.3 mg/l	mg/l
Dissolved oxygen	Hydrolab	0.05	mg/l
Temperature	Hydrolab	0.1	ºC
pH	Hydrolab	0.1	standard units
Specific conductance	Hydrolab	2	umhos
Redox potential	Hydrolab	2	mv

B.1.b Data Management and Statistics

Methods for reducing data into final results are dependent upon the analytical methods. Total Kjeldahl Nitrogen, Chloride, Total and Ortho Phosphorus, in addition to parameters obtained from the Hydrolab, were direct measurement methods which use a built-in computer program to calculate sample results. Total Suspended Solids and Chlorophyll are methods that required additional calculations (Excel spreadsheet formulas) to reduce raw data to into final results.
All data was managed, stored and transferred on Excel database. STORET data is stored and managed on Access and Excel databases. Summary data for Year 2000 and 2001 were given to MPCA. Tributary data were analyzed using Flux to normalize annual tributary loads.

B.1.c Quality Control/Quality Assurance

The Quality Control/Quality Assurance objective for this project are to:

1. Collect representative samples
2. Produce meaningful data
3. In the event of errors, identify and correct them

From published methods, QA/QC guidelines and previous experience, the objectives for precision, accuracy and completeness for each analytical parameter is given below.

Sampling Procedures:

All samples were collected using approved (EPA, USGS, etc.) methods and sampling devices. Samples were transferred from sample collection devices to pre-cleaned polyethylene or glass bottles. All water sample containers were cleaned by washing with a suitable laboratory detergent (Labtone, VWR) and rinsed with distilled de-ionized water. Sample bottles were fitted with blank labels in the laboratory. Labels contained sample description, site number, date, time, and where applicable, type of preservative.

Analytical Calibration and Standardization Frequency:

Each instrument (spectrophotometers, ph meters, balances, gas chromatographs, etc.) in each laboratory had calibration, standardization, and maintenance documents.

Calibrations and standardizations were done in a manner and frequency consistent with the manufacture's recommendation and per methods specifications. All thermometers used to record temperature in refrigerators, incubators, water baths, etc., were calibrated with a certified thermometer traceable to NBS. A maintenance and calibration log was maintained on each item.

Analytical Methods:

The methods used in this study are derived from method manuals published by the APHA (1985), EPA (1982) and or USGS (1977).

Data Reduction, Validation and Reporting:

All raw data were transcribed to the data transmittal form and stored in a notebook. Where applicable, the data were organized electronically using U.S. EPA STORET Database. Statistical analysis on replicate samples was recorded so that the degree of certainty can be estimated.

All data were reviewed and signed by a project representative. The transmittal form and all pertinent records or references to calibration and maintenance were archived.

Internal QC Checks and Frequency:

Where applicable, internal reference standards were analyzed and utilized on each sample run. External reference standards and standard reference materials from Braun or an approved provider were also used. All stock standards were properly labeled, stored, and expiration dates visibly recorded on the measured data for the certified standards must fall within the specified parameters by the provider or corrective action was taken. The project attempted to run 5-10% QA samples throughout the monitoring efforts.

Procedures to Assess Data Precision, Accuracy and Completeness:

Standard statistical procedures, such as analysis of variance, standard deviation and normalcy of data, were applied to replicate samples and reference standards to define variability and repeatability.

Corrective Action:

The internal quality assurance unit as described in the standard operating procedures performed periodic checks. Remedial action was taken whenever quality control samples fell outside of the recommended guidelines. Decisions to take remedial action were mutually decided on by the project representatives.

Quality Assurance Reviews:

A quality assurance unit was assembled to hold periodic reviews of laboratory QA/QC performance and to discuss progress, problems, and recommend remedial action if necessary. QA/QC responsibility was as follows:

Task	Responsible Person(s)
Overall Project Decisions	Pat Shelito
Overall QA/QC	Scott Hanson
Field and Sampling Activity	Scott Hanson, Scott Doig
Sampling QC	Scott Doig
Laboratory Analyzes and Lab QC	Scott Hanson
Data Processing	Scott Doig
Data Processing QC	Pat Shelito
Data Validation	Scott Doig
Performance and System Audits	Scott Hanson
Liaison with Sponsor	Scott Hanson

Grab samples were collected using a Van Dorn water sampler. Each sample was transferred to pre-labeled bottles (see below). The ph was measured with a calibrated YSI 600 fitted with automatic temperature compensation. The ph meter was calibrated before use, with minimum of two certified buffers (4 and 10) followed by reading and recording a certified ph 7.0 standard. The standard value was recorded on the field-sampling sheet. When field equipment did not function, it was indicated on the field-sampling sheet and the analysis was performed at the laboratory. Conductivity, dissolved oxygen and temperature were recorded at the same time.

Storm Event Monitoring:

Frequency and site selection for storm event sampling were determined, as hydrology of the individual sub-watersheds was understood. Data from the volunteer citizen-sampling program were used to assist in determining these factors. Grab samples were used to obtain a water sample.

Hydrology:

The stream rating curves were developed by mathematical relationships between water levels (gage) and discharge measurements.

The stream measurements were entered in a spreadsheet and resulting discharges with their corresponding gage readings were saved automatically into site-specific files. These files were individually imported into a macro menu driven sheet where log-log regression analysis and subsequent stream ratings were produced automatically.

Automated sampling sequences were initiated by the data loggers based on a positive change in stream height of 0.05 feet or more within one hour. Once the sampling sequence is initiated, 24 samples were taken regardless of ensuing rainfall or flow conditions. In determining when to initiate an event sampling sequence, two possible errors are possible: 1) sampling a non-occurring storm, and 2) not sampling an occurring storm. The above methodology reduced the possibility of the latter, more serious error.

Initial samples were favored for insuring that the nutrient flush is represented. Samples were transported to Mille Lacs Band of Ojibwe DNRE water lab in a cooler with ice packs and composite in representative one-liter samples for analysis. Copies of the data logger programs and the stream ratings were provided at each hydro loci site to ensure correct operation and functioning. Annual mass loading estimates were derived from substance concentrations, corresponding flows and the average daily flows for the time period using FLUX.

The non-point hydrologic data were downloaded on a bi-monthly basis to the laboratory computer. Each data logger records and stores approximately 3,000 records of information per month and requires a detailed downloading procedure to insure the safety of the data. The data were initially transferred to a storage module (Campbell Scientific), which is read into the laboratory computer using the software package PC208 (Campbell Scientific). The data were then translated into EXCEL software and stored in subdirectories also named for each site. Graphs of the average daily discharge were produced automatically, and compared with rainfall records for anomalies. The records of the download periods were kept in a separate ring binder.

Error in Stream Flow Measurement:

Nearly all non-point watershed data are dependent on stream discharge estimates that are used in conjunction with substance concentrations to determine annual mass loadings from the local watershed. The multi-step procedure involved in determining discharges and resulting loading estimates illustrates the large number of possible error sources and their composite effect. Estimating the variability of each step is difficult and certain assumptions were made.

Stream rating errors are calculated from the regression equations used, but the total error includes the error of the individual flow measurements used to make the rating. Variability in stream estimates is characterized but duplicate measurements, and the accuracy of the current meter is addressed largely by factory re-calibration on a biannual basis. For these reasons, much of the error must be assumed to be minimal and addressed largely by assurance documentation.

Storm event samples were composited on a flow-weighted basis with site-specific bottle selection schemes that are based on initial hydro graph characterizations and are repeated with each storm. The sampling schemes are intended to represent the entire storm event. Any error associated with the sample bottle selection would be made on a consistent basis and would represent bias in the event load estimate. The magnitude of the bias would be proportional to the storm event frequency.

Errors in stream measurements, discharge-rating regressions, loading calculation methods and analytical measurement can be characterized directly, but the additional components of the total error are more difficult to access. Variability in stream gauging apparatus, sample collection apparatus, sample bottle selection, sample compositing and data handling, although minimized by a good quality assurance program are difficult to evaluate.

Components of the total error associated with different collection and measurement activates are thought to be independent of each other and equal in magnitude. Much of the error involved, if normally distributed, would cancel out and the limiting sum of these positive and negative variations would be their mean value. Any cumulative bias involved in the measurement process would become a component of the mass balance error.

B.1.d Water Modeling Techniques

A lake phosphorus model is used to evaluate water and phosphorus inputs as they relate to lake phosphorus concentrations. A model has been developed and tested for Mille Lacs Lake (Walker 2001) and is presented below:

$$C = (Lw + Lx) / (Qn + UA)$$

where C is lake phosphorus concentration (ppb); Lw is watershed phosphorus load (kg/year); Lx is other phosphorus load components (kg/year); Qn is net inflow (= inflow + precipitation - evaporation + groundwater, hm^3/year); U is effective settling velocity (1.9 m/year) and A is lake surface area (536.5 km^2). This model was modified by including point sources with Lx and including groundwater.

This model, or for that matter any steady-state model, may not adequately represent conditions in a large, wind-swept lake with long residence times. Other methods (eg. sediment core analysis) may be required to infer future conditions and appropriate management strategies.

B.1.e Watershed Modeling Techniques

Watershed phosphorus loading was estimated through a combination of direct field measurements, modeling and the use of relevant literature estimates.

Tributary monitoring from this study was analyzed using FLUX to normalize annual tributary loads and estimate unmonitored tributaries. An appropriate citation or notation will be given when referencing all other phosphorus loading values in the results section.

B.2 Results

B.2.a Description of Project Area

The area surrounding Mille Lacs Lake is largely rural in character. Many lakeshore residents are seasonal, although the conversion to year-round homes is increasing. There are numerous marinas and fishing charters that service anglers in both the winter and summer. Urban services along the western shore of the lake, such as the highway 169 expansion and the Garrison sanitary sewer, will mean an increase in development pressure and population density. Additional descriptions of the project area are found in section A.1 of this report.

Soils

Soils in the Mille Lacs Lake watershed are depicted in Figure 2. The soils are classified using the "soil landscape unit" from the Minnesota Soils Atlas.

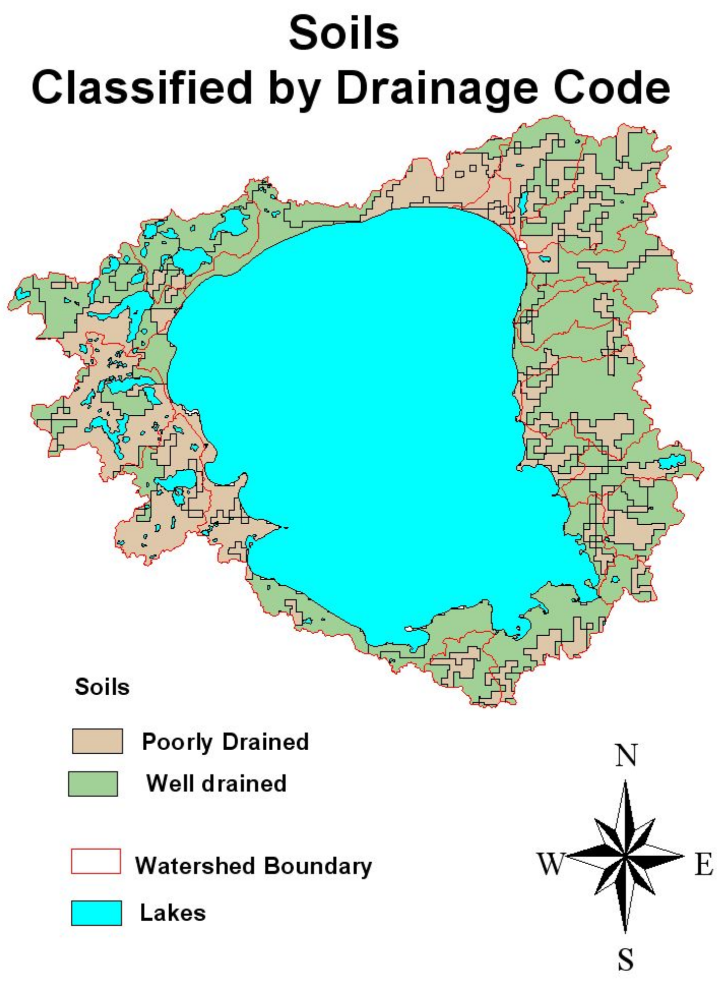

Figure 2. Soils in the Mille Lacs Lake Watershed

Wetlands

Wetlands in the Mille Lacs Lake watershed are depicted in Figure 3. Wetlands area classified according to Fish & Wildlife Service (FWS) Circular 39, which is most often used by local units of government for administration of the Wetland Conservation Act.

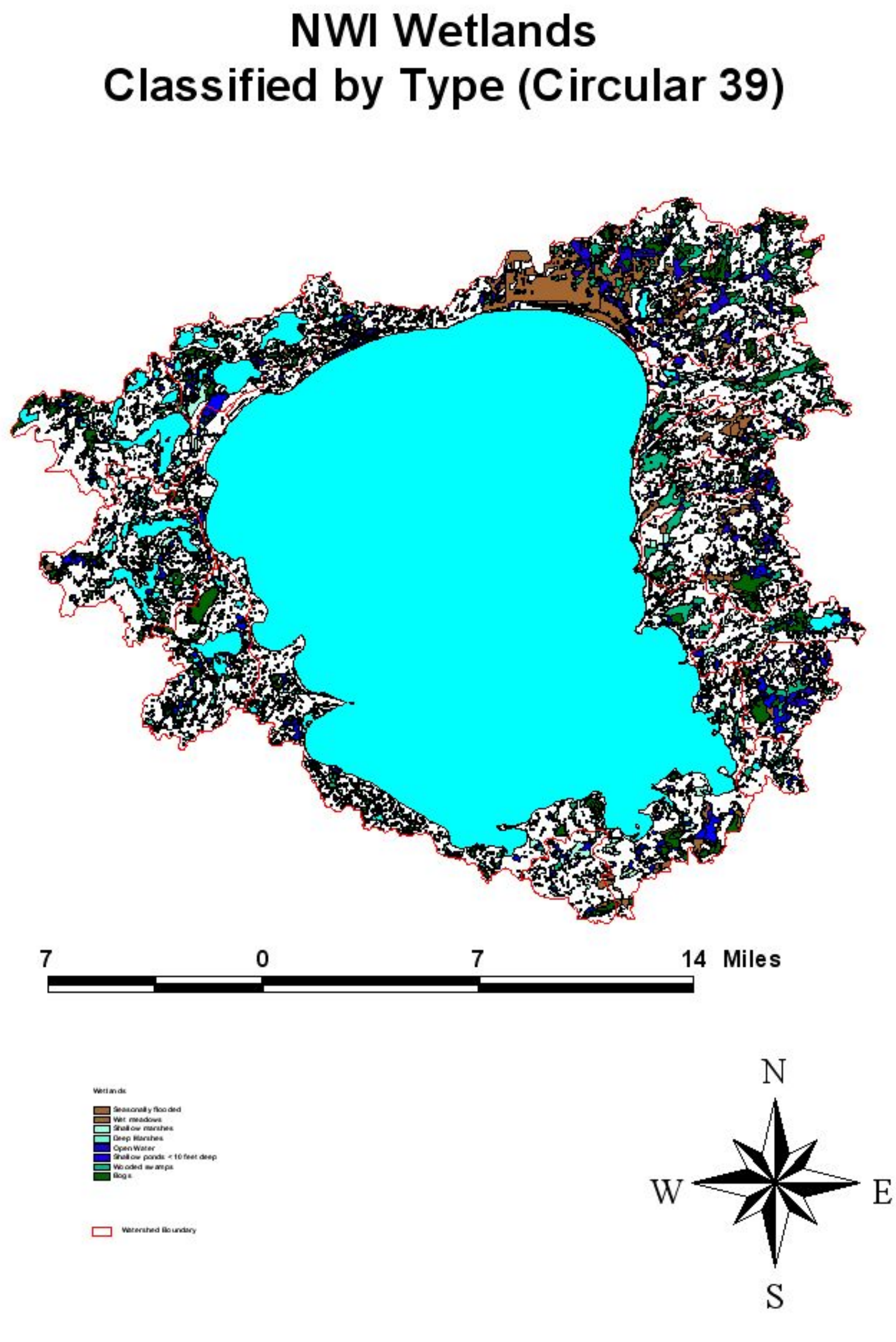

Figure 3. Wetlands in the Mille Lacs Lake Watershed

B.2.b Description of the Water of Concern

Mille Lacs Lake is the premier walleye fishing lake in Minnesota. The lake's physical features and water quality are ideally suited to walleye production. The lake's water quality, as measured in this study, appears to be at its highest level in 30 years, although sediment core analysis indicates an opposite trend. This apparent contradiction is evaluated further below.

B.2.c. Watershed and Pollution Loading Assessment

All data will be published in a separate data report available from the Mille Lacs Lake Watershed Management Group.

Tributary Monitoring Results and Analysis

As rain falls or snow melts, it runs off the land. This runoff water may flow overland in small areas, or as the land area increases, it may be collected in streams. The amount of water that runs off and the kinds and amounts of pollution carried in that runoff varies with many factors, include tributary size, topography, land use, soil type, etc.

In this study, water samples have been collected and analyzed to estimate the amounts of water that run off various tributary watersheds, or subwatersheds. This information has been used to estimate the total amount of water and phosphorus that enter Mille Lacs Lake on an annual basis. In turn, this information is useful in calculating water and phosphorus budgets, which are important for evaluating where the greatest impacts arise as well as understanding where the greatest opportunities are for mitigating these impacts.

There are 13 tributaries plus the collection of smaller land areas around the lake, referred to as 'shoreline,' flowing into Mille Lacs Lake. Together, these areas comprise the total watershed of Mille Lacs Lake. The table below lists the tributaries, their land area, the amounts of water flow and the phosphorus loads to Mille Lacs Lake. Note that there are cases where there was insufficient data to estimate flows or TP loads directly. In those cases, estimates were made by comparing with adjacent subwatersheds (see footnotes on Table B.2.c.1).

Table B.2.c.1.
Mille Lacs Lake tributary areas, runoff and phosphorus loads.

Subwatershed*	**Area (km2)**	**Area (%)**	**Runoff (m/yr)****	**Runoff (hm^3)**	**FWM TP (ppb)*****	**TP Load (kg)**
Shoreline	147.0	27.1	0.16	23.52	103	2423
Ditch 36	47	8.6	0.15	7.05	73	515
Seguchie	45.6	8.4	0.10	4.56	33	150
Garrison	43.1	7.9	0.10	4.31	28	121
Whitefish	34.5	6.3	0.13	4.485	21	94
Peterson	39.6	7.3	0.15	5.94	103	612
Borden	28.6	5.3	0.13	3.718	93	346
Round Lake	29.9	5.5	0.10	2.99	50	150
Twenty Lakes	23.9	4.4	0.15	3.585	50	179
Cedar	19.5	3.6	0.15	2.925	87	254
Seventeen	17.2	3.2	0.15	2.58	141	364
Groundhouse River	14.4	2.6	0.15	2.16	50	108
Thaines	47	8.6	0.40	18.8	53	996
Marmon (Reddie)	6.1	1.1	0.10	0.61	60	37
TOTAL	**543.4**	**100.0**		**87.233**		**6348**

* From Walker 2001
** Underlined numbers are estimates for subwatersheds made by comparing adjacent subwatersheds. Estimates of flow were made in cases where no flow measurements were made and estimates of FWM TP were made in cases where inadequate water quality date were available.
*** Flow-weighted mean total phosphorus, FLUX (Bruce Wilson)

Other Sources of Water and Phosphorus

There are other sources, in addition to tributary inputs, of water and phosphorus to Mille Lacs Lake. To complete the water and phosphorus budgets, these other sources must be identified and estimated.

Rain and snow falling directly on the surface of the lake adds water and phosphorus. Based on the normal amount of precipitation (0.7 m/year) plus measurements of the phosphorus content (29 ppb, Walker 2001), the annual inputs can be estimated

Water Load	375.6 hm^3/year
Phosphorus Load	10,891 kg/year

Point sources refer to pollution sources that are delivered from discrete points, usually at the end of a pipe. For Mille Lacs Lake, there is one small point source, the Vineland waster water treatment plant, which discharges into three ponds before discharging to a wetland tributary to the lake. This load has been estimated by Walker (2001):

Water Load	n/a
Phosphorus Load	51 kg/year

While the magnitude of this source is difficult to estimate, it will soon be eliminated when the Garrison Kathio West Mille Lake Sanitary District comes on line.

On-site septic systems are used to treat wastewater from individual homes. These systems, if not properly maintained or installed, could leak phosphorus to the lake. This load has been estimated by Walker (2001):

Water Load	n/a
Phosphorus Load	1,500 kg/year

This estimate of the phosphorus load is considered to be a worst case.

Surveys conducted by county staff (Appendix F.4) indicate approximately 669 non-compliant septic systems within the Mille Lacs Lake watershed (Table B.2.c.2). Non-compliance does not necessarily mean the systems are contributing phosphorus to the lake.

Table B.2.c.2
Summary of County Septic System Inventories

County	# Parcels	# Compliant	# Non-compliant	# No information
Aitkin	635	108 known 386 estimated	96	45
Crow Wing	193	32 known	2	125
Mille Lacs	~1,800	357 known 857 estimated	571 estimated	1,443

Mille Lacs Lake is a very popular fishing lake in both winter and summer. Because of its large size, and the general lack of sanitation facilities, it can be reasonably assumed, human waste enters the lake from fishing and other recreational users. In addition to poor sanitation, the phosphorus content of this waste can be estimated. The phosphorus load from winter fishing activity has been estimated by Heiskary et al. (1994). For purposes of this study, the phosphorus load from summer fishing activities is assumed to be equal to the winter loads, so the estimates in Heiskary et al. (1994) are doubled below:

Water Load	n/a
Phosphorus Load	456 kg/year

Two additional studies of the recreational use of Mille Lacs Lake were also developed as part of this study. These studies are reproduced in Appendix F.5.

Groundwater refers to water moving below the surface and seeping into the lake. Groundwater also may seep out of the lake. Generally, groundwater inflow adds phosphorus, which can be estimated. For Mille Lacs Lake, there appears to be long-term cycles in groundwater flows. The most recent estimates of groundwater inputs to Mille Lacs Lake are from (Ttotta and Cowdery 1998):

Water Load	2.68 hm^3/year
Phosphorus Load	121 kg/year

Evaporation is obviously not an input to the lake, but it is estimated to complete the modeling terms. As water vapor is lost, no phosphorus is carried with it. Walker (2001) has estimated evaporation from Mille Lacs Lake:

Water Load	370.2 hm^3/year
Phosphorus Load	n/a

Water and Phosphorus Budgets

Based on the measured and estimated inputs of water and phosphorus, as described above, budgets can be created. The water and phosphorus budgets are simply an accounting for the sources of the respective factor. These budgets represent the baseline condition upon which a management plan is based.

A water budget for a lake accounts for the total inflows and outflows, which are equal as long as the lake level does not change. The water budget for Mille Lacs Lake presented below represents a 'normal' condition, which occurs in an 'average' year - average rainfall, average runoff, average temperature, etc. Obviously, most years are not average in this sense - some years are wetter or drier, some years are warmer or cooler, etc. Nonetheless, the normal condition is used here to describe baseline conditions for water flows and pollution sources.

The water budget for Mille Lacs Lake is as follows:

Inflows	Runoff	87.2	hm^3 / year (19%)
	Rainfall	375.6	hm^3 / year (81 %)
	Groundwater	2.7	hm^3 / year (< 1%)
Outflows	Evaporation	370.2	hm^3 / year (80%)
	Outlet (Rum River)	95.3	hm^3 / year (20%)
	TOTAL (in and out)	**465.5**	**hm^3 / year**

By comparing the annual inflows to the lake with the lake volume, a water residence time can be estimated. Water residence time gives an impression as to the length of time required for water and other elements to 'flush' through the lake. This calculation is useful in understanding how responsive a lake will be to pollution. For example, a lake with a short residence time, say less than one year, will react quickly to changes in phosphorus inputs.

Water residence time is calculated by dividing the lake volume by the annual inflows. Using the numbers presented above, the water residence time for Mille Lacs Lake is 7.4 years. Residence time may also be calculated to consider the 'residence' of phosphorus in a lake. In this context, residence time may be calculated using only the annual inflows from runoff. Calculated that way, residence time for Mille Lacs Lake is 42 years. Note that residence time is much higher in dry years and lower in wet years.

The above calculation considers the residence time of water only. Because much of the phosphorus inputs come from runoff, which are carried in smaller volumes of water (compared to rainfall), the effective phosphorus residence may be much longer. Depending how this is calculated, the effective residence time of phosphorus may be up to three or four decades. In any case, Mille Lac Lake has a long residence time and is therefore slow to respond to changes in phosphorus inputs.

This finding means that it will be important to monitor changes in the baseline phosphorus inputs rather than relying on measured changes in lake quality which will occur too long afterwards.

A phosphorus budget is an accounting of phosphorus inflows to the lake. Because most of the phosphorus flowing into a lake actually stays in the lake, it is unnecessary to account for the outflows and 'balance' the equation (as with the water budget). In fact, about 92% of all the phosphorus that enters Mille Lacs Lake stays in the lake and is deposited in the lake sediments.

The phosphorus budget for Mille Lacs Lake is as follows:

Runoff	6,348	kg / year (32%)
Rainfall	10,891	kg / year (56%)
Point Source	51	kg / year (< 1%)
Septic Systems	1,500	kg / year (8%)
Winter & Summer Recreation	456	kg / year (2%)
Groundwater	121	kg / year (1%)
TOTAL	**19,367**	**kg / year**

Because it is not practical to manage or control phosphorus entering Mille Lacs Lake from rainfall, management and control activities will need to focus on other phosphorus sources.

Lake Model Output

The expected lake phosphorus concentration using the inputs as described in the previous sections:

$$C = (Lw + Lx) / (Qn + UA) = 17.4 \text{ ppb}$$

with these inputs:

$Lw = 6{,}348$ kg
$Lx = 13{,}019$ kg
$Qn = 95.28\ hm^3/year$
$U = 1.9$ m/year
$A = 536.5\ km^2$

This value agrees well with lake phosphorus concentrations measured during this study.

Lake Water Quality Trends

Lake water quality data have been collected on an irregular frequency, from various locations in the lake and using different field and analytical methods. At best, the historic water quality data is spotty, making any evaluation of trends challenging.

Studies from 1971, 1980, 1992 and 2000 appear to indicate decreasing lake phosphorus concentrations, algae abundance and increasing water transparency (from Walker 2001). However, due to the concerns with data consistency noted above, this apparent trend in improving water quality is not definitive.

Table B.3.a.1
Trends in Mille Lacs Lake Water Quality

Year	TP (ppb)	CLA (ppb)	Secchi (feet)
1971	36	--	--
1981	29	7	6
1992	27	4	7
2000	17	4	--
2001	18	2	12
2002		no monitoring	

* 1971, 1981 & 1992 from Heiskary et al. (1994); 2000 and 2001 from this project.

The data from this study are taken from lake monitoring sites ML-1, 6, 20 and 24, which are located near the western and southern shores of the lake. Given the fact that the western subwatersheds contribute proportionately larger concentrations of phosphorus, the waters along the eastern shores of Mille Lacs Lake may have higher phosphorus concentrations than those measured in this study. Unfortunately, there is no data from this area.

Based on the water quality data collected in this study, Mille Lacs Lake is now mesotrophic.

Recent water quality observations, which indicate good lake water quality, may be a result of a) reductions in agricultural lands in the watershed, b) improvements in air quality or c) improvement in the operation and maintenance of septic systems. The MLLWMG points out that these are all one-time improvements.

Sediment Core Analysis (Complete Report Contained in Appendix F.6)

The sediment core taken on March 11, 2002 shows an increase in sedimentation accumulation rates beginning about 1970 and increasing steadily. A lake-wide estimate of the present sedimentation rate is 0.019 gm/cm^2/year. The percent of organic matter increases with the increasing sedimentation rate beginning in 1950. As well, the diatom assemblage and the diatom-inferred total phosphorus indicate a lower transparency and an increasing phosphorus load.

According to the completion report, "all (loss on ignition profile, changes in diatom community composition, and DI TP reconstruction) indicate that soil erosion and nutrient loading have been on an upward trend for 40 to 50 years." This conclusion is inconsistent with the apparent water quality trends (Table B.3.a.1). However, this method is a more reliable indicator and integrator of long-term nutrient impacts (see Wang et al. in press).

The increasing nutrient loading to the sediments is a concern because as these impacts accumulate, the likelihood for inducing internal phosphorus recycling increases. While there is insufficient data to prescribe when internal recycling may occur or its magnitude, it is prudent to mitigate all external phosphorus sources to the extent possible.

Internal Phosphorus Loading

At this time, the phenomenon of internal phosphorus recycling does not appear to be occurring in Mille Lacs Lake. However, mesotrophic lakes, like Mille Lacs, are subject to this phenomenon following increases in phosphorus input rates, which appear to be occurring.

Internal phosphorus recycling refers to a condition where previously settled phosphorus is recycled back into the lake water. When phosphorus inputs increase to a point where phosphorus builds up in the lake sediments faster than it can be buried, it becomes available for recycling. Lakes reaching this stage of eutrophication are very difficult to manage and reversing this condition is extremely challenging.

The sediment phosphorus accumulation data indicates an increasing phosphorus buildup is occurring in the sediments of the lake. This is a substantial concern. If Mille Lacs Lake sediments began releasing phosphorus, it would have a potentially huge impact. If for example, the sediment phosphorus release rate were 1 $mg/m^2/d$ (half the rate for aerobic sediments found in Jacoby et al. 1982), and assuming this occurred for 60 days over half the lake bottom, the seasonal phosphorus input would be 16,080 kg - about equal to the total of all present phosphorus inputs.

Based on available data, it is difficult to accurately forecast if or when this may occur in Mille Lacs Lake or what amount of external phosphorus would need to be mitigated to arrest the trend of accumulating sediment phosphorus. Therefore, at a minimum, continued monitoring and aggressive attention to nonpoint source phosphorus mitigation is essential.

Conclusion

Mille Lacs Lake is mesotrophic. Recent lake water quality data appear to indicate the lake's condition has improved in the past two or three decades, however these data are inconclusive. Sediment core analysis indicates the lake's condition has degraded and that nutrient inputs have increased over the past five decades. The sediment analysis, because it represents a consistent record that integrates lake-wide impacts over time and space, is a more reliable indicator of water quality trends, at least with respect to increasing nutrient inputs.

The source or sources of increasing nutrient inputs to the lake can not be identified from the sediment core analysis. This study has measured or estimated contemporary phosphorus sources only. At this time, there is no clear understanding of specific sources of nutrient increases as reflected in the sediment core analysis. Therefore, mitigation measures should be applied generally throughout the watershed.

B.3. Discussion

B.3.a Assessment of the Project's Resource Water Quality

Mille Lacs Lake is mesotrophic. There is conflicting evidence whether the lake's water quality is improving or degrading. At a minimum, it appears nutrient and sediment loading to the lake has increased over the past 50 years. If this increased loading continues, the lake's water quality can not be maintained, especially if internal phosphorus recycling is initiated.

Mille Lacs Lake is a premier walleye lake. The management of the walleye fishery has been the topic of great interest and debate in Minnesota. Because the quality of the walleye fishery in Mille Lacs Lake is directly related to the quality of the water and nearshore habitat, efforts to protect Mille Lacs Lake water quality are also important for the preservation of the quality walleye fishery.

This project does not address issues or concerns regarding the management of the walleye fishery.

Schupp and Wilson (1993) reviewed MN DNR fisheries data and demonstrated the relationship between lake water quality and the relative abundance of various gamefish species. They reported the maximum abundance of walleye was found at a water quality of TSI=45. TSI refers to 'Trophic State Index,' which is a measure of lake water quality. TSI=45 translated to these water quality indicator values is:

- Total Phosphorus Concentration = 17 parts per billion (ppb)
- Chlorophyll Concentration = 4.4 ppb
- Secchi disk transparency = 9 feet

The present water quality of Mille Lacs Lake practically matches these values exactly (see Table B.3.a.1). Many factors combined contribute to the high quality walleye fishery in Mille Lacs Lake. Lake water quality, the main emphasis of this project, is currently in the optimum range. Therefore, it makes sense from the perspective of protecting the walleye fishery to protect the lake's water quality near its current level.

B.3.b Assessment of Pollutant Loads

Rainfall

Rainfall and atmospheric deposition accounts for the largest portion (56%) of the lake's annual phosphorus budget. Because it is not possible to mitigate this pollution sources, no assessment is needed.

Subwatersheds

The target ecoregion flow-weighted mean phosphorus concentration for this area is 35 to 50 ppb (Bruce Wilson, personal communication). On this basis, these subwatersheds exceed baseline conditions (see Figure 4) in this ecoregion (from Table B.2.c.1):

Flow-Weighted Mean TP > 100 ppb

- Shoreline
- Peterson
- Seventeen

Flow-Weighted Mean TP > 50 ppb

- Ditch 36
- Borden
- Cedar
- Thaines
- Marmon (Reddie)

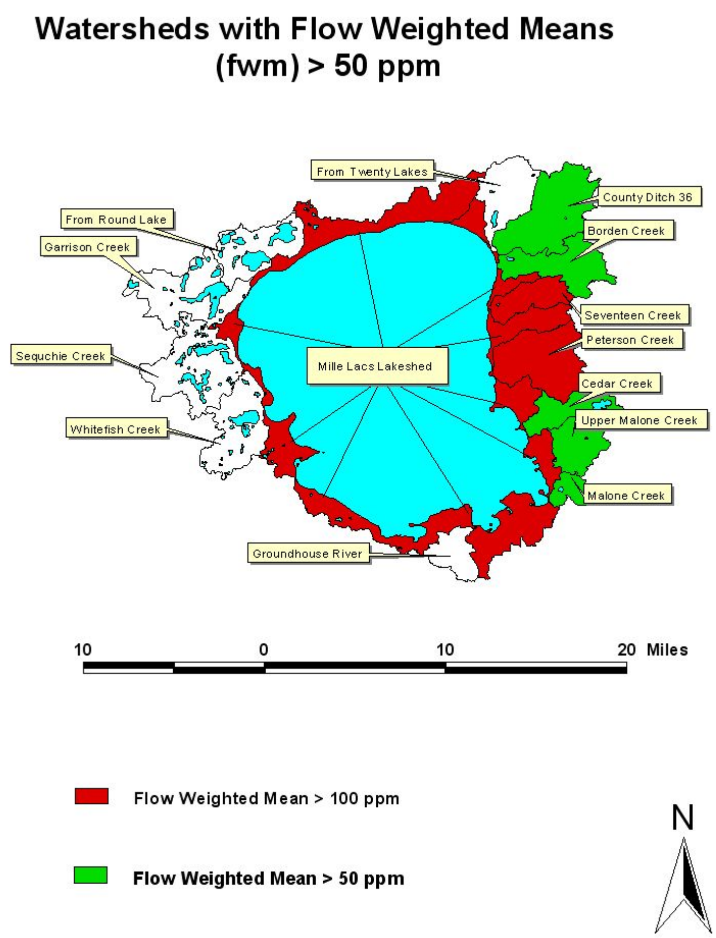

Figure 4. Mille Lacs Lake Subwatersheds with High Phosphorus Loading

Septic Systems

There are approximately 669 non-compliant septic systems in the Mille Lacs Lake watershed that contribute an estimated 1,500 kg/year of phosphorus to the lake. Both the estimate of septic systems that are non-compliant and therefore leaching phosphorus and the estimate of the overall phosphorus loading are imprecise.

Winter & Summer Fishing

The shear numbers of recreational users during the summer and winter points to a serious concern regarding the discharge of human waste directly into the lake. The survey data show the general lack of sanitation facilities on boats and in ice houses. Thus, while it is difficult to precisely estimate the real impact, efforts should be made to reduce this pollution source to the greatest possible extent.

In addition to human waste, trash and litter are problematic during both the winter and summer. There is a high level of support among all users to provide more waste disposal facilities around the lake.

Potential Future Phosphorus Sources

1. Highway 169 Upgrade

Highway 169 along the west shore of Mille Lacs Lake is scheduled to be expanded. A Draft Environmental Impact Statement (DEIS) has been prepared to evaluate the environmental impacts of various alternative road alignments (MN DOT 2002). The following list indicates the impacts that have been evaluated:

- Right-of-Way/Relocation
- Tribal Trust Land Impacted
- Economics
- Benefit-Cost Analysis
- Social and Community Impacts
- Land Use
- Park and Recreational Areas
- Pedestrian and Bicycle Movements
- Environmental Justice
- Transit
- Utilities
- Secondary and Cumulative Effects
- Noise
- Energy
- Surface Water Drainage
- Water Quality
- Floodplains
- Geology Groundwater/Sole Source Aquifer
- Wetlands
- Vegetation
- Fish & Wildlife

- State/Federal Threatened Endangered Species
- Prime and/or Statewide Important Farmlands
- Wild and Scenic Rivers
- Visual Quality
- Architectural/Historic and Archaeological Resources
- Contaminated Properties

Water quality issues are of the greatest concern to the Mille Lacs Lake watershed project. The possible impacts to water quality were evaluated in a separate report (Walker 2001). The following conclusions are excerpted from the report:

- Projected increases in concentrations of phosphorus and suspended solids are small and probably not measurable.

- The potential increases are controlled more by regional urban development than by selection of a specific highway alternative.

- Given the planned diversion of wastewater and potential implementation of Best Management Practices for controlling runoff from highway segments and new urban development and assuming that existing waterbodies and wetlands in the watershed are preserved, it is likely that any of the alternatives could be implemented without causing a net increase in Mille Lacs Lake phosphorus concentration. [Note: Recent alignment alternatives may have impacts to wetlands not anticipated in the Walker 2001 report]

- Loadings of road deicing salts and in-lake concentrations are projected to increase by 17 to 32%.

- Overall regional water quality impacts would be lowest for alternatives that create the least amount of additional impervious area.

- Although difficult to quantify, risk of significant water quality impacts during the construction phase would be much larger than the long-term average impacts evaluated here. Localized sedimentation & construction impacts can be minimized through prudent design of drainage systems, implementation of BMPs, and prudent construction management.

The proposed Highway 169 improvements can induce or facilitate increases in development and the concomitant increases in nonpoint source pollution. The increased nonpoint source pollution can be mitigated to some extent by proper land management and the use of best management practices. The Walker (2001) study was done under the assumption that wetlands would not be affected. Since then, the final alignment for the north half of the project (St. Albans Bay and Wigwam Bay) does affect approximately 200 acres of wetlands. This impact could result in increased phosphorus loading to the lake. To the best extent practicable, it is suggested that all Highway 169 associated mitigation requirements be implemented within the watershed of Mille Lacs Lake.

A special land use study analysis was conducted as part of the TH Highway 169 Draft Environmental Impact Statement (Orning and Digre 2001). Orning and Digre (2001) projected a population increase from 92,730 (in 2000) to 138,817 (in 2030) in the three county area around the project area. Much of this growth 'will go into converting seasonal dwellings/cabins to permanent homes.'

2. Increased Development Density & Sanitary Sewer

ML Wastewater Management, Inc. will be completing construction of a wastewater treatment plant in September 2003. The treatment plant will treat wastewater generated by the Mille Lacs Band of Ojibwe as well as wastewater from the Garrison Kathio West Mille Lake Sanitary District which includes the City of Garrison and parts of Garrison and Kathio Townships. The Sanitary District will begin construction of their collection system in May 2003. It is expected that construction of the collection system will take two to three years. The completed regional wastewater treatment system will reduce sanitary pollution into Mille Lacs Lake by replacing poorly functioning or failing on-site septic systems in the area. The discharge of treated water from the plant will be directed outside of the Mille Lacs Lake watershed.

There is concern that increased development, which is likely to occur in this area as a result of central sewage collection, may result in increased nonpoint source pollution. Increased population density and the associated infrastructure may lead to increased nonpoint source pollution, that is, pollution from runoff. The increased nonpoint source pollution is mitigated to some extent by proper land management and the use of best management practices, however, there will likely be a net increase in pollution.

Increases in population and development density are likely to occur in the Mille Lacs Lake watershed independently of the highway improvement or the sewer system. It behooves the communities in the Mille Lacs Lake watershed to coordinate their planning and zoning activities to assure the greatest possible protection of the resource they share and depend upon.

Ross et al. (no date) performed a build-out analysis on the sewer district's service area. Their analysis concluded there would be minimal impact to the water quality of Mille Lacs Lake as a result of secondary development. However, their analysis focused only on increases in impervious surface, so they may have underestimated the increases in nonpoint sources pollution, including phosphorus, from other sources. It should be pointed out the sanitary district has adopted the MLLWMG's model stormwater ordinance (Appendix F.7).

Mille Lacs Lake is of enormous value to the communities around it as well as to the state. Degradation in water quality could be disastrous. Future development is unavoidable. Increases in nonpoint source pollution are a certain result of unconstrained or poorly controlled development. The baseline data and modeling conducted during this project indicate it is possible to protect the lake, even in light of future development. Thus, it makes sense to be proactive in preserving its water quality. We know degraded water quality translates into real economic impacts.[1]

3. Animal Operations

There are known feedlots in the Mille Lacs Lake tributary watershed. No comprehensive analysis of feedlot location or impact was done as part of this study.

Minnesota Pollution control Agency interns did a windshield survey in the Aitkin County part of the Mille Lacs Lake watershed. Sites with evidence of a large number of cows are indicated (Figure 5). This is not a comprehensive survey. There are no registered sites in the watershed in Mille Lacs

[1] The Lake Bemidji Watershed Management Project (1996) found that a 10% decline in tourism, which is related to a similar decline in water quality, would result in a $12,600,000 loss to the local economy.

County and only two in Crow Wing. In Crow Wing County and Mille Lacs County, data came from animal permit registration information.

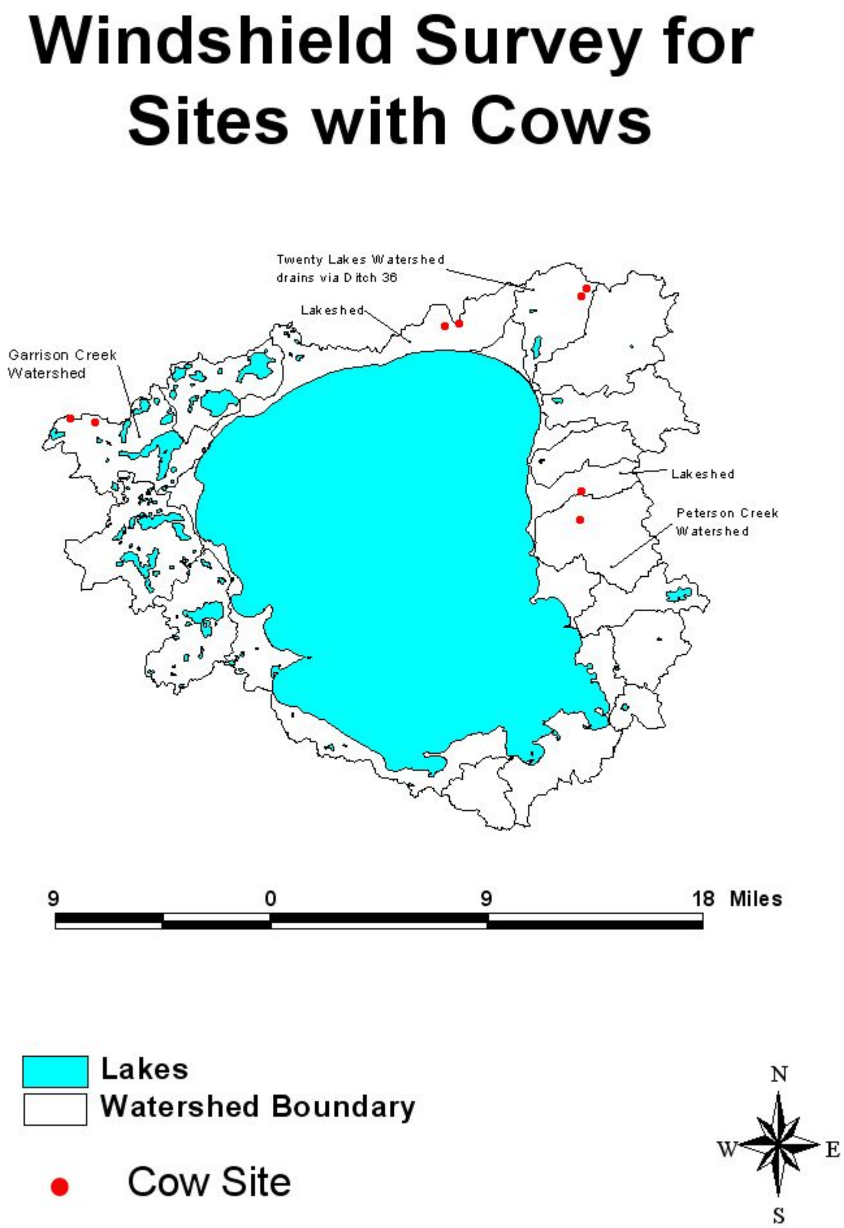

Figure 5. Locations of Animal Operations

4. Internal Phosphorus Recycling

Continued increases in phosphorus loading to Mille Lacs Lake will, at some point, trigger internal phosphorus recycling. Should internal phosphorus recycling be initiated, the magnitude of that input could equal that of all other external phosphorus sources. The surest way to avoid this is to prevent or mitigate further increases in external phosphorus inputs and reduce current excessive inputs.

Internal phosphorus loading may also be initiated or accelerated by long term increases in climate warming, which is expected for this area. Higher air and water temperatures will result in longer growing seasons (and shorter ice-covered periods) and more pronounced wet and dry cycles. This means that Best Management Practices used to mitigate the impacts of land development will need to take longer growing seasons and more extreme runoff events into account as they are designed and implemented.

Planning and Zoning Concerns

The Mille Lacs Lake Watershed Management Group (MLLWMG) considered planning and zoning concerns in the Mille Lacs Lake watershed in mid-2000. Phase One of that project is summarized below:

1. A situation analysis was prepared that describes the background and general scope of planning and zoning concerns in the framework of the Mille Lake Watershed Management Project. This document was designed as a lead-in to a questionnaire that was enclosed.

2. A questionnaire was sent to 28 people representing local units of government and others to assess planning and zoning concerns. The survey was designed to 'set the stage' for a facilitated meeting of this group.

3. Responses to the questionnaire were summarized and used to frame the agenda for the facilitated meeting.

4. A facilitated meeting was held to discuss the Mille Lacs Lake Planning and Zoning Concerns.

Comprehensive watershed coordination was identified as critical to addressing Planning and Zoning issues:

1. Comprehensive (Watershed) Coordination. There is clearly a need for comprehensive coordination with regard to planning and zoning issues as they bear on a management and protection plan for Mille Lacs Lake. No group or agency now has the authority to coordinate planning and zoning in the Mille Lac Lake watershed. The MLLWMG was identified as the logical group to convene key parties in the watershed.

The MLLWMG has taken action in support of the Comprehensive Planning Project, proposed by Minnesota Planning.

Specific regional issues that could be better coordinated at the watershed level include the Highway 169 upgrade and the West Side Wastewater Collection and Treatment System.

2. Goal Setting. It is a common understanding that planning and zoning is an important element for protecting Mille Lacs Lake. However, there does not appear to be a common understanding as to what the lake needs to be protected from or for. The lack of a goal or goals is problematic because there is only vague guidance for management and protection activities.

Specific lake and watershed management goals are needed to address water quality, fish and fish habitat, exotic species and aesthetics.

3. Planning and Zoning Concerns. There is a widespread belief that development pressure around Mille Lacs Lake is increasing at an alarming rate and the area could be better prepared to manage that development. There are specific planning and zoning concerns that require further attention with regard to better enforcement, adequacy and consistency among local units of government:

    - Wetlands
    - Septic systems
    - Vegetation removal
    - Erosion control
    - Lot size
    - Flood plain
    - Fish houses – winter and summer
    - Impervious surface
    - Wellheads
    - Lack of uniform enforcement

There is agreement that this issue should be further developed among local units of government in a series of facilitated meetings.

The East Central Regional Development Commission (ECRDC), the Region 5 Development Commission, the Arrowhead Regional Development Commission and Minnesota Planning have proposed a five-phase program to develop a 'sub-regional comprehensive plan' for the Mille Lacs Lake watershed. The development of this plan would involve extensive coordination among local units of government, the tribal government, development commissions, federal and state agencies and special districts. This project would also include the MLLWMG's future involvement in watershed management and protection activities.

The results of this plan are intended to:

- Help protect significant natural resources
- Protect significant state investments
- Promote wise development
- Guide local planning actions of jurisdictions in the Mille Lacs Lake watershed

At this time, only the first of five phases will proceed. This first phase includes pre-planning work that will explore funding sources, identify staff and consultants, meet with local units of governments, develop a method to expand membership, develop operating procedures, develop a public participation plan and identify state agencies that should participate in the planning discussions. The phases of the proposal include:

Phase I	Pre-Planning Work
Phase II	Assessing the Planning Area - Identifying Resources and Gathering Data
Phase III	Visioning and Plan Development
Phase IV	Draft Plan Document, Local Review and Adoption
Phase V	Plan Implementation and Administration

Funding for the first phase is provided through Minnesota Planning and the Regional Development Commissions. Funding for the remaining phases is to be determined soon. If fully funded and implemented according to the proposed schedule, the development of the Mille Lacs Lake Comprehensive Watershed Plan should be completed in 2005.

B.3.c Resource Water Quality Goals

Mille Lacs Lake water quality, as measured in this study, appears to be at its best level in recent history. As well, there is evidence its current water quality is in the optimum range for walleye production. Thus, it makes sense to maintain the lake's quality at these levels.

There is contrary evidence from the sediment core analysis that indicates the phosphorus inputs to the lake have been increasing for the past five decades. This signal should not be ignored. This means that to maintain the lake's water quality at the level measured in this study, mitigating measures should be taken.

The MLLWMG has adopted this goal statement:

> *The water quality of Mille Lacs Lake will be preserved at its 2000-2001 levels through an ongoing program of advocacy, education, protective actions, planning and monitoring.*

B.3.d Target Reductions Needed to Meet Water Quality Goals

The sediment core analysis indicates that phosphorus loading to the lake has been increasing for five decades. There are two likely impacts to lake water quality if this trend is not reversed:

1. Lake water quality will degrade as a result of this history of escalating phosphorus inputs. Because of the lake's long residence time, evidence of poorer water quality may take two or three decades.

2. The build up of increasing phosphorus will eventually reach a point where it is greater than the rate at which it is buried. At that point, internal phosphorus recycling, the reintroduction of sediment phosphorus, will be initiated. This will have immediate and probably large water quality impacts.

Unfortunately, we lack precise models or quantitative data needed to identify exact phosphorus loading reductions to attain Mille Lacs Lake's water quality goal. Therefore, the target phosphorus reductions described below aim to minimize excessive inputs or mitigate future increases.

<u>Subwatershed Reductions</u>

For those subwatersheds with flow-weighted mean total phosphorus (FWMTP) concentrations > 50 ppb, best management practices can be considered. Target reductions are calculated by reducing the FWMTP measured in this study to 50 ppb:

Table B.3.d.1
Target Phosphorus Reductions for Subwatersheds with FWMTP > 50 ppb

Subwatershed	FWMTP (ppb)	TP Load (kg/year)	Target Reduction* (kg/year)
Shoreline	101	2,423	1,223
Peterson	103	612	315
Seventeen	141	364	235
Ditch 36	73	515	162
Borden	93	346	160
Cedar	87	254	108
Thaines	53	996	56
Marmon (Reddie)	60	37	6
TOTAL Target Reduction			**2,265**

* Target reduction calculated by reducing FWMTP to 50 ppb.

The reduction proposed in Table B.3.d.1, 2,265 kg/year, represents a 36% reduction in the total subwatershed loading.

Septic System Reductions

Approximately 669 non-compliant septic systems contribute an estimated 1,500 kg/year of to Lake Mille Lacs. While these estimates are imprecise, it is reasonable to take steps to improve the inspections and performance of these systems. The proposed target for this plan is to reduce the phosphorus loading from septic systems by two thirds or 1,000 kg/year.

Winter/Summer Recreation Reductions

The phosphorus inputs relating to winter and summer recreational activities are relatively small. Nonetheless, these inputs can be mitigated.

The estimated phosphorus load from recreational activities is 456 kg/year, or about 2% of the lake's phosphorus budget. A target reduction of 50% (228 kg/year) is proposed here.

Mitigation of Future Increases

Increases in phosphorus loading resulting from the highway 169 upgrade, development induced by providing sanitary sewer service, inadequate planning and zoning controls, or other activities should be carefully reviewed and fully mitigated to assure there is no net increase in phosphorus loading to the lake.

C. IMPLEMENTATION PLAN

C.1 Implementation Plan Objectives

Mille Lacs Lake water quality is good today, but there are troubling indicators that it is threatened. Specifically, the sediment core analysis shows a trend of increasing phosphorus inputs to the lake spanning the past five decades. This trend cannot continue without having some negative impact. The MLLWMG does not want to have the lake's current good condition lull those who value Mille Lacs Lake into complacency.

Because the water quality of Mille Lacs Lake is very good right now, a management goal that aims to protect the lake's quality is appropriate. The MLLWMG has adopted this goal statement:

> *The water quality of Mille Lacs Lake will be preserved at its 2000-2001 levels through an ongoing program of advocacy, education, protective actions, planning and monitoring.*

Management objectives to support this goal have also been adopted. The proposed implementation program has two major emphases: 1) hiring a project coordinator and 2) continuing intensive monitoring.

Management Objective 1: Increase the awareness and knowledge of watershed residents, lakeshore owners, recreational users, resort owners, local elected officials and state regulators with regard to the need for lake and watershed protection.

Management Objective 2: The MLLWMG must be effective advocates for the protection of Mille Lacs Lake.

Management Objective 3: Implement watershed protection to mitigate excessive phosphorus loading and offset the anticipated increases in nutrient inputs as well as other kinds of pollution.

Management Objective 4: Minimize future increases in nonpoint source pollution through appropriate local planning and zoning controls.

Management Objective 5: Implement an ongoing monitoring and evaluation program.

Management Objective 6: Program administration.

C.2 Identification of Priority Management Areas

Priority management areas correspond to the adopted management objectives. The six management objectives are re-stated below along with a description of specific priorities that have a clear geographic or social aspect:

Management Objective 1: Increase the awareness and knowledge of watershed residents, lakeshore owners, recreational users, resort owners, local elected officials and state regulators with regard to the need for lake and watershed protection.

Priority Management Area: Those people and organizations identified in the objective.

Management Objective 2: The MLLWMG must be effective advocates for the protection of Mille Lacs Lake.

Priority Management Area: None.

Management Objective 3: Implement watershed protection to mitigate excessive phosphorus loading and offset the anticipated increases in nutrient inputs as well as other kinds of pollution.

Priority Management Area: The subwatersheds identified in Table B.3.d.1.

Priority Management Area: Those areas associated with projects or activities being planned or proposed. These areas that are known at this time:

- Highway 169 corridor
- Service area of the Garrison Kathio West Mille Lake Sanitary District

Management Objective 4: Minimize future increases in nonpoint source pollution through appropriate local planning and zoning controls.

Priority Management Area: The Mille Lacs Lake watershed.

Management Objective 5: Implement an ongoing monitoring and evaluation program.

Priority Management Area: Mille Lacs Lake and its watershed.

Management Objective 6: Program administration.

Priority Management Area: None.

C.3 Best Management Practices (BMP) Alternatives and Analysis

C.3.a Evaluation of BMPs

Best management practices or other appropriate management actions will be evaluated for various management actions organized under each management objective. The MLLWMG has discussed and agreed to the actions listed below.

Because no detailed analysis has been conducted in any of the subwatershed, we have minimal knowledge of specific problem areas or 'hot spots.' Thus, watershed BMP analysis is largely premature until such a time as specific problem areas can be identified. At this time, we have identified target reductions in several areas.

BMP alternatives are listed under each management objective and are taken from Minnesota's 2001 Nonpoint Source Management Program Plan - Appendix B.

Management Objective 1: Increase the awareness and knowledge of watershed residents, lakeshore owners, recreational users, resort owners, local elected officials and state regulators with regard to the need for lake and watershed protection.

Management Actions

The MLLWMG has been frustrated at the apparent lack of participation and interest in this project. They have concluded that the lake's good water quality, the lack of a readily identifiable threat and the high percentage of seasonal lakeshore residents have contributed to this poor participation. Nonetheless, the MLLWMG is committed to raising awareness among all watershed stakeholders to effect the long-term protection of Mille Lacs Lake.

These management actions have been recommended by the MLLWMG:

1. Develop and maintain a database of stakeholder and media contacts.

2. Develop educational and information materials for frequent distribution through various media.

3. Develop and facilitate quarterly public official forums.

4. Build and maintain an engaging web site.

BMP Alternatives: N/A.

Management Objective 2: The MLLWMG must be effective advocates for the protection of Mille Lacs Lake.

It makes sense that the MLLWMG take on the role of being advocates for the betterment of Mille Lacs Lake.

Management Action

5. The MLLWMG should be active participants in and be a visible presence at all appropriate opportunities where protection of Mille Lacs Lake can occur.

BMP Alternatives: N/A

Management Objective 3: Implement watershed protection to mitigate excessive phosphorus loading and offset the anticipated increases in nutrient inputs as well as other kinds of pollution.

Section B.3.d of this plan identified specific phosphorus reduction targets. The management actions listed here aim to accomplish those targets.

Management Actions

6. Implement appropriate watershed projects. Before specific BMPs can be evaluated, it is necessary to conduct a comprehensive subwatershed analysis. Pending that analysis, a re-check of the feasibility of the target phosphorus reductions should also be done.

7. Design and implement demonstration projects. Demonstration projects in the shoreline subwatershed should be implemented in coordination with the education actions. These projects should focus on phosphorus reduction and shoreline stabilization BMPs.

8. Develop programs and actions to reduce recreation-related sanitary pollution to the lake.

9. Identify, upgrade and replace failing or non-compliant septic systems.

10. The MLLWMG should oversee lake and watershed management activities to facilitate timely and appropriate protection or mitigation actions. Specifically, target reductions for future phosphorus loading increases will be fully mitigated (see section B.3.d).

BMP Alternatives - applicable BMPs listed from *Minnesota's 2001 Nonpoint Source Management Program Plan, Appendix B: Best Management Practices Definitions* (MN PCA):

Part I - Agricultural BMPs

4 Conservation crop rotation
12 Fencing
13 Field border
17 Grassed waterway or outlet
22 Use exclusion
24 Mulching
33 Riparian buffer
37 Streambank protection
39 Timing and placement of fertilizers
42 Waste management systems

Part II - Erosion & Sediment Control BMPs

38 Fertilizer application control
44 Detention basins
47 Parking lot storage
49 Retention basins
51 Storage/treatment facilities

Part III - Other BMPs

54 Aeration of lawns
56 Correct use of soils for septic tanks
61 Maintain setbacks from surface waters
64 Proper installation of septic tanks and drainfields
66 Routine maintenance of septic tank systems
67 Soil testing and plant analysis

Part IV - BMPs for Shorelands

These BMPs are repeated here because the shoreline sub watershed is the greatest contributor of phosphorus pollution to the lake (see Table B.2.c.1)

- Riparian buffer
- Fertilizer application control
- Shoreline stabilization, where possible
- Buffers

Management Objective 4: Minimize future increases in nonpoint source pollution through appropriate local planning and zoning controls.

Management Action

11. The MLLWMG should be an active participant in the comprehensive planning project.

BMP Alternatives: Based on outcome of planning project.

Management Objective 5: Implement an ongoing monitoring and evaluation program.

Because the diagnostic study had conflicting or imprecise conclusions regarding the nature and extent of the threat of nutrient enrichment, ongoing monitoring is a critical element of the management of Mille Lacs Lake.

Management Action

12. Continue a comprehensive lake and stream monitoring program.

BMP Alternatives: N/A

Management Objective 6: Program administration.

Management Actions

13. Representation on the MLLWMG should be expanded to include resort owners.

14. Hire a full-time advocate and program coordinator.

BMP Alternatives: N/A

C.3.b Cost Estimates for Each Alternative

Because the alternate BMPs apply generically, it is not possible to estimate costs for their application.

C.4 BMP Selection and Identification

C.4.a Selected BMP Package and Justification

Only action no. 6 in section C.3.a identifies BMPs, therefore, no specific BMPs can be selected at this time.

C.4.b Rationale and Justification of the BMPs in the Package

No BMPs have been identified at this time.

C.4.c Pollution Control Effectiveness Analysis

The ultimate evaluation of BMPs should weigh their effectiveness against the target phosphorus reductions found in section B.3.d.

C.5 Implementation Monitoring and Evaluation

C.5.a Phase II Monitoring Plan

Lake Monitoring

Six lake stations should be established and monitored regularly. Station nos. ML-6 and ML-24 from this study should be retained. In addition, three new stations should be established (Figure 6). Water quality samples should be collected from mid-April through mid-October using the same laboratory and field methods used in this study. The parameters and sampling frequency should include:

Table C.5.a.1
In-Lake Sample Parameters and Frequency

Parameter	Frequency	No. Samples/Season
Ortho Phosphorus	Every 3 weeks	9
Total Phosphorus	Every 3 weeks	9
Nitrate/Nitrite-Nitrogen	Every 3 weeks	9
Total Kjeldahl Nitrogen	Every 3 weeks	9
Chloride	Every 6 weeks	5
Chlorophyll	Every 3 weeks	9
Color	Every 6 weeks	5
Alkalinity	Every 6 weeks	5
Dissolved Oxygen	Every 3 weeks	9
Temperature	Every 3 weeks	9
pH	Every 3 weeks	9
Specific Conductance	Every 3 weeks	9
Redox	Every 6 weeks	5
Secchi disk transparency	Every 3 weeks	9

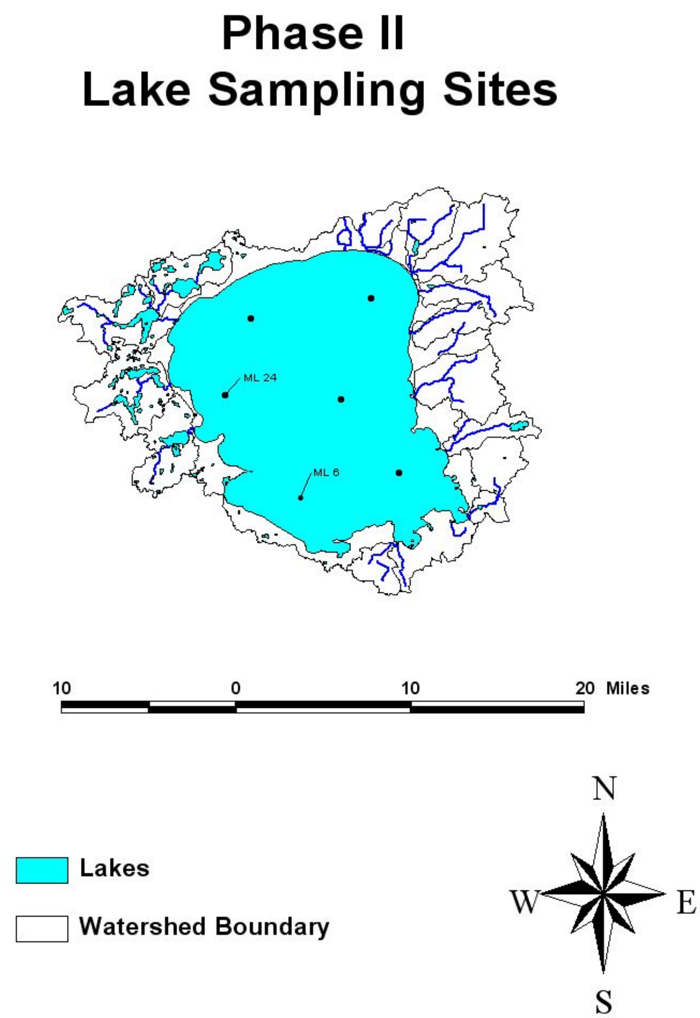

Figure 6. Phase II Lake Monitoring Sites

Because water quality changes may be subtle or occur over a long period, it is important to monitor for changes occurring in the nearshore areas of the lake. These changes include increases in rooted plants or periphyton, which can be easily monitoring by volunteers. A volunteer monitoring program should be developed and implemented.

Satellite imagery is useful for Mille Lacs Lake to monitor long-term water clarity trends. This technology is available through the Grand Rapids office of the Mn DNR.

<u>Subwatershed Monitoring</u>

The same 13 subwatershed streams and the lake's outlet in this study should be monitored in Phase II. Four of those streams have continuous stage monitoring. Snowmelt plus six to ten runoff events should be sampled each year and be analyzed for these parameters:

Table C.5.a.2
Subwatershed Sample Parameters

Parameters

Ortho Phosphorus Total Phosphorus Chloride Nitrate/Nitrite
Total Kjeldahl Nitrogen Total Suspended Solids Dissolved Oxygen
Temperature pH Specific Conductance Flows

C.5.b BMP Evaluation Procedures

BMP evaluation procedures will be determined following the selection and implementation of appropriate BMPs.

C.6 Roles and Responsibilities of Project Participants

Mille Lacs Lake Watershed Management Group

The MLLWMG will continue their role overseeing all aspects of the implementation plan. The MLLWMG will be expanded to include resort owners (see management Action No. 13, below) and others. The Project Coordinator will work in close association with the MLLWMG Steering Committee.

Because the MLLWMG has representation from all project partners, it will continue to coordinate their respective activities and responsibilities. The MLLWMG may reorganize its working committees for the implementation plan.

Mille Lacs Band of Ojibwe DNRE

In addition to their participation in the MLLWMG, the Mille Lacs Band of Ojibwe DNRE will conduct lake and tributary monitoring. This role includes field monitoring and data collection, laboratory analyses, reporting and preliminary statistical analysis.

Others

All other project participants will continue to appoint representatives to the MLLWMG and its working committees as they have for Phase I. A fiscal administrator has yet to be identified for Phase II.

C.7 BMP Operation and Maintenance Plan

A BMP operation and maintenance plan will be developed following the selection of BMPs.

C.8 Information and Education Program

An information and education program is contained in several of the management actions detailed below.

C.9 Permits Required for Completion of this Project

Because no specific BMPs or projects are being proposed at this time, there are no known permit requirements.

C.10 Identification and Summary of Program Elements

The main emphasis of the proposed implementation plan is to hire a project coordinator to take the lead in implementing the management actions through the proposed management program. In this vein, except for the monitoring program, most of the management actions become elements of the project coordinator's job description.

Management Actions

1. Develop and maintain a database of stakeholder and media contacts.

It is important to keep local residents, government officials, media and others in the community informed about lake and watershed protection issues. Developing and maintaining a stakeholder and media database is an obvious way to organize and facilitate this communication. This task will be part of the job description of the program coordinator. There will be incidental costs over and above the program coordinator's compensation. These include:

	Year 1	Year 2	Year 3
Software	$200	$100	$100

2. Develop educational and information materials for frequent distribution through various media.

A key element of the program coordinator's job will be to develop educational and informational materials. The program coordinator may do this work in some cases or may retain a consultant in other cases. The program coordinator, in consultation with the MLLWMG, should develop an education and information plan during the first six months.

	Year 1	Year 2	Year 3
Consulting	$2,000	$2,000	$2,000
Printing & Postage	$1,000	$1,000	$1,000

3. Develop and facilitate quarterly public official forums.

The program coordinator, in association with the MLLWMG, should plan and facilitate quarterly public official forums. The forums should be designed to inform local officials regarding lake and watershed management and protection issues as well as encourage positive and coordinated governmental action.

	Year 1	Year 2	Year 3
Room Rental	$500	$500	$500
Printing & Postage	$200	$200	$200

4. Build and maintain an engaging web site.

The program coordinator should retain a consultant for the initial web design and implementation.

	Year 1	Year 2	Year 3
Consulting	$1,000	$500	$500
Software & Hosting	$200	$200	$200

5. The MLLWMG should be active participants in and be a visible presence at all appropriate opportunities where protection of Mille Lacs Lake can occur.

This task will be part of the job description of the program coordinator. The program coordinator should expect to spend at least half of the time out of the office, actively engaging the community in lake and watershed protection messages.

	Year 1	Year 2	Year 3
Mileage	$300	$300	$300

6. Implement appropriate watershed projects. Before specific BMPs can be evaluated, it is necessary to conduct a comprehensive subwatershed analysis. Pending that analysis, a re-check of the feasibility of the target phosphorus reductions should also be done.

This task will be overseen by the program coordinator and will require the assistance of the SWCD staff. Detailed land use inventories as well as field inspections of suspected problem areas should be completed in Year 1. Landowner education and BMP evaluation should be completed in Year 2. Implementation of BMP should be initiated in Year 3.

The largest portion of the phosphorus load to the lake comes from the ‘shoreline’ subwatershed. This means that watershed landowner BMPs will be an important element of protecting the lake.

	Year 1	Year 2	Year 3

SWCD Staff	in kind	in kind	in kind
BMP Implementation	$ 0	$ 0	tbd

7. Design and implement demonstration projects. Demonstration projects in the shoreline subwatershed should be implemented in coordination with the education actions. These projects should focus on phosphorus reduction and shoreline stabilization BMPs.

This task will be overseen by the program coordinator and may require the assistance from SWCD staff or consultants. Projects should focus on phosphorus reduction, but also address erosion control, shoreline stabilization, vegetation removal, wetland protection and impervious surfaces.

A general budget category is included here to allow for flexibility in the design and implementation of demonstration projects. The budget is smaller in the first year to allow time for the development of a rational plan for implementing the demonstration projects.

	Year 1	Year 2	Year 3
Demonstration Projects	$5,000	$10,000	$10,000

8. Develop programs and actions to reduce recreation-related sanitary pollution to the lake.

The program coordinator, in cooperation with the MLLWMG, will develop plans and programs to reduce recreation-related pollution. The programs should emphasize education and awareness, enlist the assistance of volunteers and include an evaluation element. A small budget is provided for educational materials, waste receptacles, etc.

	Year 1	Year 2	Year 3
Demonstration Projects	$2,000	$2,000	$2,000

9. Identify, upgrade and replace failing or non-compliant septic systems.

The program coordinator will work with County staff and the Mille Lacs Band of Ojibwe DNRE to assure adequate inventories, inspections and compliance occurs throughout the Mille Lacs Lake watershed.

	Year 1	Year 2	Year 3
Mileage	$200	$200	$200

10. The MLLWMG should oversee lake and watershed management activities to facilitate timely and appropriate protection or mitigation actions. Specifically, target reductions for future phosphorus loading increases will be fully mitigated (see section B.3.d).

The program coordinator will work with local government staff and project managers to assure future phosphorus loading increases are fully mitigated through the use of BMPs.

	Year 1	Year 2	Year 3
Mileage	$200	$200	$200

11. The MLLWMG should be an active participant in the comprehensive planning project.

The program coordinator, as well as the MLLWMG, will be an active participant in the comprehensive planning project. The MLLWMG Steering Committee wants to provide monetary support for the comprehensive planning project. The specific amount is yet to be determined.

	Year 1	Year 2	Year 3
Contribution*	$28,000	--	--
Mileage	$200	$200	$200

* Local unit of government match = $22,000

12. Continue a comprehensive lake and stream monitoring program.

	Year 1	Year 2	Year 3
Field & Analytical	$30,277	$30,277	$30,277
Satellite Image Analysis	$2,000	$2,000	$2,000

For details of the field and analytical costs, see Appendix F.7.

13. Representation on the MLLWMG should be expanded to include resort owners.

The program coordinator will be the lead staff in continuing the work of the Mille Lacs Lake Watershed Management Group, as expanded to include resort owners.

	Year 1	Year 2	Year 3
Mileage	$300	$300	$300
Room Rental	$600	$600	$600

14. Hire a full-time advocate and program coordinator.

The MLLWMG will hire a full-time project coordinator who will oversee the implementation plan. This person should be experienced in project management and conversant in lake and watershed management.

	Year 1	Year 2	Year 3
Staff Compensation	$50,000	$52,000	$54,000
Office Support	$ 5,000	$ 5,200	$ 5,400
Office Rental	in kind	in kind	in kind

C.11 Milestone Schedule

A three year implementation plan is proposed. The milestone schedule is as follows (years & quarters):

	Year 1				Year 2				Year 3			
Action	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	x	x	x	x	x	x	x	x	x	x	x	x
2	x	x										
3	x	x	x	x	x	x	x	x	x	x	x	x
4		x	x		x				x			
5	x	x	x	x	x	x	x	x	x	x	x	x
6	x	x	x	x	x	x	x	x	x	x	x	x
7	x	x	x	x	x	x	x	x	x	x	x	x
8	x	x	x	x	x	x	x	x	x	x	x	x
9	x	x	x	x	x	x	x	x	x	x	x	x
10	x	x	x	x	x	x	x	x	x	x	x	x
11	x	x	x	x	x	x	x	x	x	x	x	x
12	x	x	x	x	x	x	x	x	x	x	x	x
13	x	x										
14	x	x	x	x	x	x	x	x	x	x	x	x

Because the emphasis of the implementation program is to continue the efforts from Phase I as well as to develop and implement projects and activities on an ongoing basis, most of the management actions span the duration of Phase II.

C.12 Implementation Project Budget

	Budget	Category*							
Mgt Action	Staff	Field & Analytical	Consulting	Demo Projects	Mileage	Soft-ware	Printing & Postage	Office Support	F F
1						$300			
2			$6,000				$3,000		
3							$600		$
4			$2,000			$600			
5					$900				
6									
7				$25,000					
8				$6,000					
9					$600				
10					$600				
11					$600				
12		$80,811							
13					$900				$
14	$156,000							$15,600	
TOTAL	**$156,000**	**$80,811**	**$8,000**	**$31,000**	**$3,600**	**$900**	**$3,600**	**$15,600**	**$**
Grant TOTAL	**$302,811**								

* In-kind and costs to be determined not included

C.13 Conclusions

The implementation plan for Phase II of the Mille Lacs Lake Clean Water Partnership Watershed Management Project continues with monitoring and evaluation as well as implementing education, advocacy and demonstration projects. The main emphasis of Phase II is to retain a Project Coordinator who will direct, coordinate and oversee all aspects of the implementation plan. In addition, continued monitoring is a significant and essential element of the implementation plan. The Mille Lacs Band of Ojibwe DNRW will conduct the monitoring program. Together, the budget for the Project Coordinator (staff costs plus office support) and the monitoring program comprise 83% of the proposed Phase II budget. However, in-kind and costs yet to be determined for watershed projects have not been included in the overall budget.

D. EPILOGUE

by Paul Andrews, chair
Mille Lacs Lake Watershed Management Group

Development of this watershed management plan is the culmination of an effort which began in August 1997 with the first meeting of the Mille Lacs Lake Watershed Management Group.

In 1999, the Group was awarded a Clean Water Partnership (CWP) Phase I Grant, which along with local matching dollars provided the funding to undertake a diagnostic study of the Lake.

Two years of water quality testing - the inlet streams, the outlet and the Lake itself - indicated improvements in quality compared with testing accomplished over the last 30 years. This trend was not confirmed by a sediment core sample of the bottom sediments taken in the winter of 2002. The core sample was analyzed and indicated an increase in fertilization beginning around 1950 and continuing today. Although additional core samples should be taken and analyzed to confirm that the results of this single core are typical of the entire Lake, the recommendations concerning future monitoring would not change.

Phosphorus levels are at a point where every reasonable effort should be made to prevent further increase. If phosphorus levels were to reach a point where internal recycling occurs, the Lake water quality would deteriorate rapidly and probably proceed to the eutrophic classification. Current knowledge of Lake and watershed management indicates that if this were to occur in a lake with the physical characteristics of Mille Lacs, the condition would be irreversible.

The largest source of phosphorus, rainfall, is greater than the total of all others. One additional source, groundwater, like rainfall, is beyond the control of man. This leaves runoff, point sources, septic systems and winter and summer recreation as the only sources of phosphorus that can be controlled.

The protection of the Lake requires a vigorous monitoring program to identify the source and quantity of contaminants in order that corrective action be taken and then to measure the effectiveness of such actions. The reduction of phosphorus input from point sources and septic systems can probably be accomplished with vigorous enforcement of existing standards. Additional rules may be necessary to increase the rate of correction of non-compliant septic systems. The prevention of additional input of phosphorus from runoff (whereas reduction of phosphorus input is the goal) will be more difficult. As development occurs at an increasing rate in the watershed, the potential for additional fertilization of the lake increases.

The only tool available to local government to insure that permitted development does occur in a manner consistent with the protection of Mille Lacs, is adequate, properly administered Planning and Zoning.

Accomplishment of the above will require continuing and more effective efforts in educating all stakeholders to the vulnerability of the Lake and to the need for a concerted effort to protect it. The current relatively good water quality and the excellent walleye fishery tends to introduce in many individuals a sense of complacency or apathy toward what could occur in the future. In others it actually produces an "If it ain't broke, don't fix it " attitude. In the instance of Mille Lacs Lake however, the "fix" must come before a complete breakdown.

The following actions are seen as logical steps in protecting Mille Lacs:

- Participation in the proposed watershed regional planning effort
- Application for and award of a Clean Water Partnership Phase II Grant
- Continuing effort by the Mille Lacs Lake Watershed Management Group to achieve these goals

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