Lake Management Plan
For
Baby, Kerr, Kid, Lost, Man, & McKeown Lakes

Cass County, Minnesota

Original development of Plan, 2002

Revised: Oct 2009, May 2018

Healthy Lakes & Rivers Partnership Committee
Baby, Kerr, Kid Lost, Man, & McKeown Lakes Association

Management Plan for Baby, Kerr, Kid, Lost, Man, & McKeown Lakes
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Introduction

2018 Update:

Since 2009 a number of additional actions and information has been collected. A list is provided here and details will be provided in the appropriate sections of this report:

- Vegetation surveys-2011
- AIS survey-2016 & Cass County AIS inspections
- Ecoli Study-2007
- New Rock Dam at McKeown Creek
- Status of our action plans

Summary of Healthy Lakes & Rivers Partnership Program:

In 2001 the lake association participated in the first Healthy Lakes and Rovers Partnership (HLRP) program and the first Lakes Management Plan for our lakes was developed. This plan was totally revised in the next HLRP in 2008 which is what follows:

In July 2008 the Baby, Kerr, Kid, Lost, Man, & McKeown Lakes Association was invited to participate in the Initiative Foundation's Healthy Lakes and Rivers Partnership (HLRP) program along with six other Lake Associations Cass County. Under the coordination of John Sumption (Cass County Water Planner and Director of Environmental Services), representatives attended two days of training on strategic planning, communication, and nonprofit group leadership.

Representatives of many state and local agencies, as well as nonprofit organizations also attended the training sessions in order to offer their assistance to each group in developing a strategic Lake Management Plan. The Baby, Man, McKeown, Kid, Kerr and Lost Lakes Association were represented at the Healthy Lakes & Rivers training sessions by: Stan Kumpula, Joni Kumpula, Sue Ready, Joanne Walsh, Karl Iten, & Gary Guttormson.

Following the training sessions, each Lake Association held an inclusive community planning/visioning session designed to identify key community concerns, assets, opportunities, and priorities. The Baby, Man, McKeown, Kid, Kerr and Lost Lakes Association held this planning session on August 2, facilitated by Curt Hanson, Initiative Foundation. Approximately 15 people were in attendance, with about 30 percent of the participants describing themselves as year round residents. Details of the public input received at this session are provided within this plan.

This document is intended to create a record of historic and existing conditions and influences on the six lakes in our association and to identify the goals of the Lakes community. Ultimately it is meant to also help prioritize goals, and guide citizen action and engagement in the priority action areas. Clearly, State agencies and local units of government also have a vital role and responsibility in managing surface waters and other natural resources, but above all else this Lake Management Plan is intended to be an assessment of what we as citizens can influence, what our desired outcomes are, and how we will participate in shaping our own destiny.

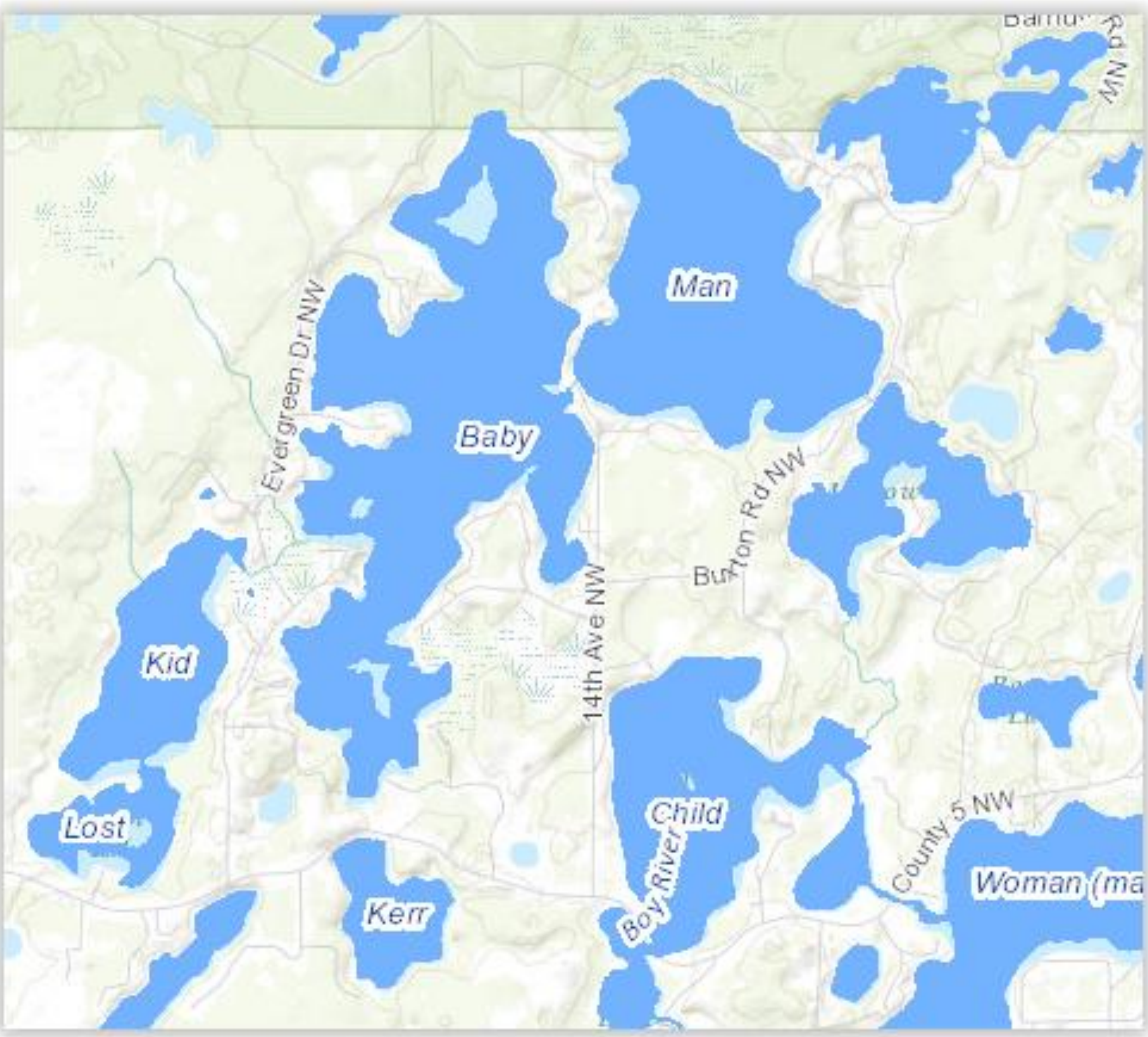
This Lake Management Plan is also intended to be a "living document;" as new or better information becomes available, as we accomplish our goals or discovered that alternative strategies are needed, it is our intent to update this plan so that it continues to serve as a useful guide to future leaders.

In discussing lake management issues, it is impossible to avoid all scientific or technical terms. We have tried to express our goals, measures of success, and other themes as simply and clearly as possible, but have included a glossary of common limnological terms at the end of the plan to assist the reader. Limnology is the state of lake conditions and behavior.

Finally, we would like to thank the funders of the Healthy Lakes & Rivers Partnership program for Cass County, including The McKnight Foundation, Laura Jane Musser Trust, U.S. Environmental Protection Agency, McDowall Company, the Cass County Water Plan, Lake Hubert Conservation Association, Portage-Crooked Lakes Association, and the Sibley Lake Association of Crow Wing County, the Ann Lake Sportsmen's Club of Kennebec County, various staff from the Initiative Foundation, and over thirty generous individuals.

Physical Characteristics and location of Baby, Man, McKeown, Kerr, Kid, & Lost Lakes

Baby (#11-0283), Man (#11-0282), McKeown (#11-0261), Kerr (#11-0268), Kid (#11-0262), and Lost Lake (#11-0062) are located in Cass County, east of the City of Hackensack and southwest of Longville.



The table below summarizes some of the physical characteristics of the lakes within this chain. The littoral area is that which is equal or less than 15 feet deep (data is from 2004 computations except water clarity is from data taken between 1992 and 2008 but the number of years of data collection varies for each lake.

Summary of Lake Properties:

Lake	Baby	Man	Kid	McKeown	Kerr	Lost
Bathymetry Data: year, transects (1)	1972,110	1972,75	1976,18	1975,17	DNR map	NA
Bathymetry maps completed	1974	1974	1977	1976		
Lake Surface Area, Acres	740.0	449.3	163.3	157.6	74.6	69.8
Shoreline length (not incl islands), miles	10.2	4.3	2.8	3.9	1.6	1.9
Surface area per mile of shoreline	72.5	105.2	58.7	40.4	47.6	37.3
Lake Volume in Acre-Ft (2)	15,191.1	12,730.4	2,676.7	1,110.3	2,247.9	844.3
Mean Depth, Feet	20.5	28.3	16.4	7.0	30.1	12.1
Littoral Area at 15', Acres	314.1	123.1	55.2	142.1	19.2	
Littoral Area, % of total area	42.4%	27.4%	33.8%	90.2%	25.7%	
Maximum Depth, Feet	75.0	96.0	52.0	38.0	79.0	34.0
Number of Property Owners	145.0	56.0	23.0	54.0	9.0	7.0
Surface Area per Prop Owner	5.1	8.0	7.1	2.9	8.3	10.0
Number of Islands	3.0	0.0	0.0	1.0	0.0	2.0
Average Secchi Disk, Feet	13.4	12.2	13.4	15.7	15.3	14.1
Secchi Disk Collection Period	1995-2010	1995-01 +04,05,08-10	2004-10	1995-2010	1998-06,09-10	2004-09

Note: Area, Volume, & Shoreline calculations completed in 2004 Method used was AutoSketch CAD program, version 7, except Lost Lake volume was approx. wo bathymetry map

(1)-Number of Bathymetry transects exceeds those done by the DNR and reflect more accurate maps

(2)-Volume calcs based on planimetered area at 20' contour intervals except 5' interval was also planimetered

Water Level:

The DNR Division of Waters has historic water level data for Baby, Man, McKeown, and Kid Lakes, with summary statistics presented below. A chart showing the long term fluctuation for McKeown Lake (the only lake with a substantial record) is presented on the following table:

	Baby	Man	McKeown	Kid
Period of Record	5/23/95-8/31/04	10/26/94-10/28/05	11/12/36-10/28/05	5/1/79
# of readings	3	5	119	1
Highest Recorded Water Level	1,327.65 ft (May, 23, 1995)	1,327.95 (Oct. 26, 1994)	1,327.65 (June 6, 1985)	1,329.1
Lowest Recorded Water Level	1,327.45 ft (Aug. 31, 2004)	1,327.46 ft (Oct. 28, 1995)	1,325.93 (Nov. 12, 1936)	1,329.1
Recorded range	0.2 feet	0.49 feet	1.72 feet	0
Average Water Level	1,327.56 ft	1,327.63 ft	1,327.2 ft	1,329.1 ft
Ordinary High Wtr Level	1,327.9 ft	1,327.9 feet	1,327.9 feet	1,329.1 feet

The lake levels for all six lakes are relatively stable and rise and fall together unless blockages occur between the creeks such as caused by beaver dams and tree and branch obstructions, usually at culverts. Without any obstructions, McKeown, Man, and Baby lakes are generally within a few inches of each other, at approximately elevation 1,328 feet above sea level. Kid Lake and Lost Lake are joined by a short channel between them and their waters flow to Baby Lake through an unnamed creek at the southwest side of Baby Lake. They rise and fall together and can be a little higher than Baby Lake due to the smaller size creek and 42” culvert under Evergreen Drive. Kerr Lake water flows to the south end of Baby Lake through a 24” culvert under County Highway 5. Kerr Lake is usually about 1 foot higher than Baby Lake because of the restricted flow through the small culvert. The culvert has sediment in it that restricts flow, but the main cause of increased elevations in Kerr Lake is the frequent construction of a beaver dam at the upstream side of the culvert.

The dam on McKeown Creek is the major controlling factor of Lake Levels. The dam was constructed in 1936 and raised the lake levels about 1.5 to 2 feet. Since then, according to Minnesota DNR records, Baby Lake levels have only varied by about one foot. The reason for such a small variation is the nature of the watershed. The overall watershed size is not much larger than the lakes themselves. Thus, when large rainfall events occur, the lakes do not rise significantly. Also, several springs exist and when there are dry periods, the springs keep flowing due to stable and higher groundwater levels on the north, west, and south sides of the watershed. The higher lake levels of Moccasin, Webb, and Trillium Lakes are evidence of this. These lakes are 26, 18, and 18 feet higher, respectively, than our watershed lakes. Further, a preliminary study was done by a Hydraulic Engineer using gross but conservative assumptions for flow routing through the lakes. The study determined that Baby Lake would not rise more than 12 inches after the occurrence of the National Weather Service 1% chance rainfall. Even the Standard Project Rainfall, an event that occurs less often than once in 1000 years, would only raise the level of Baby Lake by 18”

McKeown Lake Dam Constructed in 1936

A new rock Dam was built below the existing structure in 2015. It has three pool levels and the existing dam stop logs and fish ladder was removed. This allows for better fish passage and stabilizes the flow characteristics better than the original stop logs. Some flow measurements were taken coupled with stage readings. A comparison of this data with data from the original dam indicates that the new rock dam may increase water levels in our lakes by about 3 inches.

The new Rock Dam shown below the original Dam.

Watershed Description

The six association lakes are in the McKeown Creek sub-watershed of the Boy River Watershed. Figure 2 shows the McKeown Creek watershed boundaries. The boundaries were determined by how surface water runoff will flow into the lakes. There is additional water flow into the watershed by means of groundwater flow. McKeown Creek starts at the dam structure on McKeown Lake (Figure 2) and flows southerly about 1 mile into Child Lake, part of the Boy River System. The creeks between the lakes in the watershed are small and short and have not been named. The watershed area is about 9 square miles (5,793 acres). Land use within the watershed is typical of north central Minnesota with forest, wetlands and lakes constituting the largest percentage of land use types. A more detailed watershed map is shown in the appendix.

Forests comprise about ___ %, wetlands and lakes about ___% and 28%, respectively, with agricultural about ___%. The watershed area includes about 18 % of public land. About 300 acres is Federal (Chippewa National Forest land), 120 acres is State land, and 600 acres is County land. There are a significant number of individual wetlands and they vary in rating from low to high value. The highest valued wetlands are attached to the lakes. Development consists of mostly seasonal and permanent lake homes.

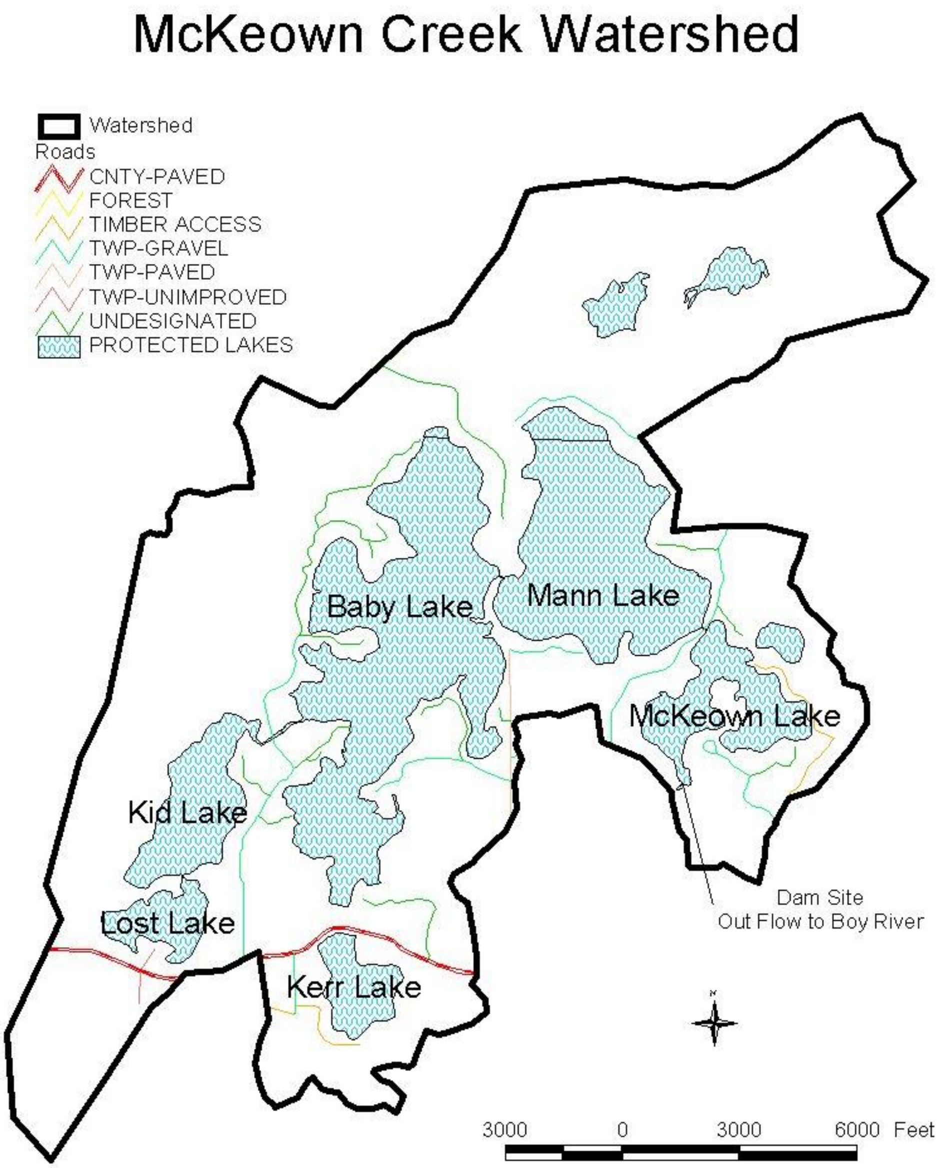


Figure 2 Watershed Map

Most of the lake shoreline is developed. A majority of shoreline property owners has more than 100 feet of shoreline and the properties are 200 feet or more in depth. A significant number of structures have been constructed since the early 1970's, when minimum lot sizes were at least 100 feet and structure setbacks were at least 85 feet. This has minimized the crowding around the shorelines of our lakes and provides opportunities for the development of proper individual sanitary systems. Of course, there was significant development before the 1970's and there are older septic systems that may not conform to current regulations. A More detailed Watershed Map can be found in Appendix VI.

Precipitation

In 1989 the Minnesota Pollution Control Agency (MPCA) conducted a Lake Assessment Program (LAP) study of Woman, Child and Girl Lakes near Longville. This study noted that average annual precipitation for the area ranges between 26-28 inches, and evaporation ranges between 30-32 inches. Annual average runoff is approximately 6 inches. One-in-ten year low and high runoff is approximately 2 inches and 8 inches respectively.

Springtime ice-out on Baby, Kerr, Kid, Lost, Man, & McKeown Lake has usually occurred by mid to late April.

Soils

The McKeown Creek Watershed lies in the central part of Cass County where the soils are highly variable. There is a lot of clay and loamy type soils, particularly 18" or more below the ground surface. These soils are not well drained. There are sandy pockets however, and they can be defined by excavation or borings, and to a lesser extent by observing the types of trees growing in the area. Soils in Southern and Northern Cass County are much sandier and well drained.

The 1997 soil survey of Cass County provides a detailed description of the variety of soils in the county. Map 71 of the report lists the great variety of soil classifications in the watershed, but for this lake management plan, only a basic summary will be provided in more simple terms. The most common classification is Warba fine sandy loam (240). The profile of this soil lists fine sandy loam in the upper 12 to 18" with clay loam or loamy soil below to depths of 60 inches. The soil survey does not go deeper than 60 inches.

There are lesser areas of sandier to sandy loam soils (Menaga Loamy Sand (679) and Cutaway Loamy Sand (620). Other soil classifications include Warba-Cromwell complex (773), which is similar to Warba but a little sandier, and Mahtomedi loamy sand (454). There are other classifications with smaller areas in the watershed. In summary, the Warba classification is the most dominant and contains clays and loam, and this causes problems for foundations and sanitary systems.

The dominant woodland trees in the Warba classification are Aspen, Basswood, Sugar Maple, and to a more limited extent, Birch, Balsam Fir, Red Pine, and White Pine. In the more sandy soils, the principal tree species are Red Pine, Red Oak, Aspen, Balsam Fir, and Jack Pine. Species of more limited extent are Birch, Cedar, Spruce, and White Pine.

Introduction/History of the Lake Association

The current goals and mission of the lake association is to enhance water quality and recreation. The water quality of our lakes is currently very good but continuous monitoring is necessary to insure that our lakes stay this way. Recreation is defined as enjoyment of the lakes through observing the beauty, boating, fishing, and swimming.

The Lake Association began in 1990 when Jim and Liz Swanson held a few meetings with some of the Baby Lake property owners to discuss concerns at that time. The major item was poor walleye fishing in Baby Lake. All property owners on Baby, Kid, Lost, Man, and McKeown Lakes were asked to join in the formation of a lake association. In 1991, the Lake Association was formed with Officers and a board. Kerr Lake joined the association in 1996, resulting in all of the lakes upstream of the McKeown Lake dam and within the McKeown Watershed being including in the association.

Accomplishments

Since formation of the association the efforts have been:

- Water quality monitoring (Secchi disk readings since 1992, Hydrolab readings from 1993 to 2002);
- Working with DNR to stock walleye in Baby Lake (stocking began in 1996 and continues every other year);
- Clearing McKeown Creek of obstructions and install a fish ladder at the dam to allow fish to migrate upstream (fish ladder installed in 1995 and renewed in 2008); now negated by the new rock dam constructed in 2015.
- Producing a newsletter three to four times per year for members (the "Lake Link" newsletter started in 1993);
- Installing loon nesting platforms on four of our lakes (Baby, Kerr, Man, & McKeown);
- Involvement with the conditions for operation of a gravel pit at the south end of Baby Lake (operational controls and landscaping were included in the permit requirements);
- Conducting a property owner survey of lake use (survey was done in 1997);

- Participation in the Healthy Lakes & Rivers Partnership (HLRP) training presented by Cass County and the Initiative Foundation (Attended the 2001 & 2008 sessions);
- Development of a shoreland property owner's manual (using a $500 door prize award from the 2003 HLRP reunion) – negated by the Shoreland Homeowners Guide produced by Cass County in 2008;.
- Installation of buoys to increase boating safety (Baby, Man, & McKeown have buoys).
- Lake Vegetation Surveys-1995 (Baby) & 2012 for all six lakes.
- MPCA assessment of all six lakes – 2010
- Water Sampling every 2 years since 2009 and also sampled in 2008.

Tabulation of Water Quality efforts by our Lake Association:

The following table reflects the information available for the six lakes in our association. This has been accomplished by many association members doing the work and coordinating with Cass County, the Minnesota Pollution Control Agency (MPCA), the DNR, Association of Cass County Lakes (ACCL), & RMB Environmental Laboratories, Inc. over several years. RMB has excellent information available on their website to understand lakes and has detailed tabulations of most of the data listed in the table and has good summary reports (rmbel.info).

Item	Years	Lakes	Done By:	Results Posted	Summary of Results
Water Clarity by Secchi Disk	1992 to 2017	All 6 Lakes except only Baby Lk has had readings for all of the years	Lake Association Members for 5 Months each year, organized by MPCA	MPCA Website through CLMP program & some in our Lake Link Newsletters, RMB, & Kumpula files	Results show that our lakes are in the lower limits of Mesotrophic Lake Status which indicates only temporary algae and aquatic plant problems. Overall summary also shown in our Lake Mgmt. plan book.
E.coli Bacteria Sampling	2007	Baby Lake-by Public Access Dock & Kumpula's Dock	Joan Kumpula collected samples & Analysis by U of MN Water Resources Center	MPCA Website & Kumpula Files	*E. coli* bacteria levels in all samples were low, most below the detection limit of the Petriflim test kit (33 cfu for triplicate plates) and many below detection limit of the MN Valley Testing Lab (1 cfu/100 mls).
Water Testing for Depth Profiles of DO & Temp	1993-96, 2001-02, 2004, 2008-09	All 6 Lakes in 2001-02 & 2004, not Kerr in 1993-96, & only Baby Lake in 2008-09	Lake Association Members, mostly Kumpula & Bjorgaard except Baby Lk in 2008-09 by MPCA	MPCA & Kumpula Files	Only Lost lake may not stratify. Only Man lake retains some Dissolved Oxygen below the Thermocline in late July and until Turnover in usually October.
Water Sample testing for Phosphates & Chlorophyll A	2008 2009,11,13,15. Tests were done before 2008–(still searching)	All 6 lakes	Lake Association Members, Led by Ralph Bjorgaard	MPCA, RMB, & Kumpula Files	Results also show that our lakes are in the lower limits of Mesotrophic Lake Status which indicates only temporary algae and aquatic plant problems. A better indicator than just Secchi Disk readings.
Vegetation Surveys	2011	All 6 Lakes	Terry Ebinger & Matt Swanson, former MN DNR employees under contract with our Lake Association	Reports developed in 2012 and on Kumpula Files	Extensive mapping and up to 14 plants were identified with no Exotic species.
Ice Out & On Data	1986-2017	All 6 Lakes since 2003 Almost all Baby Lake from 1986 to 2002	Lake Association Lake property owners	Kumpula Files, others may have files for their lakes	Interesting spread of when ice is on & off. Data may be useful for looking at trends of the open water season growing with climate change & implications on fish & aquatic veg.

HLRP groups (lake associations) have sponsored over 1400 septic compliance inspections in Crow Wing and Cass Counties from 2001 to 2006, with Request for Proposals (RFPs) offered for the "bulk purchase" of this professional service. By offering geographically clustered "demand" for compliance inspections, the host Counties has been able to award contracts which ultimately cost approximately $50 per septic system, compared to the individual price which typically ranges $100-200.

In short, over the five years that HLRP Implementation grants have supported septic compliance inspections in Cass County, approximately 27 percent have been identified as noncompliant, but of those approximately 29 percent have updated or replaced their systems on their own, or in partnership with Cass County's low-interest loan assistance program.

The following summary characterizes the impact of the HLRP sponsored on-site wastewater treatment compliance inspections accomplished in 2003 on our lake association shoreland properties:

Lake Name	# Identified for Inspection	Compliant	Non-compliant	# of systems not inspected	# of systems updated[1]
Baby	96	69	22	5	8
Kerr	4		2	2	
Kid	11	6	5		
Lost	5	2	1	2	
Man	41	30	8	3	3
McKeown	37	27	7	3	2
Total	**194**	**134**	**45**	**15**	**13**

[1]As of 2006. Since then, a number of systems have been updated so that the total number of non-compliant systems is now less than 10%.

Membership in the association for the last several years has varied from about 150 to 200 family or individual members that own shoreland property.

Review of historical and existing conditions for each of nine focus areas

1. Water Quality

Since 1992, citizen volunteers from Baby, Man, McKeown, Kid, Kerr, and Lost Lake have participated in the Minnesota Pollution Control Agency's (MPCA) Citizen Lake Monitoring Program (CLMP), recording secchi disc transparency – a measure of water clarity. Stan Kumpula and Jim and Judy Cummings have been the primary volunteers recording these data for Baby Lake; Roger Allen and Bill Shipman for Man Lake, Ralph Bjorgaard for McKeown, Clarence Rueter for Kid and Lost Lakes for many years.

On the MPCA's web-site link, "Lake Water Quality Database," additional water chemistry data is reported. The MPCA's "Environmental Database Access" system also provides additional water chemistry data which includes total phosphorus concentrations, as well as other data.

One application of secchi disc transparency data is to convert the clarity measurements into a Carlson Trophic Status Index (TSI) score. The Carlson Trophic Status Index (TSI) is a tool used to summarize several measurements of water quality into one index value, which can be used to compare a lake to other lakes, or to historic/future data as a measure of degradation or improvement. In many ways, the index can be viewed as a measure of the potential for algal productivity. Since most people value lakes with low algae productivity, the lower the TSI value the healthier the lake. Specifically:

TSI Range	Trophic Status	Characteristics
0-40	Oligotrophic	Clean Lake
41-50	Mesotrophic	Temporary algae & aquatic plant problems
50-70	Eutrophic	Persistent algae & aquatic plant problems
Greater than 70	Hypereutrophic	Extreme algae & aquatic plant problems

Based on the data provided on the MPCA website, an average concentration (or depth) for the key TSI parameters can be determined, and the associated TSI score calculated.

Average annual Trophic Status Index measurements based on Secchi disk readings

Year	Baby	Man	McKeown	Kerr	Kid	Lost
1995	42.2	40.2	37.9	42.2	---	---
1996	40.5	40.6	38.9	40.5	---	---
1997	41.2	41.8	38.8	41.2	---	---
1998	41.3	40.9	39.2	40.9	---	---
1999	42.9	40.6	38.3	42.1	---	---
2000	42.3	40.8	39.0	42.5	---	---
2001	40.6	40.5	38.7	41.1	42.3	---
2002	41.2	45.0	38.3	40.5	41.2	---
2003	39.7	---	40.7	40.4	---	---
2004	39.8	44.0	36.0	40.7	39.5	41.4
2005	38.9	---	34.6	38.5	40.9	39.8
2006	41.9	---	36.9	40.2	39.6	39.2
2007	40.3	---	35.9	40.3	39.3	39.3
2008	39.3		33.9	38.6	40.4	40.4

Water Quality summaries produced by the MPCA are presented in the following table. They are based on Secchi, Total Phosphorus, and Chlorophyll data collected for ten years through 2012 for most of the data.

MPCA Water Quality Trophic State Index (TSI) table.

Lake:	Baby	Kerr	Kid	Lost	Man	McKeown
TSI	41	40	41	43	41	39

These data suggest that water quality in Baby, Kerr, Kid, Lost, Man, & McKeown Lakes have routinely exhibited "Oligotrophic" conditions (a TSI score below 40) or the very lowest levels of Mesotrophic (40 to 50) during the period of record.

A second method of assessing water quality and determining whether your water body is the "best that it can be" is to compare it to other lakes of similar morphology, geology, and land uses. Listed below are ranges of common measures of water quality based on many years and locations of water quality. The tables below are adapted from the MN Pollution Control Agency "Environmental Data Access" database, and compare observe results in Baby, Kerr, Kid, Lost, Man, & McKeown Lakes to common water quality ranges for lakes within the Northern Lakes and Forests Eco-region

Average Summer Water Quality (most of data from 2008 & 2009)

Parameter	Typical Range: N. Lakes & Forest Eco-region	Baby Average $\pm$ St. Dev.	Kid Average $\pm$ St. Dev.	Kerr Average $\pm$ St. Dev.	McKeown Average $\pm$ St. Dev.	Man Average $\pm$ St. Dev.	Lost Average $\pm$ St. Dev.
Total Phosphorus-in wtr column (µg/L)[1]		14.0	12.8	19.1	15.8	12.4	44.3
Total Phosphorus-top 2 meters (ug/L)[2]	14 – 27		14.4	15.2	12	11.2	18.7
Chlorophyll *a* (µg/L) mean[2]	4 – 10	4.4	3.2	2.8	2.0	2.8	4.3
Chlorophyll *a* (µg/L) maximum[3]	<15	7.8	7	4	4	5	11
Secchi disc (feet)[4]	8 – 15	13.1 $\pm$ 2.6	13.5 $\pm$ 2.2	15.3 $\pm$ 3.6	15.2 $\pm$ 4.3	12.2 $\pm$ 2.3	14.0 $\pm$ 2.3
Total Kjeldahl Nitrogen (mg/L)	0.4 – 0.75	0.47	No data	No data	No data	No data	No data
Nitrite + Nitrate Nitrogen (mg/L)	<0.01	present	No data	No data	No data	No data	No data
Alkalinity (mg/L)	40-140	No data	No data	No data	No data	No data	No data
Color (Pt-Color units)	10 – 35	No data	No data	No data	No data	No data	No data
pH	7.2 – 8.3	8.3 $\pm$ 0.1	8.3 $\pm$ 0.1	8.5 $\pm$ 0.1	8.6 $\pm$ 0.1	8.5 $\pm$ 0.1	No data
Chloride (mg/L)	0.6 – 1.2	No data	No data	No data	No data	No data	No data
Total Suspended Solids (mg/L)	<1 – 2	1.45	No data	No data	No data	No data	No data
Total Susp Inorganic Solids (mg/L)	<2		No data	No data	No data	No data	No data
Conductivity (µmhos/cm)	50 – 250	290.9 $\pm$ 39.6	303.2 $\pm$ 37.3	285.9 $\pm$ 45.6	241.7 $\pm$ 50.9	263.5 $\pm$ 39.1	No data
Total Nitrogen/Total Phosphorus ratio[5]	25:1 – 35:1	28	22	52	51	49	34

[1] The total Phosphorus shown is that calculated from the lake surface to the lake bottom.
[2] The total Phosphorus shown is from RMB labs for 2008 & 2009.
[3] Chlorophyll *a* mean and maximum is from the 2008 & 2009 samples taken from the top 2 meters.
[4] Secchi disk averages are from readings taken from 1992 to 2008 but the number of years readings were taken varies for each lake as shown on the table on page 12.
[5] The ratio is based on samples taken from 2003 to 2007 and included the total water column.

A third application of these data is to compare phosphorus concentrations to the Minnesota Pollution Control Agency water quality criterion for swimming and other recreational contact. The Northern Lakes and Forests Ecoregion phosphorus criteria level of 30 micrograms per liter (µg/L) serves as the upper threshold for full-support for swimmable use. This concentration corresponds to Carlson's TSI values of 54 or lower.

For the Northern Lakes and Forests Ecoregion, summer-mean total phosphorus concentrations above 35 µg/L were associated with nonsupport of aquatic recreational use. At concentrations above about 35 µg/L mild blooms occur over 50 percent of the summer, nuisance blooms (> 20 µg/L of chlorophyll *a*) about 15 percent of the summer.

Phosphorus concentrations above criteria levels would result in greater frequencies of nuisance algal blooms and increased frequencies of "impaired swimming."

Name	Mean Total Phosphorus (µg/l)	Carlson's Trophic Stratus Index (Secchi)	MPCA Swimming Criterion
Baby	14	41	Full Support
Kid	13	41	Full Support
Kerr	19	40	Full Support
McKeown	16	38	Full Support
Man	12	41	Full Support
Lost	44	40	Non Support

[2] Fully supporting lakes with insufficient data is better than the thresholds based on limited data; however, the lake cannot be assessed as fully supporting for aquatic recreation until more data is collected.

An e.coli study was done in 2007 at the public access and the Kumpula dock. *E. coil* bacteria levels in all samples were low, most below the detection limit of the Petriflim test kit (33 cfu for triplicate plates) and many below detection limit of the MN Valley Testing Lab (1 cfu/100 mls). None of the samples exceeded the one-time *E. coil* standard, nor did or the geometric means, calculated for both sites for the period 7/11/07 — 8/7/07.

Based on the data presented above, Baby, Man, McKeown, Kerr, and Kid Lakes all "fully support" recreational use and contact.

The lake association also conducted a total phosphorus study from 2003 to 2007. This study consisted of collecting water samples from the lakes and from flows between the lakes and over the McKeown Dam. The samples were tested by the Chippewa Testing Lab at Cass Lake, MN.
The preliminary analysis of the data and the conclusions reached were done by John Persell, a scientist for the Leech Lake Chippewa Tribe.
Note: Some Data was not calculated correctly but the general conclusions most likely won't change.

The preliminary conclusions of this study are:

- Most of the phosphorus entering Lost, Kid, Kerr and Baby lakes is from atmospheric sources; loading to Man is dominated by atmospheric deposition and with some tributary inflow; loading to McKeown is dominated by tributary inflow.

- It appears that Man Lake is the lake most likely to accumulate phosphorus over the long term under the conditions measured during this study; this appears to be due to the deep holes in the lake potentially acting as sinks and the small differential between the outflow and inflow

- Potential phosphorus loading due to septic systems appears to be within desirable limits at this time

Preliminary RECOMMENDATIONS from the Total Phosphorus Study

- Collect rainfall samples in two locations in the watershed monthly for the next 12 months to measure total phosphorus as a check on the questionable November 2006 sample.

- Incorporate phosphorus load management into the existing Lakes Association chain of lakes and watershed management plan

- In conjunction with the Cass County Environmental Department and Soil and Water Conservation District, and the Chippewa National Forest, continue to refine and implement best water quality management practices for the chain of lakes watershed

- Advocate with local, State and Federal jurisdictions for pollution controls and soil management practices that minimize atmospheric transport and deposition of phosphorus

- Reassess the chain of lakes phosphorus loading periodically, perhaps every 5 years, assessing several months annually to represent each season over a period of years as was done for this study

2. Fisheries:

In general, our six lakes are typical of the lakes in the Leech Lake Watershed. Bass, Walleyes, Crappies, Northerns, Sunfish, and Muskellunge are the major fish with, Perch, Rock Bass, and Tullibee having various populations depending on the lake.

The MN DNR lake survey summaries include significant discussions on the fisheries of the lakes and are presented in Appendix I. Note that only Baby Lake and Man Lake have summaries that are more recent and the summaries for the other four lakes are from the early 1990's and may not represent current conditions.

3. Aquatic Vegetation

Aquatic Vegetation assessments were developed for Baby Lake in 1995. In 2011, assessments were completed for all six lakes. The detailed assessments are included in Appendix IV.

Aquatic Vegetation – Baby Lake-1995

The MN DNR Fisheries Section from Walker, MN did an extensive fisheries survey in 1995. Appendix IV documents the vegetation survey in detail. The overall assessment of the aquatic vegetation is that Musk grass (Chara), a submergent small plant, is very abundant throughout the littoral zone of the lake. Bulrush, Pondweed, and Lily pads (Water lily), are also common. No exotic vegetation was found in 1995. The substrate material is mostly silt and sand. Gravel is not very common. The overall assessment for spawning habitat is that the extensive stands of Chara provide excellent spawning habitat for Muskellunge. Spawning habitat for Crappie, Bluegill, Largemouth Bass, and Northern Pike is good, while only fair for Smallmouth Bass and Walleye.

Aquatic Vegetation – all six Lakes in 2011:

In **Baby Lake**, fourteen plant types were identified; eight were of the submerged type, four were of the floating leaved type and two were of the emergent type. All of these were native. Plants were distributed to a depth of eighteen feet and 45% of sampled sites contained vegetation. Among all testing sites, the frequency of occurrence of these species was; Bladderwort(1%), Canada Waterweed(1%), Chara(6%), Clasping Leaf Pondweed(1%), Coontail(14%), Flat Stem Pondweed(9%), Illinois Pondweed(2%), Large Leaf Pondweed (2%), Watershield (1%), Floating Leaf Pondweed (1%), White Waterlilly(2%),Yellow Waterlilly (8%), Bulrush (10%) and Wild Rice(1%). Vegetation was most abundant in depths of 1-10 feet.

In **Kerr Lake,** thirteen plant species were identified, eight of these were of the submerged type, three species were of the floating leaved type and two were of the emergent type. Plants were distributed to a depth of twenty two feet and 45% of the sampled sites contained vegetation. Among all testing sites, the frequency of occurrence of these species was; Bladderwort(14%),Canada Waterweed (6%), Clasping Leaf Pondweed (11%), Coontail (31%), Large Leaf Pondweed (17%), Northern Milfoil (3%), Sago Pondweed(3%), Variable Pondweed(3%), Floating Leaf Pondweed(3%), White Waterlilly (4%), Yellow Waterlilly(3%) and Bulrush (3%). Vegetation was most abundant in depths of 6-15 feet.

In **Kid Lake,** ten plant species were identified, seven of these were of the submerged type, two species were of the floating leaved type and one was of the emergent type. Plants were distributed to a depth of sixteen feet and 44% of the sampled sites contained vegetation. Among all testing sites, the frequency of occurrence of these species was; Bladderwort(9%),Canada Waterweed (3%), Chara (3%), Clasping Leaf Pondweed (9%), Coontail (21%), Flat Stem Pondweed (7%), Large Leaf Pondweed (11%), White Waterlilly (4%), Yellow Waterlilly(3%) and Bulrush (3%). Vegetation was most abundant in depths of 1-10 feet.

In **Lost Lake,** eight plant species were identified, five of these were of the submerged type, two species were of the floating leaved type and one was of the emergent type. Plants were distributed to a depth of nine feet and 85% of the sampled sites contained vegetation. Among all testing sites, the frequency of occurrence of these species was; Bladderwort(15%),Canada Waterweed (9%), Clasping Leaf Pondweed (3%), Coontail (48%), Large Leaf Pondweed (12%), White Waterlilly (33%), Yellow Waterlilly(33%) and Bulrush (9%). Vegetation was most abundant in depths of 0-5 feet.

In **Man Lake**, ten plant types were identified; seven were of the submerged type, two were of the floating leaved type and one was of the emergent type. All of these were native. Plants were distributed to a depth of eighteen feet and 37% of sampled sites contained vegetation. Among all testing sites, the frequency of occurrence of these species was; Canada Waterweed(1%), Chara(30%), Clasping Leaf Pondweed(14%), Flat Stem Pondweed(2%), Large Leaf Pondweed (10%), Narrow Leaf Pondweed(1%), Northern Milfoil (8%), Floating Leaf Pondweed (4%), Yellow Waterlilly (1%) and Bulrush (6%). Vegetation was most abundant in depths of 1-10 feet.

In **Mckeown Lake,** ten plant species were identified, seven of these were of the submerged type, two species were of the floating leaved type and one was of the emergent type. Plants were distributed to a depth of fifteen feet and 79% of the sampled sites contained vegetation. Among all testing sites, the frequency of occurrence of these species was; Canada Waterweed (1%), Chara (47%), Clasping Leaf Pondweed (15%), Large Leaf Pondweed (11%), Coontail (3%), Narrow Leaf Pondweed (11%), Northern Milfoil (1%), Floating Leaf Pondweed (20%), Yellow Waterlilly(11%), Bulrush (20%). Vegetation was most abundant in depths of 1-10 feet.

4. Wildlife

The "Blue Book," *Developing a Lake Management Plan* notes that:

> "Minnesota's lakes are home to many species of wildlife. From our famous loons and bald eagles to beavers, muskrats, otters, and frogs, wildlife is an important part of our relationship with lakes. In fact, Minnesota's abundant wildlife can be attributed largely to our wealth of surface water. From small marshes to large lakes, these waters are essential to the survival of wildlife.
>
> The most important wildlife habitat begins at the shoreline. The more natural the shoreline, with trees, shrubs and herbaceous vegetation, the more likely that wildlife will be there. Just as important is the shallow water zone close to shore. Cattail, bulrush, and wild rice along the shoreline provide both feeding and nesting areas for wildlife. Loons, black terns and red-necked grebes are important Minnesota birds that are particularly affected by destruction of this vegetation. Underwater vegetation is also important to wildlife for many portions of their life cycle, including breeding and rearing of their young.

The primary agency charged with the management of Minnesota's wildlife is the Department of Natural Resources, Division of Fish and Wildlife, Wildlife Section. For Baby, Kerr, Kid, Lost, Man, & McKeown Lakes, the DNR Area Wildlife Manager is Gary Drotts, 1601 Minnesota Drive, Brainerd MN 56401. His phone number is 218-828-2314. His e-mail is gary.drotts@dnr.state.mn.us. Pam Perry is the Non-Game Wildlife Specialist, and can be reached at (218) 828-2228, pam.perry@dnr.state.mn.us.

The Minnesota County Biological Survey has completed the survey for Cass County.

The Beaver populations in recent years have been excessively successful on all of our lakes, causing problems with water levels and cutting down an abundant amount of shoreline trees. This is due to low populations of enemies and humans not trapping as the value of Beaver pelts is very low. During the past few years, the Lake Association has contracted with trappers to reduce the Beaver population to more reasonable levels and minimize damage to shoreline trees and maintain more stable water levels.

Invasive Species

Background

"Exotic" species -- organisms introduced into habitats where they are not native -- are severe world-wide agents of habitat alternation and degradation. A major cause of biological diversity loss throughout the world, they are considered "biological pollutants."

Introducing species accidentally or intentionally, from one habitat into another, is risky business. Freed from the predators, parasites, pathogens, and competitors that have kept their numbers in check, species introduced into new habitats often overrun their new home and crowd out native species. In the presence of enough food and favorable environment, their numbers will explode. Once established, exotics rarely can be eliminated.

Most species introductions are the work of humans. Some introductions, such as carp and purple loosestrife, are intentional and do unexpected damage. But many exotic introductions are accidental. The species are carried in on animals, vehicles, ships, commercial goods, produce, and even clothing. Some exotic introductions are ecologically harmless and some are beneficial. But other exotic introductions are harmful to recreation and ecosystems. They have been caused the extinction of native species -- especially those of confined habitats such as islands and aquatic ecosystems.

The recent development of fast ocean freighters has greatly increased the risk of new exotics in the Great Lakes region. Ships take on ballast water in Europe for stability during the ocean crossing. This water is pumped out when the ships pick up their loads in Great Lakes ports. Because the ships make the crossing so much faster now, and harbors are often less polluted, more exotic species are likely to survive the journey and thrive in the new waters.

Many of the plants and animals described in this guide arrived in the Great Lakes this way. But they are now being spread throughout the continent's interior in and on boats and other recreational watercraft and equipment. This guide is designed to help water recreationalists recognize these exotics and help stop their further spread.

The most significant exotic species currently in our lakes is the Rusty Crayfish. This species is currently being studied in Leech Lake. Rusty Crayfish are prolific and can severely reduce lake and stream vegetation, depriving native fish and their prey of cover and food. They also reduce native crayfish populations.

In 2017, another exotic species, **Banded Mystery Snails** was found in Baby Lake near the public access.. This is not considered a significant threat

The description of other exotic species is presented in Appendix III. **The Eurasian Watermilfoil, Zebra Mussels, Spiny Water Flea, and the Starry Stonewort are those that can cause significant impacts to our lakes.**

6. Land Use and zoning

The water quality of a lake or river is ultimately a reflection of the land uses within its watershed. While the specific impacts to a lake from various land uses vary as a function of local soils, topography, vegetation, precipitation, and other factors, it is ultimately the land uses which citizens have the most control over through prudent zoning

Many zoning regulations are based upon the Shoreland Management Act and/or the Minnesota Department of Natural Resources (DNR) classification of a given lake. The DNR has classified all lakes within Minnesota as General Development (GD), Recreational Development (RD), or Natural Environmental (NE) lakes, and assigned a unique identification number to the lake for ease of reference. Counties in turn have used these classifications as a tool to establish minimum lot area (width and setbacks) that is intended to protect and preserve the character reflected in the classification.

On any shoreland the permissible density and setbacks for virtually all new uses are determined by the lake or river classification standards established by the Department of Natural Resources. **Baby** (ID #11-0283), **Man** (ID#11-0282), **McKeown** (#11-0261), and **Kid** Lake (ID#11-0262) **are all classified as Recreational Development (RD) lakes**, while **Kerr** (#11-0268) **and Lost Lake** (#11-0269) **are classified by Cass County as Natural Environment (NE) Lakes**.

Natural Environment lakes are generally small, often shallow lakes with limited capacities for assimilating the impacts of development and recreational use. They often have adjacent lands with substantial constraints for development such as high water tables, exposed bedrock, and unsuitable soils. These lakes, particularly in rural areas, usually do not have much existing development or recreational use. In Cass County, an NE management district is "established to preserve and enhance high quality waters by protecting them from pollution and to protect shorelands of waters which are unsuitable for development; to maintain a low density of development; and to maintain high standards of quality for permitted development."

Recreational Development lakes are generally medium-sized lakes of varying depths and shapes with a variety of landform, soil, and ground water situations on the lands around them. They often are characterized by moderate levels of recreational use and existing development. Development consists mainly of seasonal and year-round residences and recreationally-oriented commercial uses. Many of these lakes have capacities for accommodating additional development and use. In Cass County the RD management district is established to “managed proposed development treasonable consistent with existing development and use; to provide for the beneficial use of public waters by the general public, as well as the riparian owners; to provide for multiplicity of lake uses; and to protect areas unsuitable for residential and commercial uses from development.”

General Development lakes are generally large, deep lakes or lakes of varying sizes and depths with high levels and mixes of existing development. These lakes often are extensively used for recreation and, except for the very large lakes, are heavily developed around the shore. Second and third tiers of development are fairly common. The larger examples in this class can accommodate additional development and use. Cass County’s Shoreland Ordinance notes that “the GD management district is established to provide minimum regulations in areas presently developed as high density, multiple use areas; and to provide guidance for future growth of commercial and industrial establishments which require locations on protected waters.”

In Cass County the zoning standards associated with each water body class are:

	SINGLE FAMILY RESIDENTIAL			**WITH GUEST QUARTERS**		
Lake Classification	Min. Lot Area (ft^2)	Min. Lot Width	Min. Buildable Area (ft^2)**	Min. Lot Area (ft^2)	Min. Lot Width	Min. Buildable Area (ft^2)**
General Development - Riparian	30,000	100'	12,000	60,000	180'	27,000
General Development -Non-Riparian	40,000	150'	20,000	80,000	265’	40,000
Recreational Development-Riparian	40,000	150’	16,000	80,000	225’	40,000
Recreational Development-Non-Riparian	40,000	150’	20,000	80,000	265’	40,000
Natural Environment-Riparian	80,000	200’	40,000	120,000	300’	60,000
Natural Environment-Non-Riparian	80,000	200’	40,000	160,000	400	80,000

Most lakes have numerous properties that are “grandfathered,” or developed prior to the establishment of these restrictions. In general, these pre-existing uses are allowed to remain unless they are identified as a threat to human health or environment, or are destroyed by natural, accidental causes or in association with significant renovation.

The standards in the above table only cover general dimensions and the County Shoreland Ordinance is much more detailed on every aspect development including vegetation and clearing requirements. Cass County has a web site which offers helpful contact information regarding planning and zoning matters: http://www.co.cass.mn.us/index.html. Details on shoreland standards and restrictions and answers to “frequently asked questions” regarding best management practices, resources of education or information, and additional assistance are provided through the Environmental Services Department and Planning and Zoning Department linkages. One may also download an excellent guide, “*Welcome to Cass County: An Environmental Resources and Services directory for residents and businesses*” from this site.

Additional questions may be directed to: Environmental Services Department, County Courthouse, 1st Floor, and 300 Minnesota Avenue. P.O. Box 3000, Walker, MN 56484-3000, Phone: 218-547-7241, Fax: 218-547-2440

Another aspect of zoning is the requirements for sanitary systems. Currently, it is estimated that at least 90% of the septic systems on shoreline properties meet current standards. Those that don't can have negative impacts to the quality of our lakes and groundwater. Lake properties around our lakes have a variety of on site sanitary systems. A few were installed many years ago and may not meet current standards. The septic tanks installed prior to the 1970's usually were not reinforced concrete units and many would leak and some systems only had cesspools (or septic tanks flowing to cesspools) which did not treat the sanitary wastewater as they generally were dug too deep in the ground. The major problem with the drainfield portion of any sanitary system installed before 1996 is that no soil borings were required. The soil borings provide more specific information about the soil characteristics at the soil absorption site. Every system not meeting current standards could be introducing disease causing pathogens to the environment, particularly the ground water.

Another impact of non-conforming sanitary systems is the nutrients they discharge into the groundwater. The nutrient nitrogen is hazardous to our drinking water if the concentration is too high. The nutrient phosphorous can have negative impacts to our lakes. Most lakes are phosphorous limited, meaning that any additional phosphorous will directly result in the growth of plant life in the form of algae or weeds. Too much algae and weeds will reduce the available dissolved oxygen for aquatic life, which can reduce aquatic species or change the type of species that occupy our lakes. Excessive algae and weeds can also reduce the quality of our lake water for human recreation.

7. Managing water surface use conflicts

The goal of lake management is to ensure that the lake can continue to provide the benefits that attract homeowners and users. However, conflicts among uses arise almost invariably. Successful resolution of conflicts lies in the ability of the users to work collaboratively to arrive at acceptable compromises.

The primary agency responsible for managing surface water use conflicts is the Minnesota Department of Natural Resources, Bureau of Information and Education. The Boat and Water Safety Section within the Bureau oversees surface water use and is in charge of administering the Water Surface Use Management (WSUM) program. The goal of this program is to enhance the recreation use, safety and enjoyment of the water surfaces in Minnesota and to preserve these water resources in a way that reflects the state's concern for the protection of its natural resources.

Within this context, any governmental unit may formulate, amend or delete controls for water surface use by adopting an ordinance. Submit the ordinance for approval by the MDNR Boat and Water Safety Coordinator by calling 1 (800) 766-6000 or (651) 296-3336. To gain approval the ordinance must:

- Where practical and feasible accommodate all compatible recreational uses;
- Minimize adverse impacts on natural resources
- Minimize conflicts between users in a way that provides for maximum use, safety and enjoyment, and
- Conform to the standards set in WSUM Rules.

8. Public water access

Research has shown that Minnesotans rely heavily upon public access sites to access lakes and rivers. A 1988 boater survey conducted by the University of Minnesota showed that three-fourths of the state's boat owners launch a boat at a public water access site at least once a year. In addition, over 80 percent of boat owners report using public water access sites for recreation activities other than boating.

The primary agency responsible for pubic water accesses in Minnesota is the Minnesota Department of Natural Resources, Trails and Waterways Unit. They are responsible for the acquisition, development and management of public water access sites. The DNR either manages them as individual units or enters into cooperative agreements with county, state, and federal agencies, as well as local units of government such as townships and municipalities. The DNR's efforts to establish and manage public water access sites are guided by Minnesota Statutes and established written DNR policy. The goal of the public water access program is free and adequate public access to all of Minnesota's lake and river resources consistent with recreational demand and resource capabilities to provide recreation opportunities.

Baby Lake has a public access in Tusler's Bay on the east shore. According to Minnesota Department of Natural Resources Fisheries Survey, there are some limited private accesses on Baby, Man, McKeown, Kid, Kerr and Lost Lakes:

Lake	**Ownership**	**Type**	**Description**
Baby	DNR	Concrete	East shore
McKeown	Unknown	Unknown	Small boat channel from Man Lake.
Kerr	Unknown	Unknown	--
Lost	Unknown	Unknown	Private homes and from Kid Lake.

9. Organizational Development and Communication

Summary of the initial lake management plan developed in 2002:

The lakes and the watershed are generally in a healthy condition. However, there are signs of deteriorating water quality and conflicts in surface water use. Also, continued development of the watershed is putting increased pressure on all of the natural resources available to humans as well as all other flora and fauna. If the flora and fauna decrease, this has a negative affect on the reasons why we enjoy our properties.

The collection of water quality data over the past eight years has only established a base of information from which to compare future data collection, so continued data collection is deemed necessary to worn us of any future changes that could be detrimental to our lakes and watershed. Another indication of water quality deterioration is from long time owners. Some long-term owners definitely recall that Lake Water was clearer thirty years ago than what we have now.

Another possible negative impact to water quality is the increased usage of on site wastewater treatment systems. Systems fully conforming to today's standards can discharge about one milligram per liter of total phosphorus to the groundwater and ultimately to our lakes. Non-conforming systems can discharge up to 40 times the amount that good systems discharge. The same impact on our drinking water can come from the discharge of nitrates to the groundwater. Fully conforming systems can discharge up to 40 milligrams per liter of nitrates to the groundwater while non-conforming systems can discharge up to 150 milligrams of nitrates to the groundwater. The vast amount of groundwater available will greatly dilute this impact from nitrates but shallow wells that are close to non-conforming systems may be impacted. Thus, with greatly increased usage of our wastewater systems by more leisure time available to more persons, it is imperative that non-conforming systems be abandoned and new systems installed.

With increased development and more leisure time available for most property owners, water surface usage has definitely increased and there are increased conflicts between the types of usage.

An important item recognized in the 1995 update to the Cass County Comprehensive Local Water Management Plan is Aquatic Habitat and Water Quality Protection. Among the ten items included for the county are some items that the lake association can participate in such as: the purchase of critical shoreline areas; Conservation easements on shoreline; and no-wake zones for critical habitat areas. Our lakes may have critical or very important areas to consider for non-development to minimize the impacts of further development. The Leech Lake Watershed Project provided a significant benefit to our lakes by the purchase of a peninsula of land between Lost and Kid Lakes. Another important benefit was the creation in 2004 of a wildlife management area on the NW corner of Man Lake. Jack and Betty Thomas, shoreland property owners on Man Lake, donated about 14 acres of land including about 465 feet of shoreland which is now managed by the MN DNR.

The Lake Management plan developed in 2002 included the following recommendations:

- **Support the DNR fisheries** in continued stocking of Baby Lake.
  A) Implementation Date: Ongoing.
  B) Cost: $0.00,
  C) Volunteer Labor: Help DNR when needed.

- **Status:** The DNR continues to stock Baby Lake with Walleyes every other year. This has been a very successful program as the Walleye fishing has been very good.

- **Support and pursue the non-development of important shoreline areas** around our lakes to maintain the quality of our lakes and watershed.
  A) Implementation Date: February 2001 for the possible non-development of the McKeown Lake peninsula.
  B) Cost $150,000 to $300,000. McKeown Peninsula
  C) Volunteer Labor: Initially to coordinate with the Leech Lake Watershed Project for starting the process, and then establish committee of property owners to actively pursue all necessary details to complete the acquisition.

- **Status:** The developer didn't give the lake association enough time to get into the process and the property was platted and sold to individual property owners.

- **Sponsor testing of drinking water** for all property owners to maintain the health of our property owners.
  A) Implementation Date: Fall, 2001.
  B) Cost: $50.00 to $300.00 per year.
  C) Volunteer labor: Send letters, set up collection stations, record and distribute results.

- **Status:** The lake association sponsored the free testing of drinking water in 2003 with a grant from the Initiative Foundation. Only 40 property owners took advantage of this opportunity so the lake association put this item on hold.

- **Become a member of the Minnesota Lakes Association** to obtain the benefits of their programs for lakes and the well being of Lake Property owners, and to provide a means for online communications with our online property owners.
  A) Implementation Date: Fall, 2001
  B) Cost: $150.00 per Year
  C) Volunteer Labor: Apply for membership, provide data for Website.

- **Status:** The lake association has been a member every year (Minnesota Lakes Association is now the Minnesota Waters). A Website was also set up accessible to all property owners.

- **Develop a program of testing our lake water** for total phosphorus and chloroform A to determine the Trophic status of our lakes. This is an improved method over the collection of Hydrolab and Secchi disk data. Continue the collection of Hydrolab and Secchi disk data as this is relatively inexpensive and provides broader information about our lakes.
  A) Implementation Date: Year 2002.
  B) Cost: $1,000 to $2,000 per year. The association is currently collecting water samples every two years.
  C) Volunteer Labor: Set up and collect water samples.

- **Status:** The lake association conducted a several year study of the Phosphorus Budget of all six of our lakes and a preliminary report was finished in 2008. In addition, the lake association is participating in the collection and analysis of Phosphorus and Chloroform A for all six lakes. A grant from the Initiative Foundation is paying for most of the cost. The current program includes the collection of 5 water samples from June to September by our members.

- **Sponsor the inspection of lake property owners on site wastewater systems** to reduce the impacts of non-conforming systems.
  A) Implementation Date: Year 2002
  B) Cost: $15,000 to $20,000

- **Status:** In 2003, a total of 194 septic systems were inspected and 45 were determined to be in non-compliance. The cost was from a grant by the Initiative Foundation. At this time, over 90 percent of the systems on our lakeshores of our six lakes are in compliance.

Summary of Visioning/Planning Session - 2008

A Visioning session was held on August 1, 2008, @ the Woodrow Township Hall. The meeting was announced in the association newsletter and also by a separate mailing closer to the meeting date. The turnout was minimal but there was a very lively discussion of goals and possible achievements that the lake association could accomplish in the next 3 to 5 years.

The management plan committee discussed the past and current success of the lake association such as continued monitoring of our lakes which showed good water quality; no invasive species except for the Rusty Crayfish which doesn't have significant impacts currently identified; fairly good fishing with Walleye fishing on Baby Lake considered excellent.

Several possible goals for the lake association were considered and three that were identified as the most important were:

- **Continued Water Quality Monitoring**
- **Invasive Species Plan of Action**
- **Fisheries Management Plan**

Other organizational or community assets identified which could provide assistance, support, or programs that would be beneficial included:

- MPCA
- DNR Fisheries of Walker, MN
- Cass County Soil & Water Conservation District
- Walleye Collalition
- ACCL

Prioritized Goals and Action Plan

The final chapter of our lake management plan summarizes the conclusions and priority action we have chosen to work on at this time. Specifically, for each priority action we have done our best to answer (for each goal presented):

- What are the criteria for measuring success (measured as outcomes, not effort)?
- What is our schedule for implementation (What should happen in the next 30 days, 60 days, one-year out)?
- Who is responsible for implementation or measurement (name names!)?
- What is the budget for this action/goal?

- Is this an on going action/goal, or a one-time effort? If on-going will we require additional funds for full implementation?

Through the healthy lakes program, the lake association has identified three areas that need to be developed into a current action plan (also identified in the Visioning Session):

1. **Invasive Species**
2. **Fisheries management**
3. **Water Quality monitoring**

Aquatic Invasive Species (AIS) Prevention/Management Plan

Purpose:

- To educate all lake users on AIS prevention techniques
- To have a process in place for early identification of potential problems including periodically monitoring for the presence of invasive aquatic plants or species
- To have an action plan in place to quickly mobilize resources to deal with an "invasion"

Phases of the Plan:

- Prevention
- Early Detection
- Rapid Response
- Containment
- Management

Prevention:

The prevention phase primarily relies on education and awareness initiatives focused on two sets of lake users 1) Lakeshore Property Owners on our six lakes, 2) People who use our lakes (accessing our lakes from public ramps, resort ramps, non-public ramp areas, guests of lake owners that fish from private docks or onboard their boats).

During the Prevention phase, preparation will take place for the other phases of the AIS Plan. If an "invasion" happens, it is critical to have several preliminary steps completed in order to effectively mitigate the potential harm that could occur. In order to obtain state DNR grants to contain and/or manage the "invasion" situation, a baseline study/inventory of aquatic vegetation (Lake Vegetation Management Plan – LVMP) must be completed. This means that in order to obtain a grant(s) to contain the spread of AIS our Association must first have this type of study conducted. Using an anticipatory planning approach, the Association will fund and/or seek grants/donations to complete an LVMP on all six lakes. Because of the expense associated with the aquatic vegetation inventory a "risk factor" approach will be used to determine the order of lakes to undergoing the inventory. The initial inventory process will begin on Baby with the other lakes in this order; Man, McKeown, Kerr, Kid, Lost lakes. The risk-criteria are based on the following factors: the presence of the public access, resort or private access points, volume of water flowage and connections between lakes. Susceptibility for infection and rapid spreading are key concerns.

Secondly, the Association will evaluate its financial capability to participate in the DNR AIS inspection program. The Association would need to provide matching dollars for hiring a part-time DNR trained staff to monitor for AIS at the Baby Lake public access. Prior to initiating this actions, during 2009 and every year thereafter, the Association's executive committee will seek partnerships with other area lake associations to get their commitments to jointly fund/hire a part-time DNR intern to monitor all of the respective lakes' public accesses. Note that the DNR matching grant applications are due in the fall of the year and are awarded each year in January based on availability of funding. A new grant application must be filed annually.

Thirdly, the Association should work to establish an AIS emergency fund of $30,000 to ensure it has resources to secure a matching DNR grant if an infection occurs. Other lake associations experiencing an AIS event have determined that a rapid containment/elimination effort using DNR matching funding has been delayed or stalled because the lake association wasn't able to rapidly provide the required matching funding.

Fourth, the Lake Association will be a member of organizations like the Association of Cass County Lakes that actively monitors the AIS issue and educates their members about AIS regional issues.

Lake Owners Education Programs/Initiatives (involving members and non-members):

- Ongoing publication of education oriented articles in the Lake-Link newsletter
- Guest Speakers at Annual Membership Meetings
- AIS oriented DNR brochures distributed to lake owners' launching boats in the spring
- Volunteers recruited to "meet and greet" boat ramp uses on high volume times, such as opening weekends of walleye, bass, and muskies, or on holidays and tournament events.
- **Note:** since 2014, Cass County is receiving a yearly AIS grant and has hired and trained AIS inspectors. The Baby Lake public access has had Cass County inspectors there during significantly active periods.
- Install additional AIS warning signage along all major township roads leading to our lakes – periodically changing the signage for a newer/fresher looking signs.

Non-Owners/Lake Users/Resorts

Public and Private Boat Ramps: With Association volunteers or hired DNR monitors, periodically check boat trailers for any aquatic plants or species, post DNR provided notices on windshields, visit with lake users to inform them about concerns for AIS, prior to launch inquire regarding other lakes they have visited recently to assess risk and inform them of potential infections coming from those lakes

Resorts: The Baby and Man Lake Representatives will annually visit the resorts to encourage cooperation in our AIS program. AIS signage will be offered/provided by the Association. Each year, the Lake Reps. will request that resort owners distribute at check-in new/updated DNR AIS educational materials to each of their guests bringing personal boats. Also to provide educational materials to other resort guest that might bring back bait buckets from other lakes (concern for transporting infected water back to our lakes).

Area Bait Stores:

Lake owners should check for educational signage at area bait stores regarding AIS bait water transfer issues. If signage is displayed, thank the store owner. If signage isn't present, request that the owner display an educational sign.

Road Signage on area lakes regarding AIS:

An updateable sign identifying all area/regional infected lakes to alert our lake uses about lakes they may occasionally visit/fish on.

Early Detection/Monitoring Program:

Working with DNR Aquatic staff, provide on-going education for a core group of Lake Association members to act as “first lookers.” Publish the names of the “first lookers” in the Lake-Link as people on our lakes to contact in case someone is concerned.

Rapid Response:
Notification of DNR of Suspected Infection
The “first looker” or any lake resident should call the Association President regarding a suspected infection. The President of the Association will notify the following DNR staff regarding a concern regarding a potential infection. DNR staff to be contacted include:

Confirmed Infection - Notification of Association Board/Lake Owners/Lake Users/Resort Owners
Using road signs, The Lake-Link, or special mailed notice, volunteers at public access notify all uses about the infection.

Containment:
If an infection has occurred, the President will call an emergency Association Board Meeting to present what is know about the situation and possible courses of action recommended by the DNR.

The Board may delegate to the Executive Committee or may establish a special committee to streamline decision-making regarding the best course of action to take regarding the infection.

If appropriate based upon the type of infection, the Association’s Board will seek grants from the DNR or other entities to contain or eliminate the infection.

Management:
The Association’s Board will evaluate and recommend to the membership the best course of action to deal with ongoing management related to the infection. This might include establishment of a special government district, collaboration efforts with the Township, County or State.

<u>Accomplishments To Date:</u>

Membership Newsletter Articles Published in 2008, 2009, Ongoing

- Ongoing President’s Message and articles in the newsletters emphasizing the issues surrounding AIS.
- The need for the members to be vigilant about following the appropriate AIS protection measures with their own watercraft and bait practices and to inform their guests of the same
- Awareness of other area lakes that are infected
- To support the Association’s AIS plan development and implementation process
- **Volunteers at Baby Lake Public Access 2007, 2008, 2009 and ongoing**
- In 2007 resident members living close to the Baby Lake public access requested and received AIS prevention publications and flyers from the DNR
- These members talk with access users regarding AIS best practices, distribute AIS information to boaters, and pick weeds off trailers and place on windshields of careless individuals (with personalized notes on the DNR flyers regarding their careless actions)
- To continue this effort, a grant request will be developed in the fall of 2009 to seek matching funding to support the periodic presence of a DNR trainee at the public access

AIS DNR Speaker at Annual Meeting

- At the 2009 meeting a DNR AIS speaker gave an update of AIS issues in our region

- The speaker also encouraged the organization to consider using matching funds and seek a DNR grant to hire part-time AIS trained interns to be present at the Baby Lake public access to supplement the volunteer's efforts especially at peak use times i.e. fishing tournaments, season openers, etc.

Distribution of AIS Publications to Membership

- The President of the Association requested and received from the DNR a variety of AIS publications to be distributed to the membership
- These were distributed at the 2009 Annual Meeting and maybe included in future newsletters.

Membership/Participate in the Association of Cass County Lakes (ACCL)

- Members attend the ACCL meetings where ongoing AIS area updates are reported
- Also where DNR AIS staff and private citizens present information related to the topic

AIS Plan Has Been Developed and Implemented

- In 2009 the Association developed a Prevention/Management AIS Plan as part of the Healthy Lakes Initiative.
- Plan was adopted at the fall Board of Director's meeting for immediate implementation.
- The Board of Directors established a Standing Committee of the Board to oversee the ongoing improvement and implementation of the AIS Plan. **Currently, this committee is not functioning since the then AIS chairman has moved from the lake.**

Recommendations:

Collaborate with other area lake associations to seek matching funding from the DNR to hire a person trained in AIS watercraft inspection to monitor public landings on area lakes.

Fisheries Management Plan:

Purpose:

To establish groups of residents from each Association lake to develop and implement plans to sustain and improve the diverse fish populations (from plankton to trophies)
in their lake.

Current Status: this plan has not been successfully implemented as not enough willing participants have volunteered.

Phases of the Plan

- Identification of interested people and forming committee
- Identify issues affecting the specific fishery
- Develop plans to resolve the issues and if appropriate present the plans to the Board of Directors
- If additional resources are needed beyond the Association's capacity, the committees will work with the Board to seek these resources

Structure:

Each lake will establish a Fisheries Advisory Group of 2 or 3 people to serve as that lake's advisory/planning group (one could be the lake representative). Each lake advisory group should occasionally meet to discuss goals, objectives and develop plans (if warranted) for their specific lake.

One or more representative from each lake's Fisheries Management Advisory Group is a member of the Board's Standing Committee on Fisheries Management

Lake plans will be reviewed by the Board's Fisheries Management Committee and it will develop recommendations to be presented/discussed periodically at the Board's regularly scheduled meetings.

Planning Suggestions/Process:

Establish a written Fisheries Management Plan for each lake. (Example of what the plan could contain:

- a multi-year study of the status report of the lake;
- Aquatic vegetation and substrate surveys to determine the existing suitability for what types of fish.
- A clear statement of desired outcomes i.e. what needs to be done, by when, by who, and what are the desired results?;
- develop recommendations for single solution or multiple actions as needed;
- identify potential outside resources that could be partners;
- determination of how long it would take and the amount of resources necessary to see the desired results, i.e. what Association or other resources or funds are necessary?

Request that the DNR do a fish population count on each lake every several years to establish a baseline (more frequently then is the current practice). **To date, the DNR fisheries is only doing fish populations on lakes with public accesses & those lakes directly connected, so only Baby and Man lake qualify.**

In conjunction with other lakes' Fisheries Management Advisory Groups, meet with the local DNR's fish management specialist. **(Meetings have occurred periodically).**

Circulate published articles about new findings in effective Fisheries Management within the various advisory groups and submit ideas to the *Lake-Link* newspaper editor.

Determine whether a creel count is scheduled and/or would be beneficial for assessing the lake's status.

With lake property owners and association members, assess whether any special type of restrictions should be imposed or lifted on the lake, i.e. limit of 4 walleyes, slot limits, no-spearing regulations, reduction of Muskie harvest size to 38 or 39 inches & request stocking of the Leech Lake Strain to reduce the impact of the Shoepack Lake strain stocked in the 1970's, sunset the catch and release program, or other proven fisheries management practices.
With the assistance of outside experts, determine where sensitive spawning areas are located and evaluate ways to improve spawning areas or more effectively protect them.

Determine the level of each lake's owners' interest in supporting various initiatives that might affect fishery management of their lake.

Work with lake property owners to seek ways to reduce land water runoff and/or improvement of shoreline native plant management to improve water quality.

Promote and education landowners and others who fish on a lake about the best ways to help survival rates and increase the success of the Catch and Release Program.

Track/chart the changes in fish population and compare them to the lake's classification – where does the lake fit percentage wise in various species of fish with other similar classified lakes.

If a fisheries management change is desired/warranted, establish a plan of the various methods that might increase the species population in the lake and an estimate of the cost to implement the plan.

Review specific plans with the Board's Standing Committee on Fisheries Management and present the specific lake fisheries management plans to the Board of Directors for review and approval.

If a grant, donation or other outside funding is being sought, coordinate all requests through the Board to eliminate the potential of several lakes approaching the same funding source. It may be possible to package requests so that all lakes benefit.

Before specific requests are made to the DNR from individual lakes, lakes will work through the Standing Committee Chair for coordination purposes – so the DNR isn't confused by multiple Association members contacting them and to ensure that good multi-lake planning is taking place.

Accomplishments to Date:

- The Lakes Association was originally formed because of the deteriorated fishery status of Baby Lake and over time grew to include the 6 lakes in the watershed.
- A group of Baby Lake land owners worked with local and state officials to establish a public landing with the agreement that the DNR would periodically stock walleyes.
- At the 2008 Membership Annual Meeting, members voted to pay for two walleye stockings over a three year period on Man Lake.
- In 2012, the DNR Musky study of Baby and Man Lake was presented to the members at the annual lake association meeting and also included in the Lake Link newsletter. 3 lake association directors met with the DNR Fisheries manager and Lake Specialist to discuss the study. The DNR is going to wait until 2018 to determine if further fisheries actions are warranted.

Water Quality Management Plan:

Purpose:

Monitor various water quality parameters to become aware of potential problems.
Conduct various water quality studies that provide insight to the quality of our lake water.

Phases of the Plan:

Monitoring
Update previous water quality studies
Conduct additional assessments that provide further details of our lakes water quality

Monitoring:

The monitoring of various water quality parameters such as Secchi Disk, Phosphorus, and Chlorophyll "a" can be used to develop the Trophic Status Index (TSI). This value tells where our lakes are with regard to the potential for algal productivity. Continuous monitoring of these values also tell whether the lake water quality is changing and can be an indicator of potential problems.

Secchi disk readings have been taken for several years and this effort needs to continue. Only Kid and Lost Lakes have Secchi disk records for less than eight years and it is important that a record of 8 to 10 years be established to evaluate any trends in the values. The other four lakes have records that establish that they are stable for now and may even be improving with regard to water clarity which is viewed as being healthy. The lake association will continue to take Secchi Disk readings during the months of May to October each year as part of the Minnesota Pollution Control Agency's Citizen Lake Monitoring Program.

In 2008 and 2009, the lake association participated in the Initiative Foundation's (IF) Lakes Monitoring Program which involves the collection of water samples from the top 6 feet of the lake depth for analysis by RMB Labs from Detroit Lakes, MN. Five samples from each lake are collected during the months of June to September. The samples are analyzed for total phosphorus and chlorophyll-a. These values are then used to calculate the lakes TSI. The MPCA is doing the sampling for Baby Lake. The lake association should continue to participate in this program.

Update of past studies:
The lake association undertook a study of the Phosphorus loading in our six lakes and the rainfall analysis included one unusually high value of total phosphorus and created an uncertainty of the results. An attempt was made to get additional rainfall samples analyzed but the laboratory doing the work has closed. The background data for the Phosphorus loading study has now been received and needs to be reviewed to either confirm the accuracy or revise the loading calculations. The samples of Phosphorus from the 2008 & 2009 program can also be used to compare to the Phosphorus loading study. The rainfall value in question was November 2006 rainfall. The original study was initiated in 2003 and was not completed until 2007 because additional sampling of flow between the lakes was deemed necessary.

Conduct additional assessments:
The IF Lake Monitoring program currently underway as detailed above and the lake data collected and computed by the lake association for the Phosphorus Budget study leads to having data for another program by the MPCA; the Lake Assessment Program (LAP). Accordingly, the lake association has requested that the MPCA do a LAP for all 6 lakes in our association. They have tentatively agreed to do that using the two years of water samples collected in 2008 and 2009, plus the data that the lake association has calculated involving lake volumes, shoreline length, surface area, and littoral surface area. The LAP was completed in 2010. The LAP will give us another evaluation of our lakes quality by knowledgeable MPCA staff.

In summary, the lake association should do the following;

- **Continue Secchi disk readings for all of our six lakes.**

- **Continue to participate in the collection of water samples for analysis of total phosphorus and chlorophyll-a. (Note: for 2010, Kid & McKeown Lakes qualify for the MPCA grant but the other four lakes in our association will cost about $200 to $250 each). The lake association is currently participating every other year as costs are about $1500 to $2000 per year for all six lakes.**

- **Collect water samples and flow data for outlet flows from each lake in our association and from McKeown Creek at a cost of about $2000 per outlet. Our existing data is not sufficient to get a good analysis. Note; this has not been implemented to date.**

- **Get some additional rainfall samples to use in reviewing the Phosphorus Budget study.**

Appendix I
DNR Lake Survey summaries

Status of **Baby Lake**, according to the MN Dept. of Natural Resources fisheries summary (**2012**):

. Baby Lake is a 705 acre lake located near Hackensack, Minnesota that has 11.73 miles of shoreline and a maximum depth of 69 feet. There is a state owned public access on the southeast shore. The Minnesota Department of Natural Resources (MNDNR) has classified Minnesota lakes into 43 different classes based on physical, chemical, and other characteristics. Baby Lake is in Lake Class 23; lakes in the class are generally deep and very clear lakes. Baby Lake is managed primarily for muskellunge,
smallmouth and largemouth bass, with secondary species being northern pike, bluegill, black crappie, walleye, yellow perch and cisco (tullibee).
Muskellunge were specifically targeted during spring 2012. Lengths of fish caught ranged from 17 to 45 inches, with catch rates above the long term goal for Baby Lake. Using a mark-recapture design, the muskellunge population of 30.0" and longer fish was estimated to be 2.9 fish per acre. Abundance of smallmouth and largemouth bass was the highest observed to date. Smallmouth bass ranged in length from 9 to 20 inches and averaged 13 inches overall. Largemouth bass lengths ranged from 5 to 16 inches and averaged 9 inches. Walleye numbers are lower than the historic high found in 2006, but are within the average for Lake Class 23. Two strong year classes of age-4 and age-2 fish were observed, and the majority of age-4 fish were 15 inches at the time of this survey. Overall, the average length of walleye sampled was also 15 inches and fish up to 24 inches were captured. Northern pike catch rates were similar to previous surveys and lengths ranged from 16 to 31 inches. . Yellow perch numbers were also similar to previous surveys and lengths ranged from 5 to 10 inches. Black crappie and cisco numbers were very low with only 5 black crappie and 2 cisco sampled in 2012. Bluegill catch rates and sizes are also on the lower end of the averages for lake class 23.
Other fish species that are available to anglers are bowfin (dogfish), hybrid sunfish, pumpkinseed sunfish and rock bass.
People can have significant impacts on lakes and the fish populations they support. Harvest, lakeshore development, removal of shoreline vegetation, and introductions of invasive species can all adversely affect fish populations. Currently the only aquatic invasive species (AIS) that has been identified in Baby Lake is the rusty crayfish. AIS are moved from infested to non-infested waters by anglers, boaters, and lake shore owners and can adversely impact lakes and fish populations. To avoid spreading AIS, lake users are required to remove all aquatic plants or animals from their watercraft and drain all water from their boat before leaving the access. If you suspect an infestation of an invasive species in this lake, save a specimen and report it to a local natural resource office. Additional information on all of these topics can be found on the DNR website (www.dnr.state.mn.us) or by contacting the Walker Area Fisheries office.

Shoreline areas on the land and into the shallow water provide essential habitat for fish and wildlife that live in or near Minnesota s lakes. Overdeveloped shorelines can’t support the fish, wildlife, and clean water that are associated with natural undeveloped lakes

Shoreline habitat consists of aquatic plants, woody plants and natural lake bottom soils. Plants in the water and at the water s edge provide habitat, prevent erosion and absorb excess nutrients. Shrubs, trees, and woody debris such as fallen trees or limbs provide good habitat both above and below the water and should be left in place. By leaving a buffer strip of natural vegetation along the shoreline, property owners can reduce erosion, help maintain water quality, and provide habitat and travel corridors for wildlife.
Baby Lake is the only lake in the lake association that has a planned fish stocking program. The lake is stocked with walleye fingerlings every even year, usually in October.

Status of **Man Lake,** according to the MN Dept. of Natural Resources fisheries summary (**September 3, 2013**)

Man Lake is a 445 acre lake located between Longville and Hackensack, Minnesota.

Man Lake has 4.5 miles of shoreline and a maximum depth of 93 feet. There is no public access on the lake; however anglers using small, low-profile boats may access the lake through the inlet channel from Baby Lake. The Minnesota Department of Natural Resources (MNDNR) has classified Minnesota lakes into 43 different classes based on physical, chemical, and other characteristics. Man Lake is in Lake Class 23; lakes in the class are generally deep and very clear lakes. Man Lake is managed primarily for Muskellunge, Smallmouth Bass and Walleye, and secondarily for Largemouth Bass, Northern Pike, Bluegill, Black Crappie, Yellow Perch, and Cisco (Tullibee).

Three Muskellunge were sampled during the 2013 summer netting; however, targeted sampling in 2012 sampled 46 Muskellunge ranging in length from 34.5 to 50.3 inches. Smallmouth Bass were abundant in the 2013 assessment with fish from 10 to 20 inches were sampled and averaged 15 inches long. The catch rate for Walleye was higher than in most lakes in this Lake Class. Walleye ranged in length from 14 to 30 inches, with most fish sampled shorter than 18 inches. The catch of Largemouth Bass in DNR test nets in 2013 was greater than observed in any previous survey of Man Lake. Largemouth Bass lengths ranged from 5 to 16 inches and averaged 9 inches long.

Northern Pike catch rates were similar to previous surveys and similar to other waters in Lake Class 23. Fish ranged in length from 16 to 33 inches and averaged 23 inches long. The Bluegill catch rate was within the average range for similar lakes and Bluegill lengths ranged from 3 to 7.5 inches. Black Crappie numbers were higher than found in other lakes of this type, and DNR test net catches have increased steadily during the past twenty years. Sampled crappies ranged from 4 to 13 inches long in 2013. Yellow Perch numbers were lower than previous surveys and were low compared to other Lake Class 23 waters. The catch rate of Cisco (Tullibee) in the 2013 Man Lake assessment was similar to previous sampling on this lake and to other lakes of this type, and ranged in length from 6 to 10 inches. This species is an important food source for predators such as Muskellunge, Northern Pike and Walleye.

Other fish species found during the 2013 sampling include Pumpkinseed Sunfish, Rock Bass, White Sucker and Yellow Bullhead.

People can have significant impacts on lakes and the fish populations they support. Harvest, lakeshore development, removal of shoreline vegetation, and introductions of invasive species can all adversely affect fish populations. Currently the only aquatic invasive species (AIS) that has been identified in Man Lake is Rusty Crayfish. AIS are moved from infested to non-infested waters by anglers, boaters, and lake shore owners and can adversely impact lakes and fish populations. To avoid spreading AIS, lake users are required to remove all aquatic plants or animals from their watercraft and drain all water from their boat before leaving the access. If you suspect an infestation of an invasive species in this lake, save a specimen and report it to a local natural resource office. Additional information on all of these topics can be found on the DNR website (www.dnr.state.mn.us) or by contacting the Walker Area Fisheries office.

(Additional comments from the previous survey):

There are bulrush stands scattered around the entire lake. Bulrush provides spawning habitat for a variety of fish species such as bass, sunfish, and crappies. It also serves as a nursery area for juvenile fish. Emergent vegetation protects shorelines and lake bottoms from erosion. Bulrush can also protect the lake from pollution by absorbing and breaking down pollutants. Because of their ecological importance, emergent plants may not be removed without first obtaining a DNR permit. An important component of smallmouth bass habitat is rocks of all sizes. It is important that riparian owners leave these rocks in the lake to provide places for smallmouth bass to spawn and hunt for food.

Anglers can help maintain or improve the quality of fishing by practicing selective harvest. Selective harvest allows for the harvest of smaller fish for table fare, but encourages release of medium to large size fish. Releasing these fish will help maintain the fish population in Man Lake and will provide anglers with opportunities to catch more and larger fish in the future. Large fish can help maintain balance in the fish community.

Status of ***Kerr Lake,*** *according to the MN Dept. of Natural Resources fisheries summary* ***(June 15, 1992)****:*

The catch rate for northern pike (NOP) in Kerr Lake was 6.0 fish/gillnet, which equals the median catch for this lake class. The weight of NOP taken was 31.5 lbs/gillnet, which is well above the third quartile catch of 19.75 lbs/net. NOP taken by gillnets were large, with a mean weight of 5.2 lbs. NOP growth was good. The average length of Kerr Lake NOP at formation of annulus 3 was 24.6 inches - considerably above the 17.7 inch average for other class 28 lakes in this area. Good fishing is reported for NOP.

The trap net catch for bluegill (BLG) was 35.4 fish/lift, which falls in the upper part of the inter-quartile range for lake class 28. The gillnet catch of BLG was 24.3 fish/net, which is higher than most lakes in this class. Most BLG (77%) were less than 6.0 inches, though 23% were 6.0 inches or more. No BLG were greater than 7.9 inches. At formation of annulus 5, the average length of BLG sampled was 4.8 inches. Most sampled BLG reached 6.0 inches only after formation of their seventh or eighth annulus.

The pumpkinseed (PMK) catch rate of 7.2 fish/net was greater than most lakes in this lake class. About 27% of the PMK sampled were 6.0 inches or longer, but none exceeded 7.4 inches.

There were 2.3 black crappie (BLC) caught per gillnet in Kerr Lake, which falls within the inter-quartile range for this class of lakes. The sampled BLC were all 10.4 inches or less. BLC averaged 8.2 inches at the time they formed annulus 5. This growth appears to be slower than that observed in other class 28 lakes in this area.

Four small (5.5 - 8.9) largemouth bass (LMB) were sampled during the survey. Local reports indicate bass fishing is good, but limited access keeps fishing pressure low.

Yellow perch (YEP) were caught at a rate of 7.0 fish/gillnet. This rate was close to the median for class 28 lakes. The perch sampled were small, ranging from 4.0 to 7.9 inches.

Status of **Kid Lake**, according to the MN Dept. of Natural Resources fisheries summary (**July 9 1990**):

Northern cisco has been collected in Kid Lake during the past two assessments, but not during the previous two.

The northern pike gillnet catch of 5.0 is within the historical range of 2.5 to 7.0. All of the fish collected during this assessment were less than 26 inches long. Previous assessments sampled fish larger than 30 inches.

The bluegill trap net catch of 48.4 is near the historical range of 10.8 to 36.3. There is a decline in PSD and RSD-7 values when compared to the 1959 values (PSD: 1959-76; 1990-51 and RSD-7: 1959-31 and 1990-15). The growth rate determined from the 1990 sample of bluegill is slower than the growth rate reported for the 1959 sample.

Largemouth bass and black crappie are present in Kid Lake, probably in greater abundance than indicated by mid-summer gillnetting and trap netting.

The yellow perch gillnet catch of 10.0 is within the historical range of 6.5 to 13.2.

The gillnet catch of walleye (6.0 in 1990; historical range of 5.5 to 10.2) is high when considering the type of shoal water soils present in Kid Lake and that no walleye stocking is done. This past assessment, as well as all previous, sampled several year classes of walleye indicating excellent natural reproduction even though classic walleye spawning substrate appears very limited in Kid Lake.

Status of **McKeown Lake**, according to the MN Dept. of Natural Resources fisheries summary (**August 13, 1992):**

Walleye could immigrate into Kid Lake from downstream lakes. Immature fish have been present in every assessment, thus immigration is not likely the only source of walleye for Kid Lake.

Fish populations conducted in 1959, 1978, and 1992.

Muskellunge: None sampled in 1992. Only one each in 1959 and 1978.

Northern Pike - Abundance (as measured by gillnet catch rate) higher than during previous assessments. Quality size (greater than 28 inches long) fish present. Natural reproduction good.

Cisco (Tullibee): None sampled in 1992 (Were sampled in previous assessments).

Bullhead: Three species. Abundance typical. Large fish present.

Bluegill: Abundance unchanged from previous assessments. Ten percent of bluegill sampled greater than 7 inches long. Growth rate slow.

Largemouth bass: Not many captured. Difficult to net. Electro fishing is a better sampling method.

Black Crappie: Abundance unchanged from earlier assessments. Three year classes sampled. Fish were small.

Walleye: Two large individuals were sampled.

Status of **Lost Lake**, according to the MN Dept. of Natural Resources fisheries summary (**July 12, 1990**):

The northern pike gillnet catch of 13.5 is high. Most of the fish sampled were less than 20 inches long, but fish 30 inches long were collected. The northern pike growth rate is near the statewide average.

The bluegill trap net catch was 23.8. The sample collected exhibited fair quality indices - PSD=54; RSD-7=19; RSD-8=2. Their growth rate is not fast.

Presumably due to the types of sampling gear used, few largemouth bass or black crappie were collected. Angling for these species is reportedly good to excellent.
The yellow perch gillnet was very low.

For More Information

Walker Area Fisheries Supervisor
07316 State Hwy 371 NW, Walker, MN
Phone: 218-547-1683
Email: Walker.Fisheries@state.mn.us (mailto:Walker.Fisheries@state.mn.us)
Website (/areas/fisheries/walker/index.html)

Appendix II

Aquatic Vegetation Surveys

Baby Lake Aquatic Vegetation (1995)

Aquatic Vegetation and Shoal water Substrates

Number of transcents: 30
Maximum depth of aquatic vegetation sample (ft): 22.0
Dates of field work: 04/28/95 through 04/28/95

Abundance of Aquatic Plants

Common Name	Type	Frequency of Occurrence (%)	Abundance Rating	Mean Abundance
Musk grass	Submergent	100	Abundant	82.2
Hardstem Bulrush	Emergent	87	Common	62.2
Yellow Waterlily	Emergent	77	Common	53.9
Bushy Pondweed	Submergent	87	Common	51.1
Sedges (Cyperaceae)	Emergent	63	Common	46.1
Floatingleaf Pondweed	Emergent	80	Common	41.1
White Waterlily	Emergent	67	Common	40.0
Flatstem Pondweed	Submergent	67	Rare	30.0
Greater Bladderwort	Submergent	77	Rare	26.1
Ctaspingleaf Pondweed	Submergent	53	Rare	24.4
Coontail	Submergent	60	Rare	21.1
Greenfruited Burreed	Emergent	37	Rare	20.6
Variable Pondweed	Submergent	60	Rare	20.0
Illinois Pondweed	Submergent	47	Rare	15.6
Cane	Emerget	37	Rare	13.9
Common Cattail	Emergent	37	Rare	12.8
Arrowhead/Duck Potato Group	Emergent	37	Rare	11.7
Sago Pondweed	Submergent	23	Rare	9.4
Wild Rice	Emergent	23	Rare	8.3
Wild Celery	Submergent	20	Rare	7.8
Water Arum	Emergent	17	Rare	7.2
Narrowleaf Pondweed	Submergent	10	Rare	3.9
Swamp Fivefinger	Emergent	10	Rare	3.9
Lobelia	Emergent	3	Rare	2.8
Threesquare	Emergent	3	Rare	2.8
Blue Flag	Emergent	7	Rare	2.2
Canada Waterweed	Submergent	10	Rare	1.7
Little White Waterlily	Emergent	3	Rare	1.7
Northern Water Milfoil	Submergent	10	Rare	1.7
Swamp Horsetail	Emergent	3	Rare	1.7
Whitestem Pondweed	Submergent	10	Rare	1.7
Giant Burreed	Emergent	3	Rare	0.6
Largeleaf Pondweed	Submergent	3	Rare	0.6
Little Yellow Waterlily	Emergent	3	Rare	0.6
Quillwort	Submergent	3	Rare	0.6

Notes: 1. Floating-leaf species are tallied with emergent species
2. See User's Manual for calculation details.

Shoal water Substrates

Common Name	Frequency of Occurrence (%)	Abundance Rating	Mean Abundance
SILT	80	Common	51.1
SAND	73	Common	44.4
DETRITUS	57	Rare	25.0
MUCK	30	Rare	17.2
RUBBLE 3-10	17	Rare	11.7
GRAVEL	17	Rare	6.1
BOULDER >10	10	Rare	2.8
CLAY	0	Absent	0.0
LEDGE ROCK	0	Absent	0.0
MARL	0	Absent	0.0

See Abundance of Aquatic Plants table for calculation detail

Fish Spawning Conditions

Species Name	Rating	Comments
Black Crappie	*Good*	*FIRM SUBSTRATES WITH MODERATE AMOUNTS OF VEGETATION AROUND ENTIRE LAKE*
Bluegill	*Good*	*FIRM SUBSTRATES WITH MODERATE AMOUNTS OF VEGETATION AROUND ENTIRE LAKE*
Largemouth Bass	*Good*	*FIRM SUBSTRATES WITH MODERATE AMOUNTS OF VEGETATION AROUND ENTIRE LAKE*
Muskellunge	*Excellent*	*EXTENSIVE STANDS OF CHARA EXIST AROUND ENTIRE LAKE*
Northern Pike	*Good*	*A NUMBER OF SHALLOW VEGETATED BAYS EXIST AROUND LAKE*
Smallmouth Bass	*Fair*	*SUITABLE ROCK/RUBBLE AREAS EXIST*
Walleye	*Fair*	*FIVE OF THIRTY VEGETATION TRANSECTS INDICATE ABUNDANT RUBBLE*

Erosion & Pollution

Code Source	Type	Extent	Site

(NONE OBSERVED)

Erosion & Pollution Description

(None Observed)

Aquatic Plant Surveys (2011 & 2012)

Note: this is just the summary pages from the surveys. The total size of the two reports for the surveys is 110 pages

Introduction

Baby, Kid, Kerr and Lost Lake are located in Cass county. Baby Lake has a surface area of 737.3 acres, Kid Lake has a surface area of 166.7 acres, Kerr Lake has a surface area of 73.8 acres and Lost Lake has a surface area of approximately 50 acres. An assessment was taken of the lakes on July 19th 2012 and the point intercept method was utilized as described in the DNR document entitled "Protocols for aquatic plant surveys by the Minnesota Department of Natural Resources for the collection of pre-treatment data for MN DNR grant program" Pilot projects to control Curly Leaf Pondweed or Eurasian Watermilfoil on a lakewide basis for ecological benefits" by Wendy Crowell, dated April 13, 2006. This survey was conducted by Terry Ebinger and Matt Swanson. Conditions for the Mann Lake survey; air temperature of 76 degrees F, water temperature was 67 degrees F and the sechi disc reading was 12 feet. The sky was sunny and the wind was 5mph from the SW. For McKeown Lake; air temperature of 70 degrees F, water temperature was 66 degrees F and the sechi disc reading was 11feet. The sky was sunny and the wind was 5 mph from the SW.

Purpose of Survey

1) Record the species of aquatic plants within the lakes.
2) Record the abundance of all aquatic species
3) Develop maps of distribution for native aquatic species
4) Record any invasive species

Methods

A Geographic Information System (GIS) was used to generate sample points across the surface of the lakes in a 100 meter by 100 meter grid (figures 1-4), resulting in a total of 326 sample points for BabyLake, 70 for Kid Lake, 35 for Kerr Lake and 33 for Lost Lake.

Survey points were generated in the GIS and uploaded into a GPS system which was used to navigate the boat to each sampling point. One particular point in the watercraft was designated as the sampling point and used throughout the survey. At each point, water depths were electronically sensed by a depth finder. All plant species at each point were documented. Sampling was conducted with a double headed garden rake attached to a rope in those areas where no visible plants were at the surface. Frequency of occurrence was measured by a scale of 1-4. 1 indicating low abundance, number 2 moderate, number 3 heavy, and number 4 very dense plant growth

Result

In **Baby Lake**, fourteen plant types were identified; eight were of the submerged type, four were of the floating leaved type and two were of the emergent type. All of these were native. Plants were distributed to a depth of eighteen feet and 45% of sampled sites contained vegetation. Among all testing sites, the frequency of occurrence of these species was; Bladderwort(1%), Canada Waterweed(1%), Chara(6%), Clasping Leaf Pondweed(1%), Coontail(14%), Flat Stem Pondweed(9%), Illinois Pondweed(2%), Large Leaf Pondweed (2%), Watershield (1%), Floating Leaf Pondweed (1%), White Waterlilly(2%),Yellow Waterlilly (8%), Bulrush (10%) and Wild Rice(1%). Vegetation was most abundant in depths of 1-10 feet.

In **Kid Lake,** ten plant species were identified, seven of these were of the submerged type, two species were of the floating leaved type and one was of the emergent type. Plants were distributed to a depth of sixteen feet and 44% of the sampled sites contained vegetation. Among all testing sites, the frequency of occurrence of these species was; Bladderwort(9%),Canada Waterweed (3%), Chara (3%), Clasping Leaf Pondweed (9%), Coontail (21%), Flat Stem Pondweed (7%), Large Leaf Pondweed (11%), White Waterlily (4%), Yellow Waterlily(3%) and Bulrush (3%). Vegetation was most abundant in depths of 1-10 feet.

In **Kerr Lake,** thirteen plant species were identified, eight of these were of the submerged type, three species were of the floating leaved type and two were of the emergent type. Plants were distributed to a depth of twenty two feet and 45% of the sampled sites contained vegetation. Among all testing sites, the frequency of occurrence of these species was; Bladderwort(14%),Canada Waterweed (6%), Clasping Leaf Pondweed (11%), Coontail (31%), Large Leaf Pondweed (17%), Northern Milfoil (3%), Sago Pondweed(3%), Variable Pondweed(3%), Floating Leaf Pondweed(3%), White Waterlilly (4%), Yellow Waterlilly(3%) and Bulrush (3%). Vegetation was most abundant in depths of 6-15 feet.

In **Lost Lake,** eight plant species were identified, five of these were of the submerged type, two species were of the floating leaved type and one was of the emergent type. Plants were distributed to a depth of nine feet and 85% of the sampled sites contained vegetation. Among all testing sites, the frequency of occurrence of these species was; Bladderwort(15%),Canada Waterweed (9%), Clasping Leaf Pondweed (3%), Coontail (48%), Large Leaf Pondweed (12%), White Waterlily (33%), Yellow Waterlily(33%) and Bulrush (9%). Vegetation was most abundant in depths of 0-5 feet.

In **Man Lake**, ten plant types were identified; seven were of the submerged type, two were of the floating leaved type and one was of the emergent type. All of these were native. Plants were distributed to a depth of eighteen feet and 37% of sampled sites contained vegetation. Among all testing sites, the frequency of occurrence of these species was; Canada Waterweed(1%), Chara(30%), Clasping Leaf Pondweed(14%), Flat Stem Pondweed(2%), Large Leaf Pondweed (10%), Narrow Leaf Pondweed(1%), Northern Milfoil (8%), Floating Leaf Pondweed (4%), Yellow Waterlily (1%) and Bulrush (6%). Vegetation was most abundant in depths of 1-10 feet.

In **McKeown Lake,** ten plant species were identified, seven of these were of the submerged type, two species were of the floating leaved type and one was of the emergent type. Plants were distributed to a depth of fifteen feet and 79% of the sampled sites contained vegetation. Among all testing sites, the frequency of occurrence of these species was; Canada Waterweed (1%), Chara (47%), Clasping Leaf Pondweed (15%), Large Leaf Pondweed (11%), Coontail (3%), Narrow Leaf Pondweed (11%), Northern Milfoil (1%), Floating Leaf Pondweed (20%), Yellow Waterlily(11%), Bulrush (20%). Vegetation was most abundant in depths of 1-10 feet.

Appendix III

Exotic Species

Eurasian watermilfoil (*Myriophyllum spicatum*)

Eurasian watermilfoil was accidentally introduced to North America from Europe. Spread westward into inland lakes primarily by boats and also by water birds, it reached Midwestern states between the 1950s and 1980s.

In nutrient-rich lakes it can form thick underwater stands of tangled stems and vast mats of vegetation at the water's surface. In shallow areas the plant can interfere with water recreation such as boating, fishing, and swimming. The plant's floating canopy can also crowd out important native water plants.

A key factor in the plant's success is its ability to reproduce through stem fragmentation and runners. A single segment of stem and leaves can take root and form a new colony. Fragments clinging to boats and trailers can spread the plant from lake to lake. The mechanical clearing of aquatic plants for beaches, docks, and landings creates thousands of new stem fragments. Removing native vegetation crates perfect habitat for invading Eurasian watermilfoil.

Eurasian watermilfoil has difficulty becoming established in lakes with well established populations of native plants. In some lakes the plant appears to coexist with native flora and has little impact on fish and other aquatic animals.

Likely means of spread: Milfoil may become entangled in boat propellers, or may attach to keeps and rudders of sailboats. Stems can become lodged among any watercraft apparatus or sports equipment that moves through the water, especially boat trailers.

Starry Stonewort (*Nitellopsis obtusa)*

What is starry stonewort?

Starry stonewort is a grass-like form of algae that are not native to North America. The plant was first confirmed in Minnesota in Lake Koronis in late August of 2015. Plant fragments were probably brought into the state on a trailered watercraft from infested waters in another state.

Starry stonewort pulled from Minnesota's Lake Koronis, August 2015

How to identify starry stonewort

Starry stonewort is similar in appearance to native grass-like algae such as other stoneworts and musk-grass. Native stoneworts and musk-grass are both commonly found in Minnesota waters. Starry stonewort can be distinguished from other grass-like algae by the presence of star-shaped bulbils.

A starry stonewort bulbil or star-like structure produced by the plant. Bulbils are likely how the plant reproduces.

Why is starry stonewort a problem?

Starry stonewort can interfere with recreational and other uses of lakes where it can produce dense mats at the water's surface. These mats are similar to, but can be more extensive than, those produced by native vegetation. Dense starry stonewort mats may displace native aquatic plants.

Like all plants, starry stonewort may grow differently in different lakes, depending on many factors. At this time, we cannot predict how it might grow in any one Minnesota lake.

How does it spread?

Starry stonewort is believed to be spread from one body of water to another by the unintentional transfer of bulbils, the star-like structures produced by the plant. These fragments are most likely attached to trailered boats, personal watercraft, docks, boat lifts, anchors or any other water-related equipment that was not properly cleaned.

Zebra mussels

Introduction

Zebra mussels are native to the Black, Caspian, and Azov Sea areas in southern Russia, as well as the Ukraine, and eastern Europe and are thought to have arrived in North America via transport in ship ballast water. They were first found in North America in the Great Lakes in the mid to late 1980s and have spread across large portions of North America since. Zebra mussels were first found in Minnesota in the Duluth Harbor in 1989.

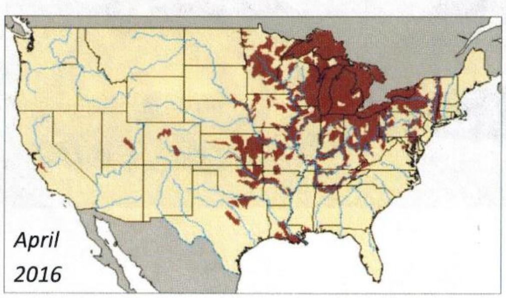
Biology and impacts

Zebra mussels have a high reproductive capacity, with a single female being capable of producing a quarter to half million eggs in a single reproductive season. This allows the mussels to form dense colonies as they attach to hard surfaces. Recently in Lake Minnetonka, newly attached mussels were found in densities as high as 200,000 per square meter. This can cause problems such as clogged intake pipes for power plants, water treatment and other utilities, and encrusted boat motors and other recreational equipment. Native mussels are prevented from feeding or moving effectively when dense colonies cover their shells, which has led to many localized extinctions of native mussel species.

Zebra mussels are efficient filter feeders, feeding on phytoplankton and smaller zooplankton from the water column. Each large adult mussel is able to filter one liter of water every day. Imagine the impact of 10,000 of these mussels per square meter filtering food from the water column! One square meter of mussels at this density would filter over 2,500 gallons of water each day! This can change the structure of the food web in lakes they invade by removing plankton from the water column, thereby reducing food for native plankton-feeding species. Zebra mussels may also increase water clarity, and by allowing more light penetration have impacts that include increased macrophyte growth and growth at greater depths.

Distribution

Zebra mussels are typically spread by dispersal of larvae, called veligers, throughout lakes and down rivers and streams. The veligers are microscopic and not visible to the naked eye, which is why it is important to not transport water from infested waters. Spread to inland lakes also occurs by overland transport in and on boats, docks and lifts.

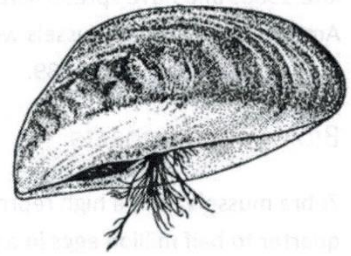


In North America, their distribution is throughout the Great Lakes Basin, major river systems such as the

Mississippi, Ohio and Hudson and inland lakes in neighboring states. Waters in US as far west as California are infested with zebra mussels. In Minnesota they are found in the Mississippi and some major tributaries, in Lake Superior, and in inland lakes scattered throughout the state. As of August 2016, DNR has confirmed the presence of zebra mussels in 121 lakes, rivers, and wetlands in Minnesota and listed a total of 130 bodies of water as infested due to their connection or proximity to an infested waterway.

Identification

Zebra mussels are bivalves, meaning "two shells", and so have two shells joined at a hinge, located at the point of their triangular shells.



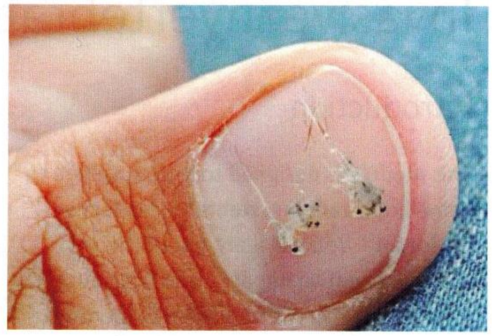
Zebra mussels are known for the alternating light and dark brown stripes on their shells. The pattern on the mussels' shells is highly variable (*see below*). Some mussels even lack the striping pattern altogether and are a solid tan, greenish or brown color. They have a flattened edge and if stood up on their edge, called the ventral side, will generally not topple over.

Zebra mussels attach themselves to solid substrates using byssal threads. Although if a mussel is ripped from the surface it is attached to, it may leave behind the threads, and so they may not always be visible for identification. They use clusters of these tan or black threads to attach themselves to items such as rocks, other molluscs, docks, boats, debris, and aquatic plants.

Zebra mussels can range in size from only a few millimeters as juveniles to as large as about 1 ½ to 2 inches as adults. The larval life stage of zebra mussels is a free-floating, microscopic stage called a veliger. These are not visible to the naked eye and require a very fine mesh plankton net to collect along with a special microscope with cross-polarized lighting to identify. While some agencies do incorporate veliger monitoring into their programs, the AIS Detector program focuses on detecting adult mussels.

You are most likely to find adult zebra mussels attached to the underside of objects floating in the water, attached to submerged portions of docks, lifts, boats, and other equipment; submerged debris; aquatic plants; and rocks in shallow lake areas.

Spiny waterflea



Introduction

Spiny waterflea are part of a group of animals called cladocerans. They are crustaceans, which is the same group that contains crabs, lobsters, and crayfish – although they may appear very different.

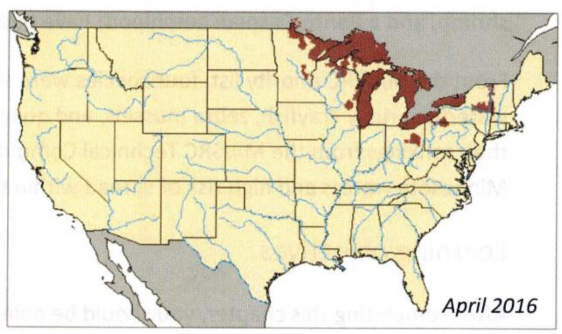
Biology and impacts

Spiny waterflea are native to northern Europe and Asia and were first introduced to the Great Lakes region in the early 1980s, likely in the ballast water of ships. Further spread to inland lakes can occur through contaminated fishing and boating gear or water transported in bait buckets, live wells, and other boat compartments.

Female spiny waterflea seasonally produce resting eggs that are resistant to desiccation. These eggs drop into lake sediments and can establish a new population if that dirt or mud is moved to a new water body. Spiny waterflea can reproduce both sexually and asexually, so even a single hitchhiking waterflea is potentially capable of establishing a new population. They can reproduce quickly, resulting in large populations in a body of water.

As predatory creatures that eat other zooplankton, spiny waterflea invasions can result in shifts in the zooplankton community. They may compete with planktivorous larval fish for the same food source, which may result in the decline of fish populations. They can also impact recreation by catching on fishing lines and other angling equipment in large clusters which can clog rod eyelets, damage reel drag systems, and reduce fish landing rates.

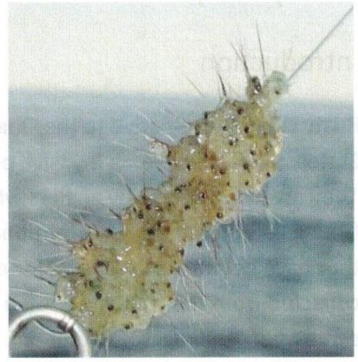
Distribution



Spiny waterflea are most often found in deep lakes, but can also establish in shallow lakes and rivers. They are planktonic and are therefore found suspended in the water column and are most abundant during the late summer and autumn months.

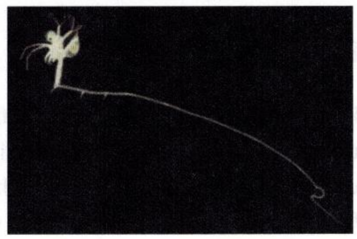
In the United States, spiny waterflea distribution is limited to the Great Lakes region (shown in red). In Minnesota, most occurrences are along the northern border, with the most notable exception being Lake Mille Lacs in central Minnesota.

Identification



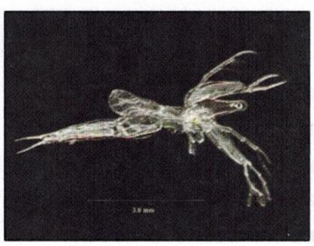
Spiny waterflea are very small creatures, typically ranging between ¼ and 5/8 of an inch in length. Spiny waterflea are most often found on fishing line and other angling equipment in clumps that resemble a gelatinous blob with black spots. The long tail extending from the spiny waterflea's body is a key identifying feature. Its spine-like appearance is what gave spiny waterflea their name. The tail typically has one to four pairs of barbs. Spiny waterflea also have distinctive black eyespots. Female waterflea may have a large, bulbous egg sac extending from their backs, which is not present in male waterflea.

Lookalikes



The closest look alike to the spiny waterflea is the **fishhook waterflea**, (*lower image at right*) another invasive species. Although present in the Great Lakes and New York, it has not yet been detected in Minnesota and should be reported if it is suspected to be present.

The fishhook waterflea has a smaller body compared to tail-length than the spiny waterflea, but the most notable distinction between the spiny waterflea and the fishhook waterflea is the hook-like structure at the end of the fishhook waterflea's tail. The tail also has a much more pronounced bend as it leaves the body than in the spiny waterflea. No other planktonic lake invertebrates have this characteristic tail. In females, the egg sac is distinctively different between the two species. The fishhook waterflea has an elongated pouch compared to the spiny waterflea's rounded, bulbous pouch.



Other zooplankton which are commonly mistaken for spiny waterflea because of their similar size, coloration, and their tendency to collect on fishing lines and other angling equipment are ***Leptodora*** and ***Chaoborus*** species (*pictured at left, top and bottom respectively*). These both have very different body shapes than spiny and fishhook waterflea and should be easily ruled out as spiny waterflea by the absence of the long spine-like tail, especially when viewed under magnification.

Other Midwestern Aquatic Exotics

Purple loosestrife (*Lythrum salicaria*)



Purple loosestrife is a wetland plant from Europe and Asia. It was introduced into the East Coast of North America in the 1800s. First spreading along roads, canals, and drainage ditches, then later distributed as an ornamental, this exotic plant is in 40 states and all Canadian border provinces.

Purple loosestrife invades marshes and lakeshores, replacing cattails and other wetland plants. The plant can form dense, impenetrable stands which are unsuitable as cover, food, or nesting sites for a wide range of native wetland animals including ducks, geese, rails, bitterns, muskrats, frogs, toads, and turtles. Many are rare and endangered wetland plants and animals and are also at risk.

Purple loosestrife thrives on disturbed, moist soils, often invading after some type of construction activity. Eradicating an established stand is difficult because of an enormous number of seeds in the soil. One adult plant can disperse 2 million seeds annually. The plant is able to re-sprout from roots and broken stems that fall to the ground or into the water.

A major reason for purple loosestrife's expansion is a lack of effective predators in North America. Several European insects that only attack purple loosestrife are being tested as a possible long-term biological control of purple loosestrife in North America.

Likely means of spread: Seeds escape from gardens and nurseries into wetlands, lakes, and rivers. Once in aquatic system, moving water and wetland animals easily spreads the seeds.

Curly-leaf pondweed (*Potamogeton crispus*) is an exotic plant that forms surface mats that interfere with aquatic recreation. The plant usually drops to the lake bottom by early July. Curly-leaf pondweed was the most severe nuisance aquatic plant in the Midwest until Eurasian watermilfoil appeared. It was accidentally introduced along with the common carp.

Flowering rush (*Botumus umbellatus*) is a perennial plant form Europe and Asia that was introduced in the Midwest as an ornamental plant. It grows in shallow areas of lakes as an emergent, and as a submersed form in water up to 10 feet deep. Its dense stands crowd out native species like bulrush. The emergent form has pink, umbellate-shaped flowers, and is 3 feet tall with triangular-shaped stems.

Round goby (*Neogobius melanostomus*) is a bottom-dwelling fish, native to Eastern Europe that entered the eastern Great Lakes in ballast water. They can spawn several times per year, grow to about 10 inches, are aggressive, and compete with native bottom-dwellers like sculpins and log perch. They are expected to be harmful to Great Lakes and inland fisheries.

Rusty crayfish (*Orconectes rusticus*) are native to streams in the Ohio, Kentucky, and Tennessee region. Spread by anglers who use them as bait, rusty crayfish are prolific and can severely reduce lake and stream vegetation, depriving native fish and their prey of cover and food. They also reduce native crayfish populations.

White perch (*Morone americana*) are native to Atlantic coastal regions and invaded the Great Lakes through the Erie and Welland canals. Prolific competitors of native fish species, white perch have the potential to cause declines of Great Lakes walleye populations.

Appendix IV

Citizen Lake Monitoring Program

The lake association has collected water samples of all of our six lakes through the Association of Cass County Lakes program with RMB Labs of Detroit Lakes, MN. This has been done for many years on an every other year basis. The summaries on the following pages reflect data for the years 2008 to 2017.

BABY 11-0283-00

Lake Information

MN Lake ID: 11-0283-00
County: Cass **Ecoregion:** NLF
Major Drainage Basin: UM
Latitude/Longitude: / **Years Monitored:** 2011 - 2017
Monitored Sites: 201

View MPCA CLMP Historical Secchi Data
MPCA Assessment Report Search County
Monthly Precipitation Data

Physical Characteristics

Surface area (acres): 737
Littoral area (acres): %
Littoral area: Max depth (ft): 69 **Max depth (m): Mean depth (ft):** N/A **Watershed size (acres):** N/A **Aquatic Invasive Species:**

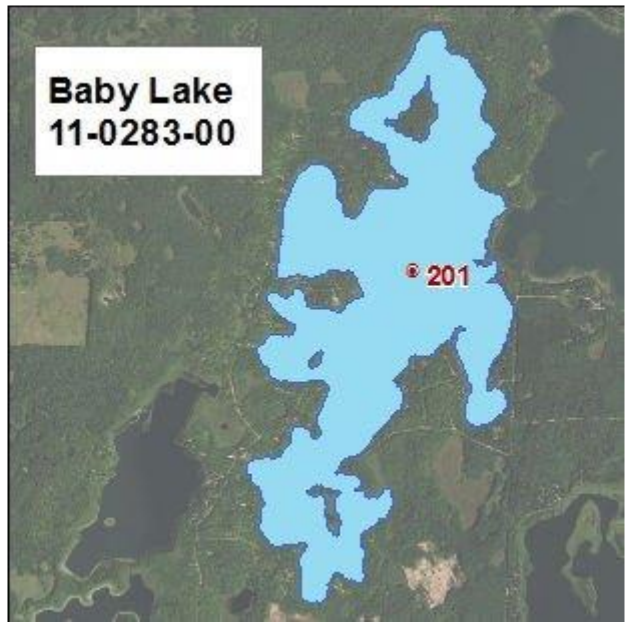
View MN DNR Fisheries Report
View MN DNR Lake Level Report

Water Quality Characteristics

(data from RMB monitoring database only)

Parameters	Prmary Site 201
Total Phosphorus Mean:	11.4
Total Phosphorus Min:	7
Total Phosphorus Max:	18
Number of Observations:	19
Chlorophyll-a Mean:	3.4
Chlorophyll-a Min:	0.9
Chlorophyll-a Max:	9
Number of Observations:	19
Secchi Depth Mean:	12.8
Secchi Depth Min:	7.5
Secchi Depth Max:	16
Number of Observations:	18
Trophic State Index Mean:	39.8

Trophic State: Oligotrophic - Mesotrophic



Trends

(Primary site only. For detecting trends, a minimum of 8-10 years of data with 4 or more readings per season are recommended)

Years Monitored: 2011 - 2017
Total Phoshporus: No significant trend exists.
Chlorophyll-a: No significant trend exists. **Secchi Depth:** No significant trend exists. **Trophic State Index:** No significant trend exists.

Ecoregion Comparisons

(Primary site only. Comparisons are based on interquartile range, 25th-75th percentile, for ecoregion reference lakes)

Ecoregion: NLF **Total phosphorus:** Below Expected Range **Chlorophyll-a:** Within Expected Range **Secchi depth:** Within Expected Range

RMB Lakes Database

Kerr 11-0268-00

Lake Information

MN Lake ID: 11-0268-00
County: Cass
Ecoregion: NLF
Major Drainage Basin: UM
Latitude/Longitude: 46.94055556 / -94.36719444
Years Monitored: 2008 - 2017
Monitored Sites: 202,203

Physical Characteristics

Surface area (acres): 73
Littoral area (acres): 26
% Littoral area:
Max depth (ft): 79
Max depth (m):
Mean depth (ft): N/A
Watershed size (acres): N/A
Aquatic Invasive Species:

Water Quality Characteristics

Data from RMB monitoring database only)

Parameters	Prmary Site 203	Site 202

Total Phosphorus Mean: 14 13.3
Total Phosphorus Min: 8 11
Total Phosphorus Max: 26 16
Number of Observations: 24 4

Chlorophyll-a Mean: 3 0.7
Chlorophyll-a Min: 1 -5.3

Chlorophyll-a Mean: 30.7
Chlorophyll-a Min: 1-5.3
Chlorophyll-a Max: 83.6
Number of observations: 234

Secchi Depth mean: 16.8
Secchi Depth Min: 12
Secchi Depth Max: 22

Number of Observations: 64

Trophic State Index Mean: 39.5

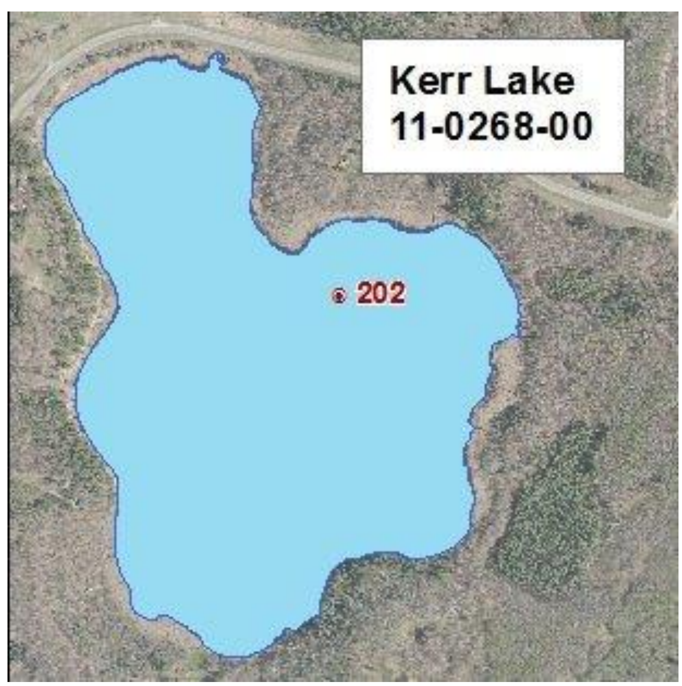
Trophic State: Oligotrophic - Mesotrophic

Trends (Primary site only)

Years Monitored: 2008-2017
Total Phosphouros: no significant trend
Chlorophyll-a: no significant trend

Secchi Depth: Decreasing with 90% confidence
State Index: Decreasing with 90% confidence

Total Phosphourus: Within Expected range
Total Chlorophyll-a: Within Expected range
Secchi Depth: Above expected range



RMB Lakes Database

Kid 11-0262-00

Lake Information

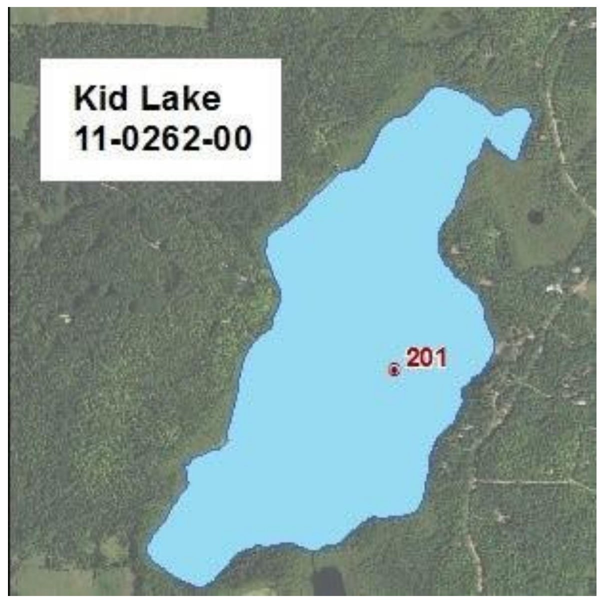
MN Lake ID: 11-0262-00
County: Cass Ecoregion: NLF
Major Drainage Basin: UM
Latitude/Longitude: / Years
Monitored: 2008 - 2017
Monitored Sites: 201

Physical Characteristics

Surface area (acres): 166
Littoral area (acres): 35%
Max depth (ft): 52

Water Quality Characteristics

(data from RMB monitoring database only)



Parameters	Primary site: 201
Total Phosphorus Mean:	**13.7**
Total Phosphorus Min:	**7**
Total Phosphorus Max	**24**
Number of Observations:	**27**
Chlorophyll-a Mean:	**3.1**
Chlorophyll-a Min:	**0**
Chlorophyll-a Max:	**8**
Number of Observations:	**27**
Trophic State Index Mean:	**40.1**

Trophic State: Mesotrophic

Trends

(Primary site only. For detecting trends, a minimum of 8-10 years of data with 4 or more readings per season are recommended)
Years Monitored: 2008 - 2017
Total Phoshporus: No significant trend exists.
Chlorophyll-a: No significant trend exists.
Secchi Depth: Decreasing with 90% confidence.
Trophic State Index: No significant trend exists.

Ecoregion Comparisons
(Primary site only. Comparisons are based on interquartile range, 25th-75th percentile, for ecoregion reference lakes)
Ecoregion: NLF
Total phosphorus: Below Expected Range
Chlorophyll-a: Within Expected Range
Secchi depth: Within Expected Range

Mann 11-0282-00

Lake Information

MN Lake ID: 11-0282-00
County: Cass
Ecoregion: NLF
Major Drainage Basin: UM
Latitude/Longitude: 46.97277778 / -94.34333333
Years Monitored: 2008 - 2017
Monitored Sites: 204

View MPCA CLMP Historical Secchi Data
MPCA Assessment Report
Search County Monthly Precipitation Data

Physical Characteristics

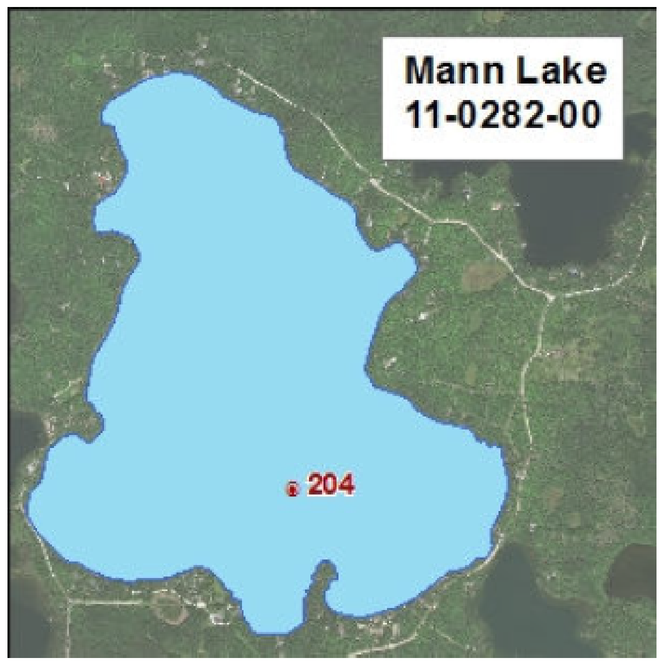
Surface area (acres): 445
Littoral area (acres): 44
% Littoral area:
Max depth (ft): 93
Max depth (m):
Mean depth (ft): N/A
Watershed size (acres): N/A
Aquatic Invasive Species:

View MN DNR Fisheries Report
View MN DNR Lake Level Report

Water Quality Characteristics

(data from RMB monitoring database only)

Parameters	Prmary Site 204
Total Phosphorus Mean:	11
Total Phosphorus Min:	6
Total Phosphorus Max:	18
Number of Observations:	28
Chlorophyll-a Mean:	3
Chlorophyll-a Min:	0
Chlorophyll-a Max:	7
Number of Observations:	28
Secchi Depth Mean:	12
Secchi Depth Min:	9
Secchi Depth Max:	15
Number of Observations:	27
Trophic State Index Mean:	39.7



Trophic State: Oligotrophic - Mesotrophic

Trends

(Primary site only. For detecting trends, a minimum of 8-10 years of data with 4 or more readings per season are recommended)

Years Monitored: 2008 - 2017
Total Phoshporus: No significant trend exists.
Chlorophyll-a: No significant trend exists.
Secchi Depth: Decreasing with 80% confidence.
Trophic State Index: No significant trend exists.

Ecoregion Comparisons

(Primary site only. Comparisons are based on interquartile range, 25th-75th percentile, for ecoregion reference lakes)

Ecoregion: NLF
Total phosphorus: Below Expected Range
Chlorophyll-a: Within Expected Range
Secchi depth: Within Expected Range

McKeown 11-0261-00

Lake Information

MN Lake ID: 11-0261-00
County: Cass
Ecoregion: NLF
Major Drainage Basin: UM
Latitude/Longitude: 46.96472222 / -94.33052778
Years Monitored: 2008 - 2017
Monitored Sites: 202

View MPCA CLMP Historical Secchi Data
MPCA Assessment Report
Search County Monthly Precipitation Data

Physical Characteristics

Surface area (acres): 147
Littoral area (acres): 128
% Littoral area:
Max depth (ft): 37
Max depth (m):
Mean depth (ft): N/A
Watershed size (acres): N/A
Aquatic Invasive Species:

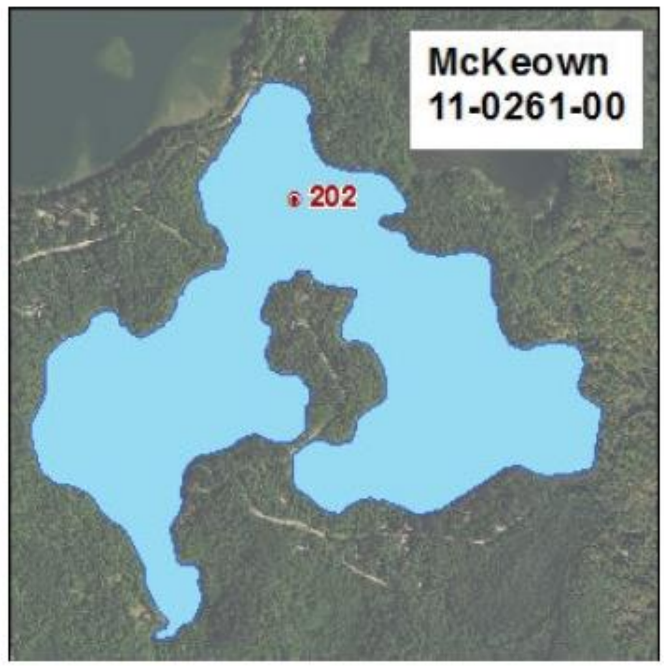
View MN DNR Fisheries Report
View MN DNR Lake Level Report

Water Quality Characteristics

(data from RMB monitoring database only)

Parameters	Prmary Site 202
Total Phosphorus Mean:	12
Total Phosphorus Min:	8
Total Phosphorus Max:	28
Number of Observations:	33
Chlorophyll-a Mean:	2.8
Chlorophyll-a Min:	1
Chlorophyll-a Max:	5
Number of Observations:	33
Secchi Depth Mean:	15.4
Secchi Depth Min:	11
Secchi Depth Max:	29
Number of Observations:	27
Trophic State Index Mean:	39

Trophic State: Oligotrophic - Mesotrophic



Trends

(Primary site only. For detecting trends, a minimum of 8-10 years of data with 4 or more readings per season are recommended)

Years Monitored: 2008 - 2017
Total Phoshporus: Increasing with 95% confidence.
Chlorophyll-a: Increasing with 90% confidence.
Secchi Depth: Increasing with 99% confidence.
Trophic State Index: Increasing with 95% confidence.

Ecoregion Comparisons

(Primary site only. Comparisons are based on interquartile range, 25th-75th percentile, for ecoregion reference lakes)

Ecoregion: NLF
Total phosphorus: Below Expected Range
Chlorophyll-a: Within Expected Range
Secchi depth: Above Expected Range

Appendix V: 2007 *E. coli* bacteria monitoring - Baby Lake

(The following is a portion of the report prepared by Barbara Liukkonen, U of Minnesota Water Resources Center. Testing was done for 22 sites in Minnesota, of which Joni Kumpula volunteered to do Baby Lake. Testing was for the above stated monitoring. Results for Baby Lake were negative, as very little E. coli bacteria were found.)

Joni Kumpula monitored Baby Lake in Cass County, collecting eight samples from each of two sites between June 12 and September 9, 2007. *E. coil* bacteria levels in all samples were low, most below the detection limit of the Petriflim test kit (33 cfu for triplicate plates) and many below detection limit of the MN Valley Testing Lab (1 cfu/100 mls). None of the samples exceeded the one-time *E. coil* standard, nor did or the geometric means, calculated for both sites for the period 7/11/07 — 8/7/07.

Minnesota has two ways of identifying whether a water body is impaired because of bacteria. The simpler method looks at whether a single sample exceeds a certain level of bacteria. The second method balances the results of many samples collected over time by calculating the geometric mean of 5 samples collected within a 30-day period. It integrates extreme or atypical values, producing an "average" that may be more representative of the bacteria levels in a stream or lake during the period of record.

Minnesota's water quality standard for bacteria impairment is based on fecal coliform, although in September 2007 the State proposed a transition to a standard based on the presence of E. *coil (Escherichla coil).* When adopted, the E. *coil* standard will be 1260 cfu/100 ml (colony forming units in 100 ml of sample) for a single sample and 126 cfu/100 ml when using the geometric mean of 5 samples collected within 30 days.

Table 1: Geometric mean of five samples collected within 30 days from Baby Lake (Cass County) during summer 2007. Calculated from certified lab analysis results.

Site Name	Site ID	Start Date	End Date	Geo Mean of Lab Analysis	Exceeds standard for geometric mean of 126 cfu/100 mls
Baby Lake	MN1101	7/11/07	8/8/07	2	No
Baby Lake	MN1102	7/11/07	8/8/07	3	No

Table 2: Test kit vs. lab results *for* MN samples collected during summer 2007
Baby Lake, Cass County, MN11O1 and MN 1102

Site Name	Site ID	Volunteer ID	Collection Date	Petrifllm cfu/100 mls	Lab Analysis Date	Lab Analysis Result
Baby Lake Kumpula Dock	MN1101	MN0711	6/12/2007	<33	6/13/2007	1
	MN1101	MN0711	6/26/2007	<33	6/27/2007	<1
	MN1101	MN0711	7/11/2007	33	7/12/2007	4.1
	MN1101	MN0711	7/17/2007.	<33	7/18/2007	1
	MN1101	MN0711	8/1/2007	33	8/2/2007	3.1
	MN1101	MN0711	8/6/2007	<33	8/7/2007	1
	MN1101	MN0711	8/8/2007	<33	8/9/2007	3
	MN1101	MN0711	9/11/2007	<33	9/12/2007	1
Baby Lake Public Access	MN1102	MN0711	6/12/2007	<33	6/13/2007	4.1
	MN1102	MN0711	6/26/2007	<33	6/27/2007	6.3
	MN1102	MN0711	7/11/2007	33	7/12/2007	18.7
	MN1102	MN0711	7/17/2007	<33	7/17/2007	<1
	MN1102	MN0711	8/1/2007	67	8/2/2007	3.1

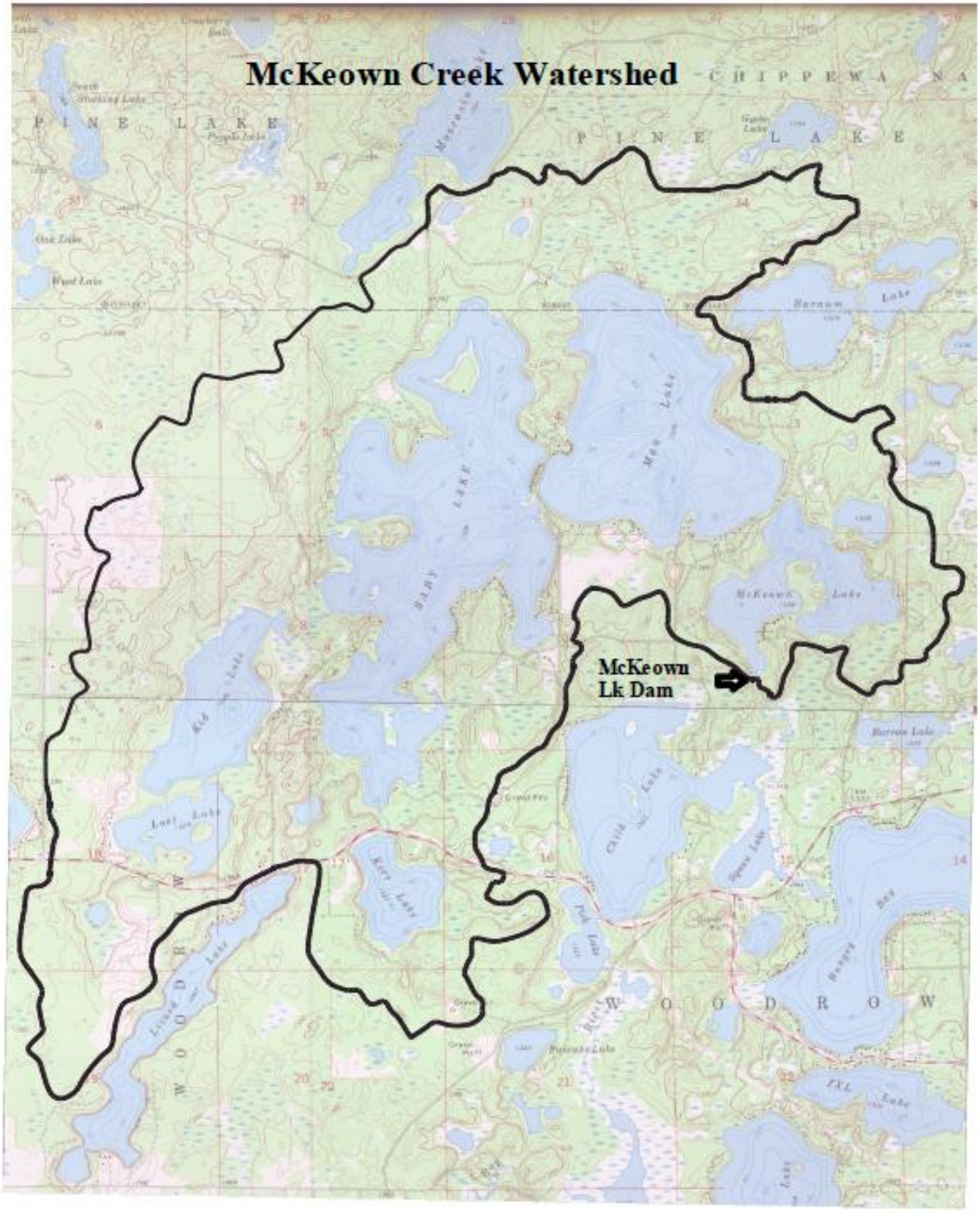
	MN1102	MN0711	8/6/2007	33	8/7/2007	
	MN1102	MN0711	8/8/2007	<33	8/9/2007	3.1
	MN1102	MN0711	9/11/2007	<33	9/12/2007	14.4

Collected as part of the Citizens Monitoring Bacteria project at the U of MN Water Resources Center.

Appendix VI

McKeown Creek Watershed

(Map on following page)


McKeown Creek Watershed
McKeown
Lk Dam

Glossary

Aerobic: Aquatic life or chemical processes that require the presence of oxygen.

Algal bloom: An unusual or excessive abundance of algae.

Alkalinity: Capacity of a lake to neutralize acid.

Anoxic: The absence of oxygen in a water column or lake; can occur near the bottom of eutrophic lakes in the summer or under the ice in the winter.

Benthic: The bottom zone of a lake, or bottom-dwelling life forms.

Best Management Practices: A practice determined by a state agency or other authority as the most effective, practicable means of preventing or reducing pollution.

Bioaccumulation: Build-up of toxic substances in fish (or other living organism) flesh. Toxic effects may be passed on to humans eating the fish.

Biological Oxygen Demand: The amount of oxygen required by aerobic microorganisms to decompose the organic matter in sample of water. Used as a measure of the degree of water pollution.

Buffer Zone: Undisturbed vegetation that can serve as to slow down and/or retain surface water runoff, and assimilate nutrients.

Chlorophyll *a*: The green pigment in plants that is essential to photosynthesis.

Clean Water Partnership (CWP) Program: A program created by the legislature in 1990 to protect and improve ground water and surface water in Minnesota by providing financial and technical assistance to local units of government interested in controlling nonpoint source pollution.

Conservation Easement: A perpetual conservation easement is a legally binding condition placed on a deed to restrict the types of development that can occur on the subject property.

Cultural eutrophication: Accelerated "aging" of a lake as a result of human activities.

Epilimnion: Deeper lakes form three distinct layers of water during summertime weather. The epilimnion is the upper layer and is characterized by warmer and lighter water.

Eutrophication: The aging process by which lakes are fertilized with nutrients.

Eutrophic Lake: A nutrient-rich lake – usually shallow, "green" and with limited oxygen in the bottom layer of water.

Exotic Species: Any non-native species that can cause displacement of or otherwise threaten native communities.

Fall Turnover: In the autumn as surface water loses temperature they are "turned under" (sink to lower depths) by winds and changes in water density until the lake has a relatively uniform distribution of temperature.

Feedlot: A lot or building or a group of lots or buildings used for the confined feeding, breeding or holding of animals. This definition includes areas specifically designed for confinement in which manure may accumulate or any area where the concentration of animals is such that a vegetative cover cannot be maintained. Lots used to feed and raise poultry are considered to be feedlots. Pastures are not animal feedlots.

Groundwater: water found beneath the soil surface (literally between the soil particles); groundwater is often a primary source of recharge to lakes.

Hardwater: Describes a lake with relatively high levels of dissolved minerals such as calcium and magnesium.

Hypolimnion: The bottom layer of lake water during the summer months. The water in the hypolimnion is denser and much colder than the water in the upper two layers.

Impervious Surface: Pavement, asphalt, roofing materials or other surfaces through which water cannot drain. The presence of impervious surfaces can increase the rates and speed of runoff from an area, and prevents groundwater recharge.

Internal Loading: Nutrients or pollutants entering a body of water from its sediments.

Lake Management: The process of study, assessment of problems, and decisions affecting the maintenance of lakes as thriving ecosystems.

Littoral zone: The shallow areas (less than 15 feet in depth) around a lake's shoreline, usually dominated by aquatic plants. These plants produce oxygen and provide food, shelter and reproduction areas for fish & animal life.

Local Unit of Government: A unit of government at the township, city or county level.

Mesotrophic Lake: A lake that is midway in nutrient concentrations (between a eutrophic and oligotrophic lake). Characterized by periodic problems with algae blooms or problem aquatic vegetation.

Native Species: An animal or plant species that is naturally present and reproducing.

Nonpoint source: Polluted runoff – nutrients or pollution sources not discharged from a single point. Common examples include runoff from feedlots, fertilized lawns, and agricultural fields.

Nutrient: A substance that provides food or nourishment, such as usable proteins, vitamins, minerals or carbohydrates. Fertilizers, particularly phosphorus and nitrogen, are the most common nutrients that contribute to lake eutrophication and nonpoint source pollution.

Oligotrophic Lake: A relatively nutrient-poor lake, characterized by outstanding water clarity and high levels of oxygen in the deeper waters.

Nutrient: A substance that provides food or nourishment, such as usable proteins, vitamins, minerals or carbohydrates. Fertilizers, particularly phosphorus and nitrogen, are the most common nutrients that contribute to lake eutrophication and non-point source pollution.

pH: The scale by which the relative acidity or basic nature of waters are accessed,

Photosynthesis: The process by which green plants produce oxygen from sunlight, water and carbon dioxide.

Phytoplankton: Algae – the base of the lake's food chain, it also produces oxygen.

Point Sources: Specific sources of nutrient or pollution discharge to a water body, i.e., a stormwater discharge pipe.

Riparian: The natural ecosystem or community associated with river or lake shoreline.

Secchi Disc: A device measuring the depth of light penetration in water.

Sedimentation: The addition of soils to lakes, which can accelerate the "aging" process by destroying fisheries habitat, introducing soil-bound nutrients, and filling in the lake.

Spring turnover: After ice melts in the spring, warming surface water sinks to mix with deeper, colder water. At this time of year all water is the same temperature.

Thermocline: During summertime deeper lakes stratify by temperature to form three discrete layers; the middle layer of lake water in known as the thermocline.

Trophic Status: The level of growth or productivity of a lake as measured by phosphorus, content, algae abundance, and depth of light penetration.

Watershed: The surrounding land area that drains into a lake, river, or river system.

Zooplankton: Microscopic animals.

Common Biological or Chemical Abbreviations

BOD	Biological Oxygen Demand
°C	degree(s) Celsius
cfs	cubic feet per second (a common measure of rate of flow)
cfu	colony forming units (a common measure of bacterial concentrations)
chl *a*	Chlorophyll *a*
cm	centimeter
COD	Chemical Oxygen Demand
Cond	conductivity
DO	dissolved oxygen
FC	fecal coliform (bacteria)
ft	feet
IR	infrared
l	liter
m	meter
mg	milligram
ml	milliliter
NH_3-N	nitrogen as ammonia
NO_2-NO_3	nitrate-nitrogen
NTU	Nephelometric Turbidity Units, standard measure of turbidity
OP	Ortho-phosphorus
ppb	parts per billion
ppm	parts per million
SD	Standard Deviation (statistical variance)
TDS	total dissolved solids
TN	total nitrogen
TP	total phosphorus
TSI	trophic status index
TSI (C)	trophic status index (based on chlorophyll *a*)
TSI (P)	trophic status index (based on total phosphorus)
TSI (S)	trophic status index (based on secchi disc transparency)
TSS	total suspended solids
μg/l	micrograms per liter
μmhos/cm	micromhos per centimeter, the standard measure of conductivity
UV	Ultraviolet

Guide to common acronyms

State and Federal Agencies

BWSR	Board of Soil & Water
COE	U.S. Army Corps of Engineers
CRP	Conservation Reserve Program - A federal government conservation program
DNR	Department of Natural Resources
DOJ	United States Department of Justice
DOT	Department of Transportation
DTED	Department of Trade and Economic Development
EPA	U.S. Environmental Protection Agency
EQB	MN Environmental Quality Board
LCCMR	Legislative-Citizen Commission on Minnesota Resources
MDH	Minnesota Department of Health
MPCA	Minnesota Pollution Control Agency
OEA	MN Office of Environmental Assistance
OSHA	Occupational Safety and Health Administration
RIM	Reinvest In Minnesota - a State of Minnesota Conservation Program
SCS	Soil Conservation Service
SWCD	Soil & Water Conservation District
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USFWS	United States Fish & Wildlife Service

Regional, watershed, community development, trade and advocacy groups

ACCL	Association of Cass County Lakes
AMC	Association of Minnesota Counties
APA	American Planning Association
COLA	Coalition of Lake Associations
IF	Initiative Foundation
LARA	Cass County Lakes & Rivers Alliance
LMC	League of Minnesota Cities
MAT	Minnesota Association of Townships
MLA	Minnesota Lakes Association
MSBA	Minnesota School Board Association
MCIT	Minnesota Counties Insurance Trust
Mid-MnMA	Mid-Minnesota Association of Builders
MLA	Minnesota Lakes Association
MnSCU	Minnesota State Colleges and Universities
RCM	Rivers Council of Minnesota
TIF	Tax Increment Financing

Codes and Regulations

110B	The Minnesota law that regulates non-metro county water plans
ADA	American Disabilities Act
B & B	Bed and Breakfast
BOA	Board of Adjustment
Chapter 70/80	Individual Sewage Treatment Standards
CIC Plat	Common Interest Community Plat
Class V	Class Five "Injection" well; any well which receives discharge
CSAH	County State Aid Highway
CUP	Conditional Use Permit
CWA	Clean Water Act
EAW	Environmental Assessment Worksheet
EIS	Environmental Impact Statement
EOA	Equal Opportunity Act
FOIA	Freedom of Information Act
GD	General Development (lake)
GLAR	Greater Lakes Area Association of Realtors
IAQ	Indoor Air Quality
ISTS	Individual Sewage Treatment System
LMP	Lake Management Plan
LQG	Large Quantity Generator (of hazardous waste)
MAP	Minnesota Assistance Program
OHW	Ordinary High Water
PUD	Planned Unit Development
RD	Recreational Development (lake)
ROD	Record of Decision
ROW	Right-of-Way
SBC	State Building Code
SDWA	Safe Drinking Water Act
SF	Square feet
SIZ	Shoreland Impact Zone
SQG	Small Quantity Generator (of hazardous waste)
SWMP	Stormwater Management Plan
UBC	Universal Building Code