Sauk River Chain of Lakes
Continuation Project

MPCA Clean Water Partnership Grant/Loan
Phase II B Final Report

Submitted by:
Sauk River Watershed District

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Sauk River Chain of Lakes Continuation Project

Cooperating Project Sponsors:

Stearns County Natural Resource Conservation Service

Stearns County Environmental Services Department

Minnesota Department of Natural Resources

Sauk River Chain of Lakes Association

Joint Powers Area 5 Engineer and Staff

Citizen Steering Committee

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LIST OF ACRONYMS

SRWD.....Sauk River Watershed District
Committee.....Sauk River Chain of Lakes Citizen Steering Committee
SWCD.....Soil and Water Conservation District
MPCA.....Minnesota Pollution Control Agency
Study.....Diagnostic Feasibility Study
MNDNR.....Minnesota Department of Natural Resources
NRCS.....Natural Resource Conservation Service
BMP's.....Best Management Practices

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E X E C U T I V E S U M M A R Y

SAUK RIVER CHAIN OF LAKES WATERSHED (A.K.A. HORSESHOE CHAIN OF LAKES)

The Sauk River Chain of Lakes is an extremely popular multi-recreational system of lakes located near St. Cloud in central Minnesota. Lake users include more than just the local lakeshore residents. People from the surrounding communities, including the Cities of St. Cloud, Minneapolis/St. Paul and greater Minnesota, enjoy using the Sauk River Chain of Lake (SRCL or Chain of Lakes). Their popularity has greatly increased over the past twenty-five years causing a chain of reactions such as an increase in resorts/camp sites usage and a housing boom in this area.

The Sauk River Chain of Lakes is composed of 14 bay - like lakes and has a watershed of approximately 601,920 acres (940.5 square miles). The Sauk River enters the "chain of lakes" from the northwest (near Richmond, Minnesota) and flows in an easterly direction through the system of lakes and ends at the dam near Cold Spring (approximately 9.4 miles from Richmond) where the flowage is again referred to as the Sauk River (MPCA Wilson 1985).

The Sauk River Chain of Lakes watershed has seen tremendous land use changes over the past 75+ years. Much of the watershed is intensely farmed with row crops and livestock operations as the main components of the agricultural economy. In addition, communities have wastewater treatment facilities that discharge into the Sauk River or its tributaries. Shoreland areas around the lakes have become urbanized changing from smaller seasonal cabins to larger, year-round residences.

The disadvantage of being located at the lower reaches of the Sauk River, and it vast watershed, is receiving the brunt of all pollution being delivered downstream by the river. The water quality concerns of today's lake users, both residents and visitors, are a result of large-scale land-use changes within the watershed.

In addition to the eutrophication process, health issues related to non-point source pollutants are also a concern for Sauk River Chain of Lakes watershed landowners. Septic systems and farming practices present potential water quality problems. The increasing rate of shoreline development has prompted concern over the cumulative contributions of on-site septic systems to the water quality of the Sauk River Chain of Lakes.

The Sauk River Watershed District (SRWD) is the official project sponsor and coordinating agency for the Sauk River Chain of Lakes Watershed Improvement project. The Sauk River Chain of Lakes project was designed to maintain and improve (if possible) water quality by reducing the impacts of non-point source pollution.

The water quality problems of the Sauk River Chain of Lakes were defined by state-of-the-art stream monitoring which used mass balance to establish goals and flow weighted mean concentrations of nutrients by primary subwatersheds. In essence, this is the basin approach to resource management. With the measured data, primary subwatersheds of the Sauk River were located and addressed in the most cost-effective manner.

Figure 1 **Sauk River Chain of Lakes Morphological Data**

PARAMETER	UNITS
Surface Area	2,456 acres
Volume	30,735 acre-feet
Littoral Zone	76 %
Maximum Depth	79 feet
Shoreline Length	75.8 miles
Maximum Length	9.4 miles
Watershed Area	601,936 acres
Lake Elevation	1086.5 feet
Mean Depth	12.5 feet

The project staff and the cooperating agencies, groups and individuals accomplished the following activities as a result of the Sauk River Chain of Lakes Watershed Management Continuation (1999 - 2003) Project:

- Installed and/or improved 36 ag-waste storage facilities within the Sauk River Chain of Lakes watershed. In addition to this CWP funding, cost share was provided to the landowners through the state cost share program (BWSR), Federal cost share dollars under the EQIP program and through the EPA 319 Clean Lakes Program (see photos).
- Generated 40+ Manure Management Plans assisting local farmers in protecting area water resources plus capitalize on the nutrients generated from animal waste.
- Installed one feedlot filter strip to trap nutrients from the feedlot area.
- Installed one large gully control structure using Stearns County 319 cost share funding with donations from the Sauk River Chain of Lakes and SRF funds from the SRWD (see photos).
- Installed 2 water and sediment retention basins on farm sites within the Sauk River Chain of Lakes watershed. These basins were very effective in retaining agricultural runoff**.** One site included restoring a wetland.
- Installed 6 grassed waterways along highly erodable land (HEL) within the Sauk River Chain of Lakes watershed to prevent sediment from reaching nearby surface waters.
- Enrolled 3 sites, totaling 10.1 acres, into the Reinvest in Minnesota (RIM) program.
- Restored 4 shoreland\riparian sites within the watershed. These projects were funded through the Stearns County Water Plan, Sauk River Chain of Lakes CWP Continuation funds and the local landowners. Landowners were offered technical assistance to restore their shoreline to a more natural state using native vegetation.

- For the past 4 years the Stearns County SWCD (in conjunction with the MN Dept of Agriculture) conducted well testing clinics for all residents within the Sauk River Chain of Lakes watershed. In addition, the Department of Agriculture offered a drop off spot for all chemical containers for proper disposal.
- Installed state-of the-art electronic monitoring equipment along four tributaries of the Sauk River (Stoney, Unnamed, Getchel and Eden Creeks), one just above the Chain of Lakes (Richmond site) and one downstream (Cold Spring Site). In addition, in-lake baseline water quality data was collected from 13 locations (13 lakes within the chain of lakes, see Figure 2). For 4 years the SRWD collected samples and analyzed results.
- Enrolled 5,000 acres into the Conservation Reserve Program (CRP) within the Sauk River Chain of Lakes watershed.
- Utilized $99,232.48 of State Revolving Funds (SRF) low interest loan dollars to help 17 lakeshore residents and 1resort upgrade their septic systems. In addition, 23 feedlot abatement projects within the Sauk River Chain of Lakes watershed utilized loan funds ($572,041.62) to help supplement available cost share funding**.** One shoreland restoration project was completed using the SRF funds and 2 landowners purchased conservation and manure management equipment under the low interest loan program.
- Abandoned one large hog operation along Lake Zumwalde. The unpermitted earthen manure pit was found to have a seepage plume approximately 300 feet draining towards Lake Zumwalde. The SRWD partnered with the Stearns Environmental Services, SWCD and NRCS to assist the farmer technically and financially to properly abandon the hog operation and to dispose of the contaminated soils.
- Distributed the “Septic System Owners Guide” developed by the Minnesota Extension Service (MES) to residents that have upgraded their septic systems. Based on studies conducted on similar sized lakes within the Sauk River Watershed, it was estimated that over 70% of septic systems were out of compliance or sub-standard, although no actual surveys were conducted. Therefore, in 1997 it was estimated that approximately 651 (out of 1211) homes around the Sauk River Chain of Lakes were out of compliance or sub-standard. According to the Stearns County Environmental Services, approximately 824 residents have updated their systems (1990-2003 permits on record) and approximately 32% of the lakeshore homes still need to be upgraded.
- The Sauk River Chain of Lakes Association (SRCLA) produced 4 Newsletters with articles from the SRWD. These newsletters were distributed to 1000+ watershed residents. The newsletter served as a project progress report and source of environmental information. Information regarding the SRF low interest loan program and cost share opportunities were continuous articles. Articles such as “Loving Your Lakeshore to Death”, “Become a Monitoring Volunteer” and shoreland BMP guidelines were offered to local residents.
- Over 20 formal informational meetings were offered with assistance from state and local agencies regarding, nutrient management, soil conservation and other water quality issues. Seminars were open to the watershed residents and the general public. Seminars included shoreland BMPs, septic systems, lakeshore landscaping, conservation tillage, water quality and economic values, new feedlot rules and ordinances, buffer strips and cost share opportunities.
- Made presentations to the Sauk River Chain of Lakes Association (SRCLA), and local area schools on water quality and the current water quality status of Sauk River Chain of Lakes and the Sauk River.
- Established the “Traveling Environmental Education Classroom”. The traveling classroom presents information about water quality in a style which captures the attention of all ages. The education board was displayed in the library of each school within the watershed for 1-2 weeks (see photos).

- Promoted the use of soil testing for lawn care and manure management through project newsletter articles and advertisements regarding area county's annual soil test day.
- Cooperated and shared information with the local residents and local and state agencies

The Sauk River Chain of Lakes has been the site of numerous limnological and ecological studies for the past 25 years due to its advanced eutrophication. The purpose of these studies (MPCA Limnological Study 1982, Phase I Diagnostic Study 1992) was to research and collect hydrologic, water quality and ecological information to make the necessary remedial decisions. The accumulative results indicate that in order to improve water quality for the Sauk River Chain of Lakes, a drastic reduction in phosphorus loading was required. If watershed and land use management practices are not changed, then degradation is expected to continue at measurable rates, or worse, due to internal recycling of phosphorus within the lake basins. This means that "swimming impaired" conditions will likely occur and "no recreation" conditions may be encountered within the next twenty years. These impairments will have immediate environmental and economic consequences to the Sauk River Chain of Lakes area.

In 1985, the Minnesota Pollution Control Agency (MPCA) completed a "Limnological Investigation" of the Sauk River Chain of Lakes identifying the major point source pollutant contributors, i.e. the Melrose Waste Water Treatment Plant (WWTP). The Sauk River Watershed District addressed the identified point sources as recommended by the MPCA. However, area citizens continued to express their concerns about poor water quality. Therefore, a Phase I Diagnostic Study was conducted on the Sauk River Chain of Lakes in 1989 as requested by the Sauk River Chain of Lake Association. The Sauk River Watershed District sponsored the Phase I Diagnostic Feasibility Study with funding from the Environmental Protection Agency (section 314 of the Clean Water Act) and the report submitted to the MPCA in 1992. The objective of this study was to determine baseline hydrologic, water quality and ecological information to make necessary remedial and management decisions. The problems identified have had a detrimental impact on recreation, aesthetics, economics, and the aquatic environment in the area.

Water quality data collected during the 1992 study concluded that phosphorus reduction had occurred since the Melrose WWTP Alum Treatment implementation and the cities of Sauk Centre, Freeport and Osakis upgraded their systems. However, the 1992 study concluded that non-point sources of phosphorus (NPS), such as agricultural and feedlot runoff and septic systems, impacted the Sauk River significantly more than previously anticipated. Therefore, "swimming impaired" conditions will likely continue and "no recreation" conditions may be encountered within twenty years causing immediate economic consequences to this area unless a major reduction in nutrient and sediment loading is transpired,

The Stearns County Soil and Water Conservation District, USDA Natural Resources Conservation Service, Minnesota Board of Soil and Water Resources, Minnesota Department of Natural Resources, U.S. Fish And Wildlife Service, Stearns County Environmental Services, Sauk River Chain of Lakes Association, Sauk River Watershed District and the area agricultural community are actively working towards improving and protecting the water quality of the Sauk River Chain of Lakes. As a result of these efforts, a strong partnership between the above-mentioned agencies has been formed. For example, the Stearns County Soil and Water Conservation District (SWCD) and Natural Resources Conservation Service (NRCS) established four programs which are centered around agricultural waste management and water quality plans to address non-point source pollution. The funds to implement these programs are from local, state and federal agencies such as the U.S. Department of Agriculture which funds the "Environmental Quality Incentive Program" (EQIP). Further information regarding the SWCD/NRCS programs implemented within the Sauk River Chain of Lakes watershed can be found on the Stearns County Soil and Water Conservation District web site.

The Sauk River Chain of Lakes are important lakes in the Sauk River Watershed District and are major economic assets to this region. Property values immediately surrounding the Sauk River Chain of Lakes were estimated to exceed $50,000,000 (County Assessor's office). Using the techniques of Todd (1990) the

estimated number of jobs attributed to these lakes' existence was 40 (or 16.5 jobs per thousand acres) and direct and indirect impact on the total gross output was estimated to be $3,007,378 (or $1,226 per acre); with total value added ($548 per acre) about $1,344,244. This is in addition to tax revenues generated for schools, roads and other public services. In general, it is reasonable to conclude that the Sauk River Chain of Lakes contributes at least $4 million to the local economy each year making these lakes a crucial factor in diversifying the local economy.

Water quality degradation can be expected to detract from the economic values that these lakes provide unless strong efforts are made to reverse the declining water quality. In 1980, Larson documented a loss of property value due to declining water quality caused by point sources of pollution. In more resent studies, Parson 2003, non-point sources of pollution have shown to have a negative economic impact to lake shore property values and area communities. In short, it is in the best interests of the entire watershed community to protect and improve its water quality of all area lakes and streams.

The primary focus of the Sauk River Chain of Lakes Watershed Management project was to prevent the chain of lakes from further degradation and to attempt to improve its current condition. Maintaining the Sauk River Chain of Lakes' water quality will have significant impact on the local area's economic diversity. Improving water quality has positive effects upon property values, recreational opportunities and jobs created in the local economies. Strong efforts have been made to attain the non-degradation goal set in the project work plan and to maintain, or improve, the water quality conditions stated in the Sauk River Watershed District's 2000 Sauk River Chain of Lakes CWP Phase IIA Final Report (previously known as Horseshoe Chain of Lakes). Efforts made through this CWP project appear to have improved the water quality conditions in several lakes within the Sauk River Chain of Lakes based on the latest lake modeling completed by the Minnesota Pollution Control Agency technical staff (see Appendix F). However, more work is needed to achieve the long term water quality goals set for the Sauk River and the Sauk River Chain of Lakes.

The project partners and local residents have recognized the changes occurring in the Sauk River Chain of Lakes and have made a commitment to improve this important water resource. In addition to being extremely important in the Diagnostic Study, local citizens and resource professionals were instrumental in the implementation of this improvement project and its overall accomplishments.

The Sauk River Chain of Lakes area citizens established a steering committee with representatives from the agricultural community, lakeshore property owners, and township board members to reflect the diverse land use within the Sauk River Chain of Lakes watershed. The Sauk River Chain of Lakes Citizen Steering Committee consulted with the Sauk River Watershed District to develop long and short term goals for Sauk River Chain of Lakes and its watershed. The Steering Committee determined that the total phosphorus, ortho phosphorus, and suspended solids concentrations in Sauk River Chain of Lakes should be reduced to attainable levels as defined by ecoregion assessments

Water Quality Evaluations

The Sauk River Chain of Lakes is made up of two types of lakes, which are referred to as flowage and non-flowage (see figure 3). The short-term and long term goals set for the Sauk River Chain of Lakes project were established to address each lake type. The short term in-lake goal for the Chain of Lakes was to reduce average epilimnetic Total Phosphorus levels to less than 90 ug/L (from approx. 262 ug/L) in the *non-flowage* lakes and less than 125 ug/L (from approximately 460 ug/L) in the *flowage* lakes. The long term water quality goal was to achieve average in-lake Total Phosphorus concentrations of 50-90 ug/L or less in the *non-flowage* lakes and less than 90 ug/L in the *flowage lakes* (see Figures 4 and 5). The short-term transparency goal for Sauk River Chain of Lakes (all lakes) was to maintain a summer average of 5+ feet. The long-term transparency goal is to maintain or exceed 6.5 feet as a summer average (see Figure 6).

Figure 2

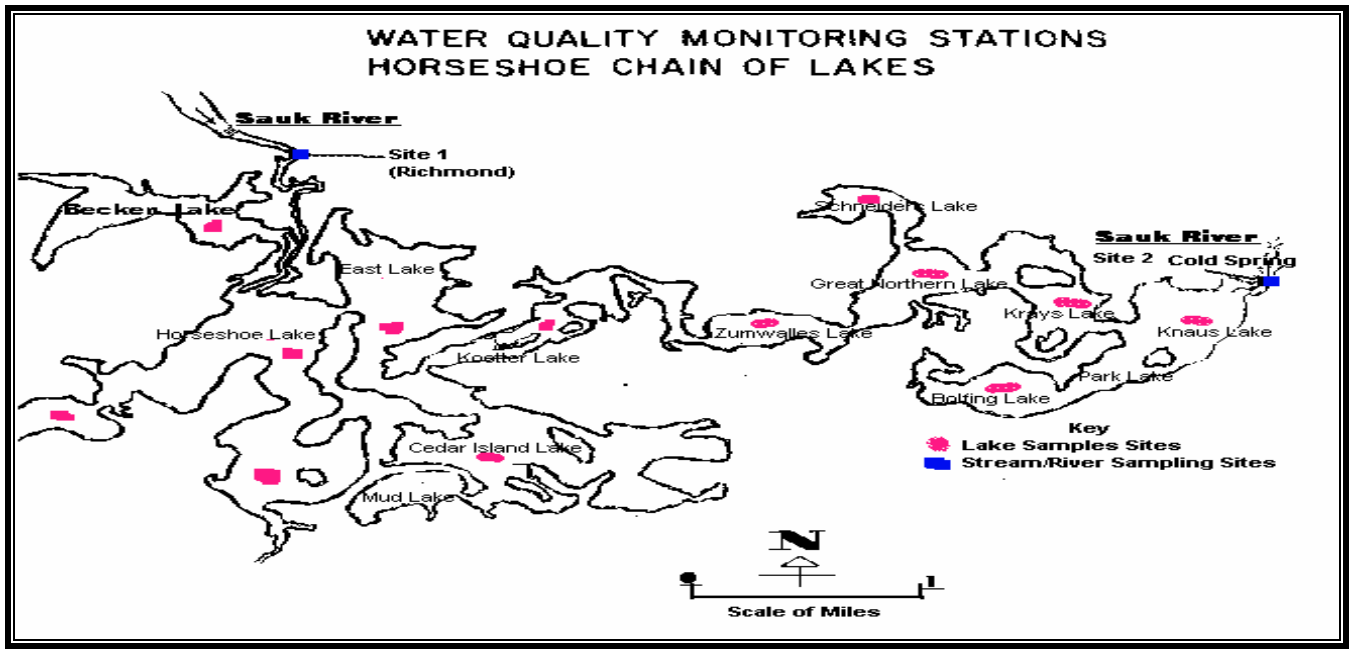

WATER QUALITY MONITORING STATIONS
HORSESHOE CHAIN OF LAKES
Sauk River
Site 1
(Richmond)
Becker Lake
East Lake
Horseshoe Lake
Koetter Lake
Cedar Island Lake
Mud Lake
Schneiders Lake
Great Northern Lake
Zumwalles Lake
Sauk River
Site 2 Cold Spring
Krays Lake
Knaus Lake
Park Lake
Bolting Lake
Key
Lake Samples Sites
Stream/River Sampling Sites
N
Scale of Miles

Figure 3

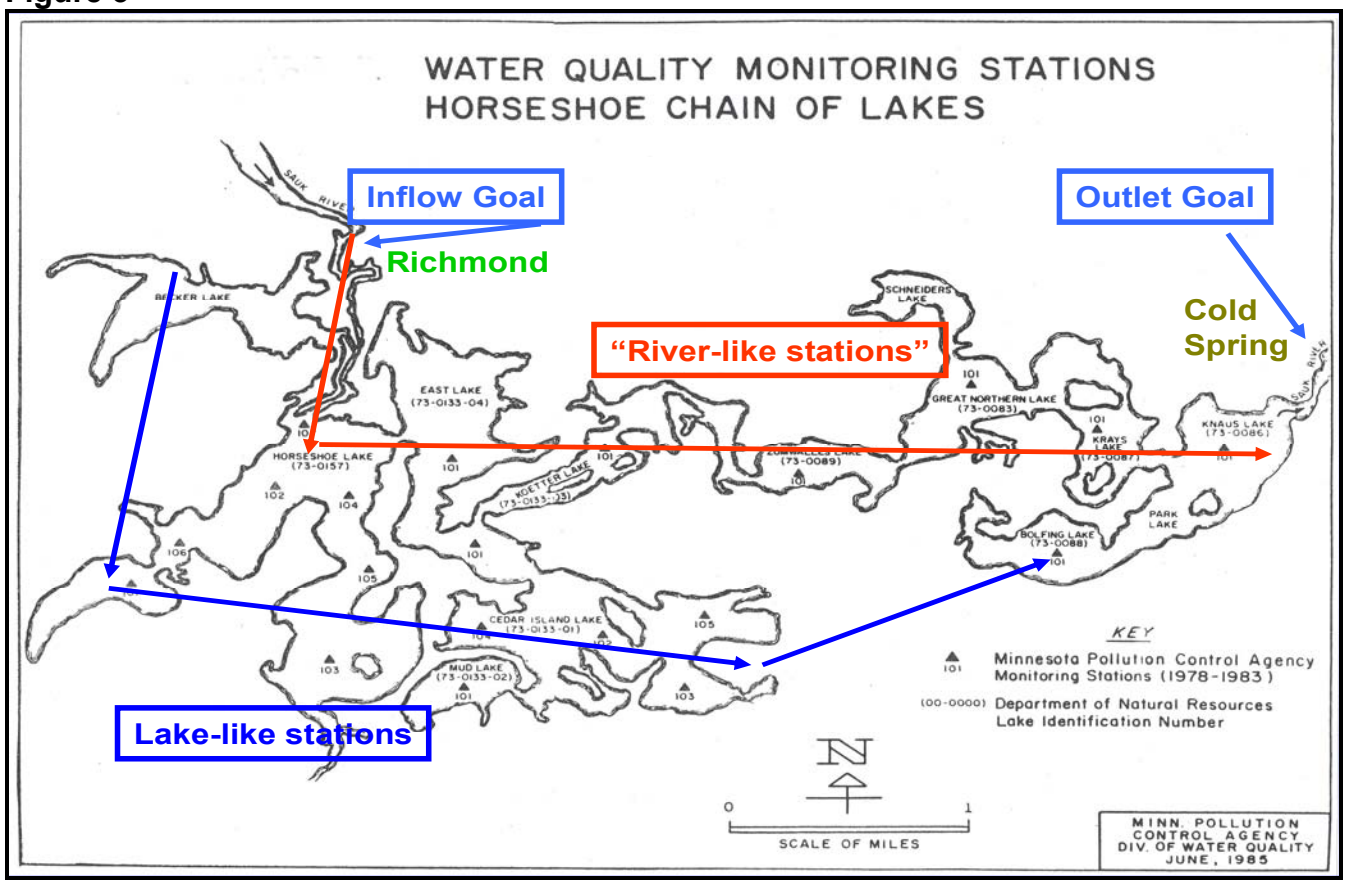

WATER QUALITY MONITORING STATIONS
HORSESHOE CHAIN OF LAKES
Inflow Goal
Richmond
Outlet Goal
Cold Spring
"River-like stations"
Lake-like stations
KEY
Minnesota Pollution Control Agency Monitoring Stations (1978-1983)
(00-0000) Department of Natural Resources Lake Identification Number
N
SCALE OF MILES
MINN. POLLUTION CONTROL AGENCY
DIV. OF WATER QUALITY
JUNE, 1985

Figure 4

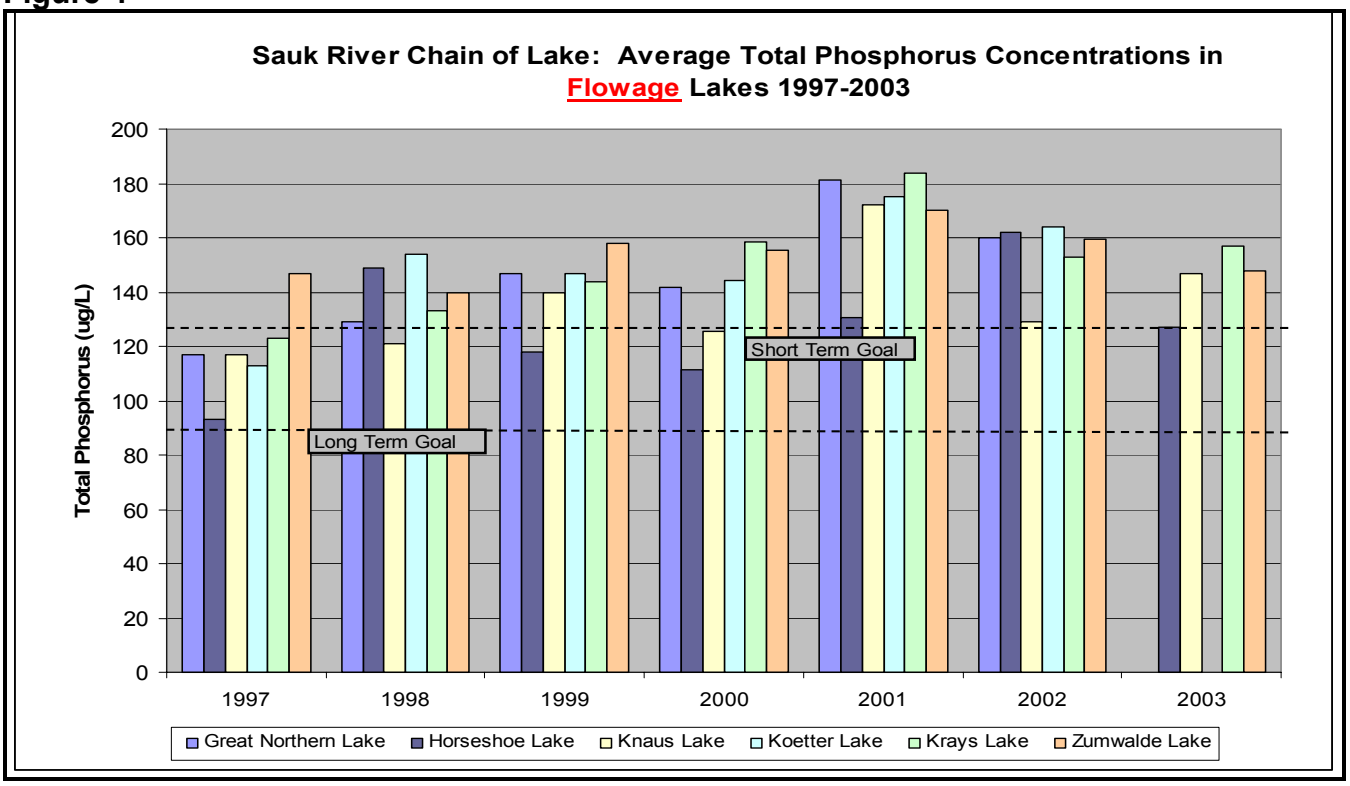


Figure 5

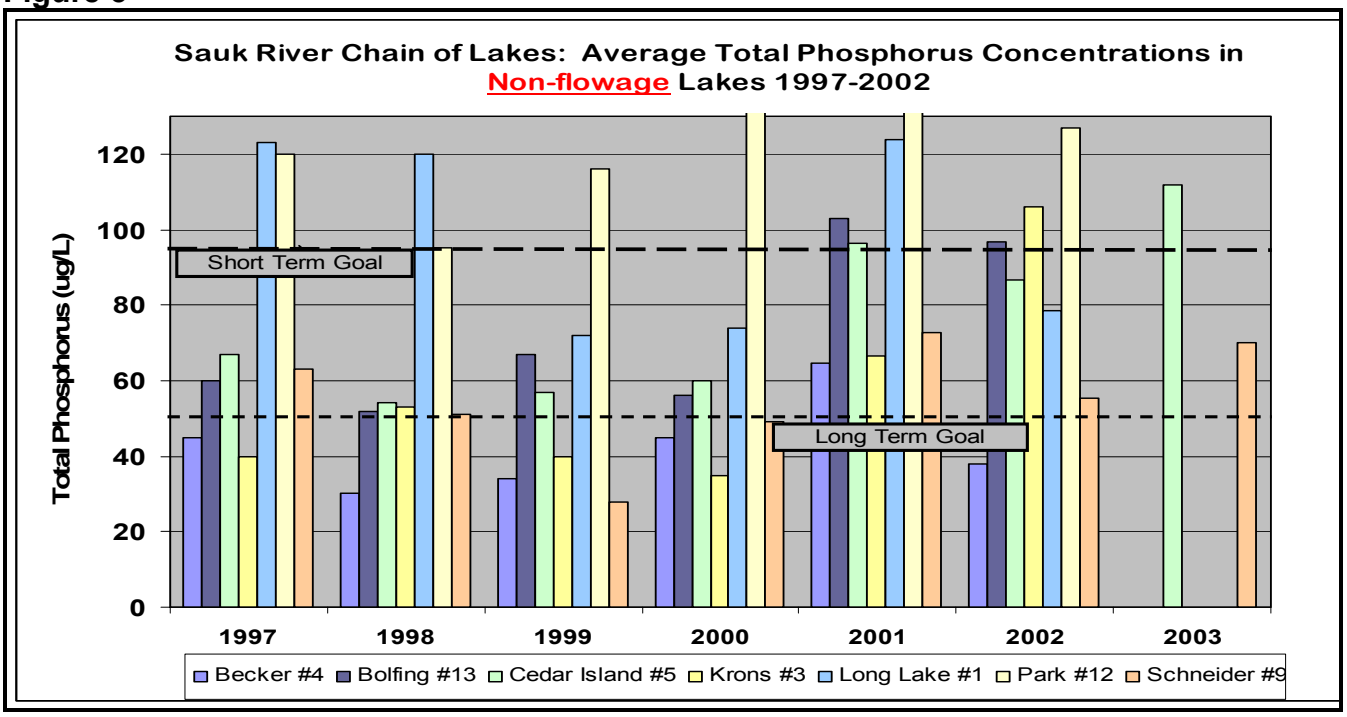


Figure 6

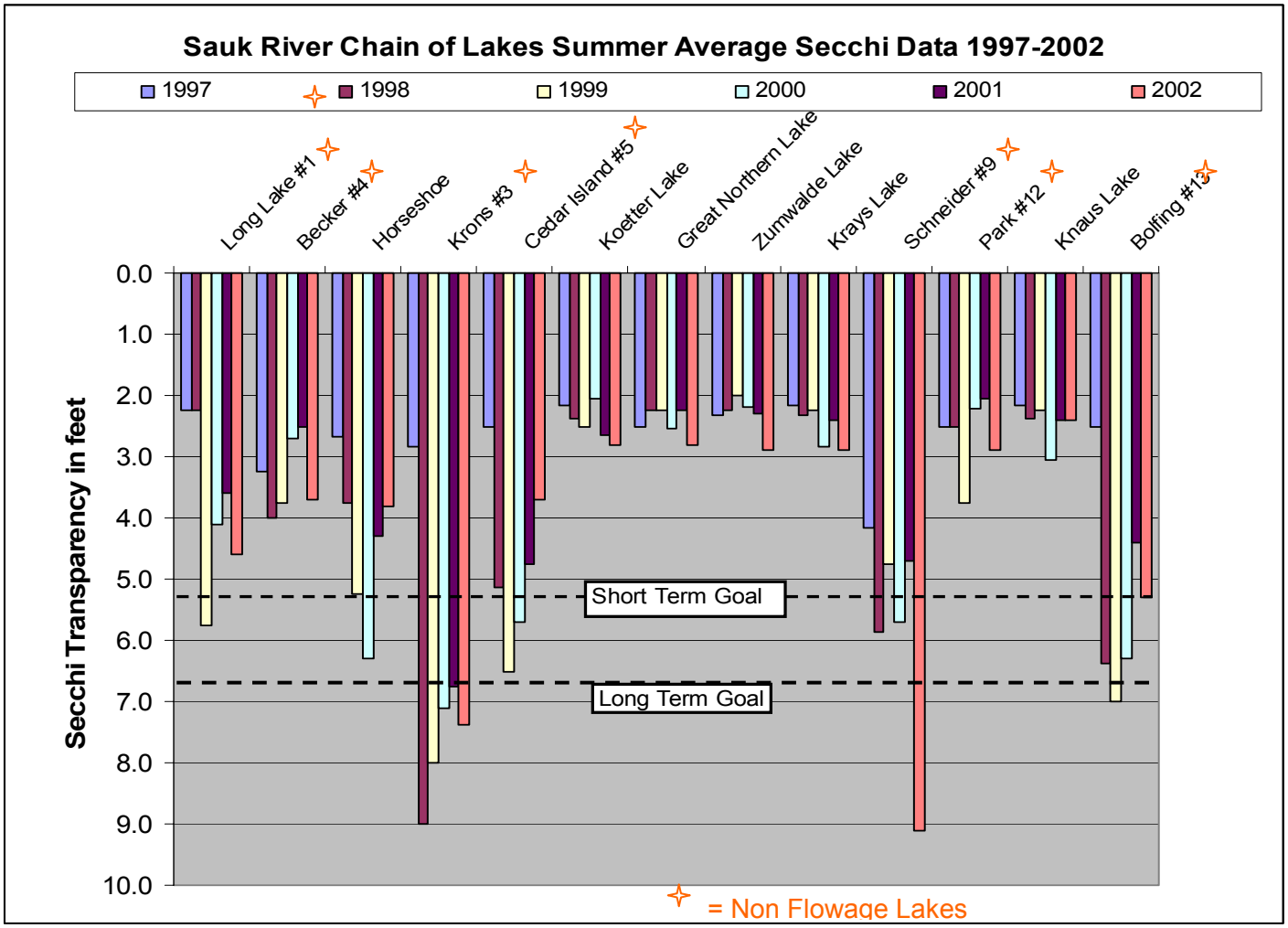
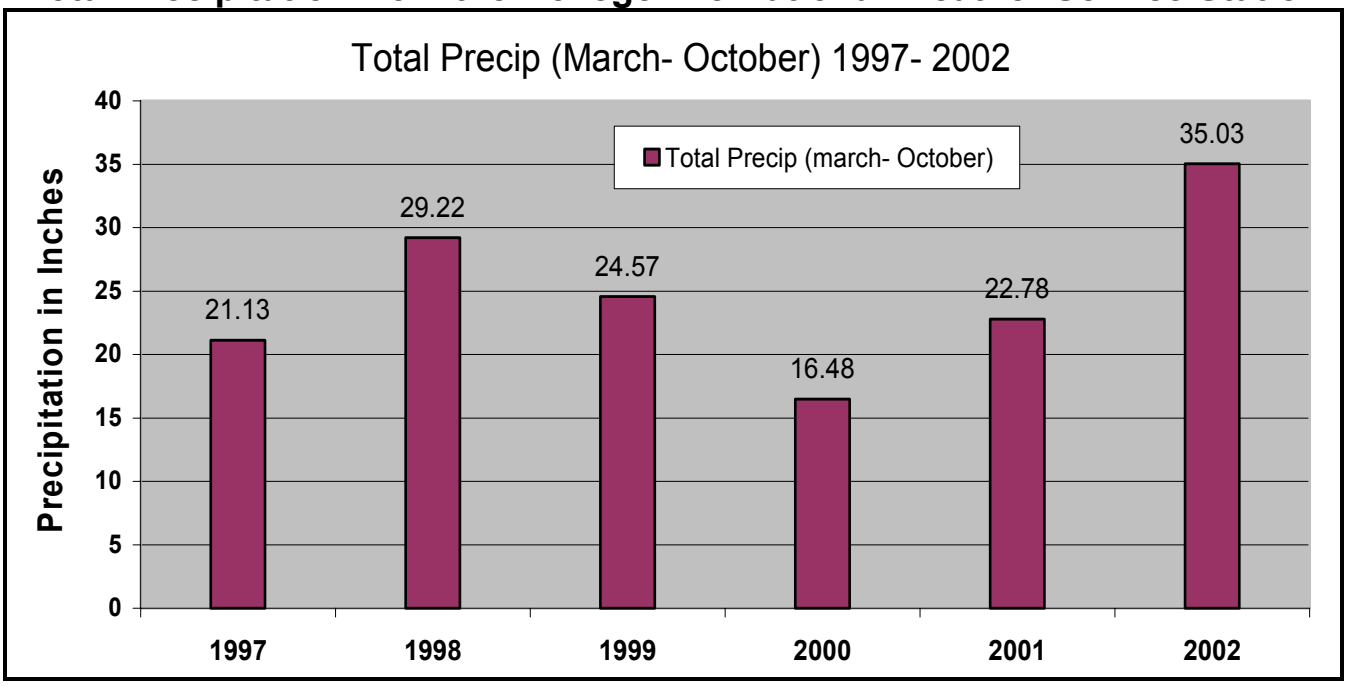

Sauk River Chain of Lakes Summer Average Secchi Data 1997-2002
1997
1998
1999
2000
2001
2002
Long Lake #1
Becker #4
Horseshoe
Krons #3
Cedar Island #5
Koetter Lake
Great Northern Lake
Zumwalde Lake
Krays Lake
Schneider #9
Park #12
Knaus Lake
Bolfing #13
Secchi Transparency in feet
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Short Term Goal
Long Term Goal
= Non Flowage Lakes

Figure 7

Total Precipitation from the Collegeville National Weather Service Station



Since the Diagnostic study (1988-92), the amount of annual rainfall has fluctuated from year to year, making it difficult to determine overall results. As shown in Figure 7 the summer rainfalls (March through October) were less frequent in years 1997, 2000-2001 which was favorable to the Sauk River Chain of Lakes overall water quality from a runoff standpoint. However, in 1998, 1999 and 2002 the rainfall increased which showed more negative results in data collected

The Sauk River Chain of Lakes was measured for Total Phosphorus concentrations during the open water seasons of 1999-2002. As shown in Figures 4 through 6 there is significant difference between the flowage and non-flowages lakes in both the Total Phosphorus concentrations and transparency levels. Figure 8 depicts these differences as seen between flowage lakes (Horseshoe, Zumwalde and Knause Lake) and non-flowage lakes (Cedar Island, Becker and Schnieder Lake) when comparing Total Phosphorus concentration data collect on the same day throughout the monitoring season.

Positive changes in water quality have occurred in the Sauk River since the 1992 Diagnostic Study according to the latest modeling data, shown in Figure13. However, it is evident that additional water quality improvements are needed in order to achieve the Total Phosphorus and transparency goals set for the Sauk River Chain of Lakes. For additional transparency and Phosphorus data see Appendix A.

Figure 8

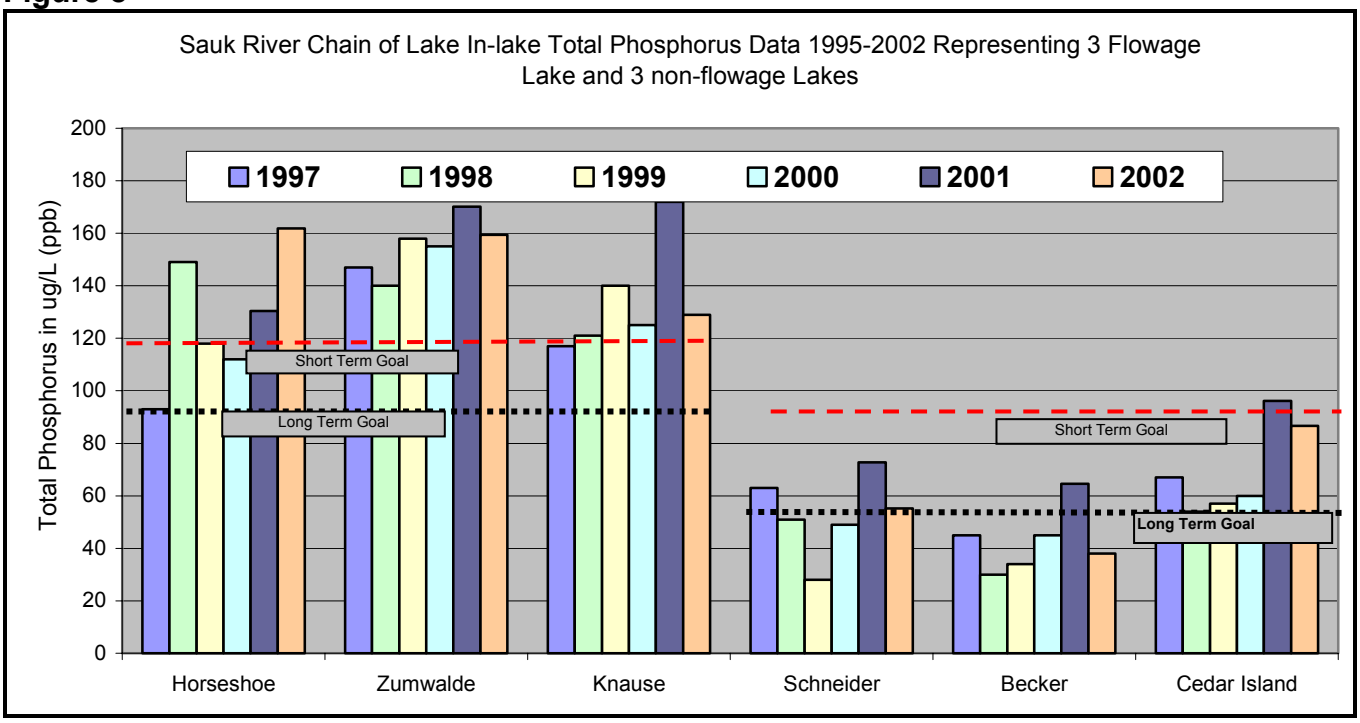


Figure 9

North Central Hardwood Forest Stream Data 1970-1992 Annual

		MAX		MEAN						MIN
Parameter	**N**	**Mean**	**SD**	**100%**	**95%**	**75%**	**50%**	**25%**	**5%**	**0%**
Tss (mg/L)	**278**	**13.7**	**22.5**	**330**	**41**	**16**	**8.8**	**4.8**	**2**	**.5**
T Ammonia	**277**	**. 2**	**.2**	**1.3**	**.46**	**.2**	**.2**	**.1**	**.04**	**.02**
NO2 + NO3	**139**	**.16**	**.15**	**.65**	**.46**	**.26**	**.1**	**.04**	**.01**	**.01**
T Phos. (mg/L)	**277**	**.13**	**.15**	**1.6**	**.36**	**.15**	**.09**	**.06**	**.04**	**.01**

(Data from MPCA Water Management)

.15 mg/L is equivalent to 150 ug/L

The primary goals of the Phase II watershed management efforts were to reduce the total phosphorus, ortho phosphorus and total suspended solids concentrations for the Sauk River to target goals of 100-150 ug/l of total phosphorus, ortho phosphorus to less than 30% of the total phosphorus and total suspended solids to < 20mg/L as shown in Figure 9. The main focus areas have been the Stoney, Unnamed and Getchel Creek subwatersheds (in conjunction with the Stearns County SWCD 319 project) since they were identified as significant contributors of phosphorus into the Sauk River.

The past eight years have been relatively “wet” with the exception of 2000. Nutrient and sediment concentrations generally increase during wet years and therefore measuring improvements in water quality becomes more difficult. This is reflected in Figures 10 through 12 which show the changes in the flow-weighted mean concentrations in Total Phosphorus from 1995-2002 during wet and dry years.

Figure 10

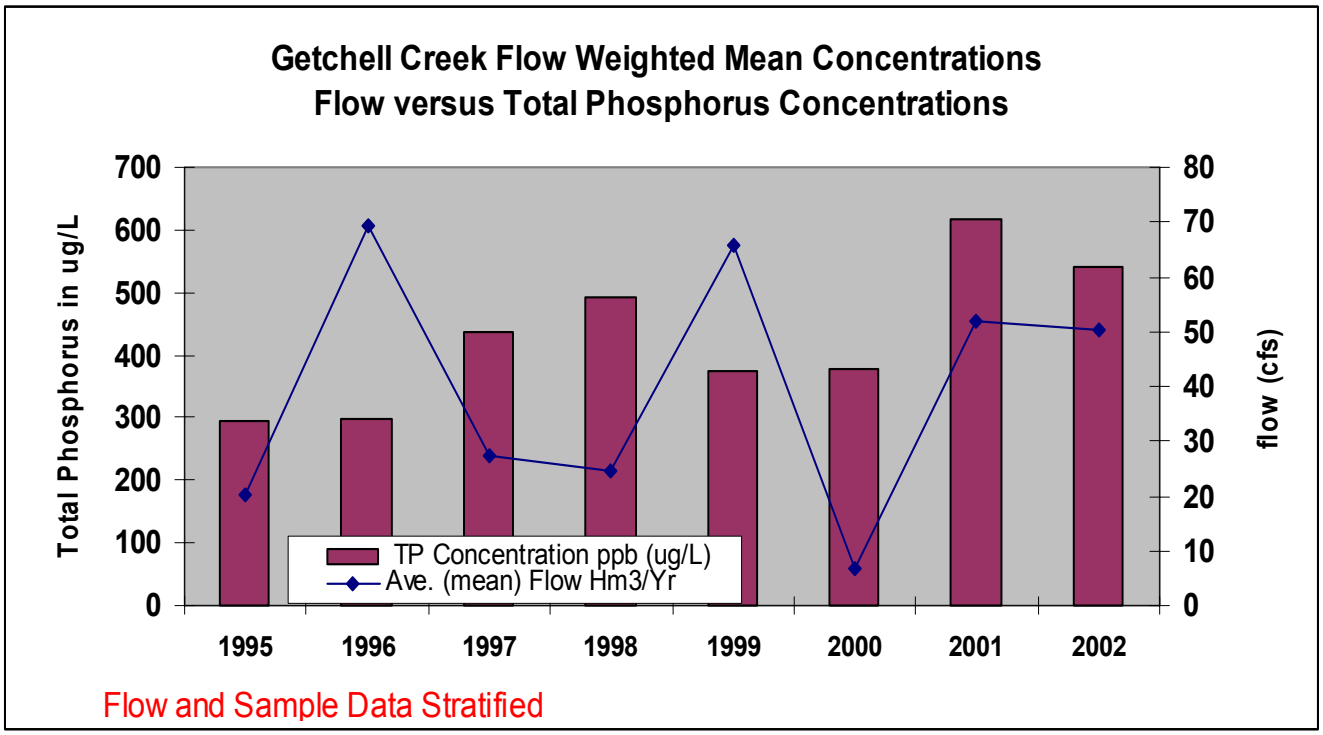
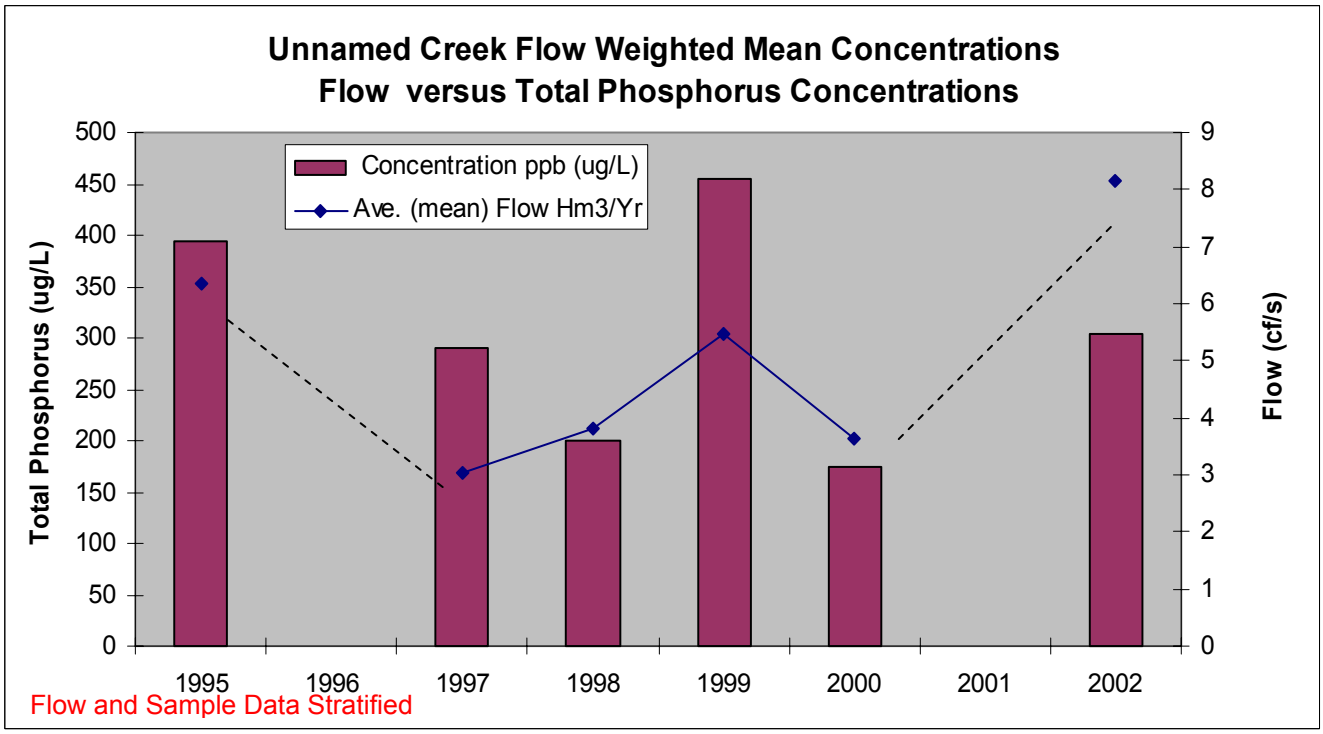
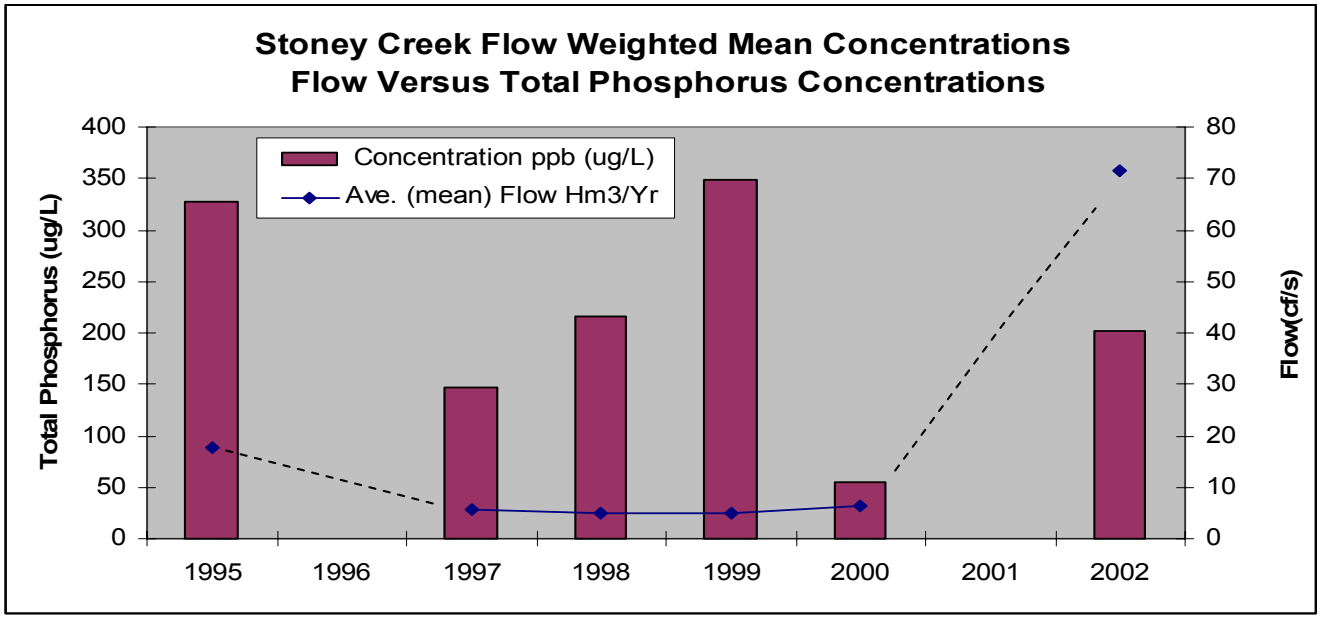


Figure 11



Note: 1996 and 2001 did not have enough flow data to run the FLUX Model.

Figure 12



Note: 1996 and 2001 did not have enough flow data to run the FLUX Model.

Upgrading feedlots and implementing Best Management Practices throughout the watershed appears to have reduced the total phosphorus concentration in the Sauk River. According to the MPCA's 2004 Sauk River Chain of Lakes Water Quality Update (SRCOL 2004 Update) the 2002 annual flow weighted mean concentration was determined to be about 176 ug/L in the Sauk River (see Figure 13). The MPCA's SRCOL 2004 Update states that the past two decades of watershed phosphorus management have made measurable (and statistically significant) improvements in water quality parameters. The average inflow total phosphorus concentrations into the Sauk River Chain of Lakes have dropped from 300 to 1220 ug P/L (MPCA, 1985) to a low value of 176 ug P/L (annual flow-weighted mean for 2002 and 2003). This represents about 48%+ decrease in total phosphorus loading over this time from improvements to a combination of municipal wastewater (majority of the reductions) and agricultural sources (likely 10 to 20% reductions).

- **1983 total phosphorus load = 347,000 pounds (wet year, 425 Hm3) vs.**
- **2003 total phosphorus load = 167,757 pounds (wet year, 326 Hm3)**

Figure 13 **Sauk River at Richmond and Cold Spring Modeling (FLUX) Summary**

Richmond Site on Sauk River

Year	Total Phosphorus FWM	CV	Est. Flows Hm3/Year	Load P kg	Load P lbs
2000	167		114.1007	19,054.8	42,015.9
2001	239		377.5671	90,238.5	198,976.0
2002	178	0.08	345.7564	61,544.6	135,705.9
2003	176	0.08	312.4141	54,984.9	121,241.7

Cold Spring Site on Sauk River

Year	FWM	CV	Est. Flows Hm3/Year	Load P kg	Load P lbs
2000	154				
2001	162		340.3	55,128.0	121,557.2
2002	160	0.08	393.4	62,936.2	138,774.3
2003	160	0.08	326.5	52,243.8	115,197.5

The 1985 MPCA study predicted lake responses to a reduction in Total Phosphorus loading. The current lake modeling results completed by the MPCA indicate that the Sauk River Chain of Lakes are following the 1985 predictions rather closely (see Figures 14 and 15). Additional information regarding the Sauk River Chain of Lakes Water Quality lake modeling results is available on the MPCA web site and Appendix F.

Figure 14

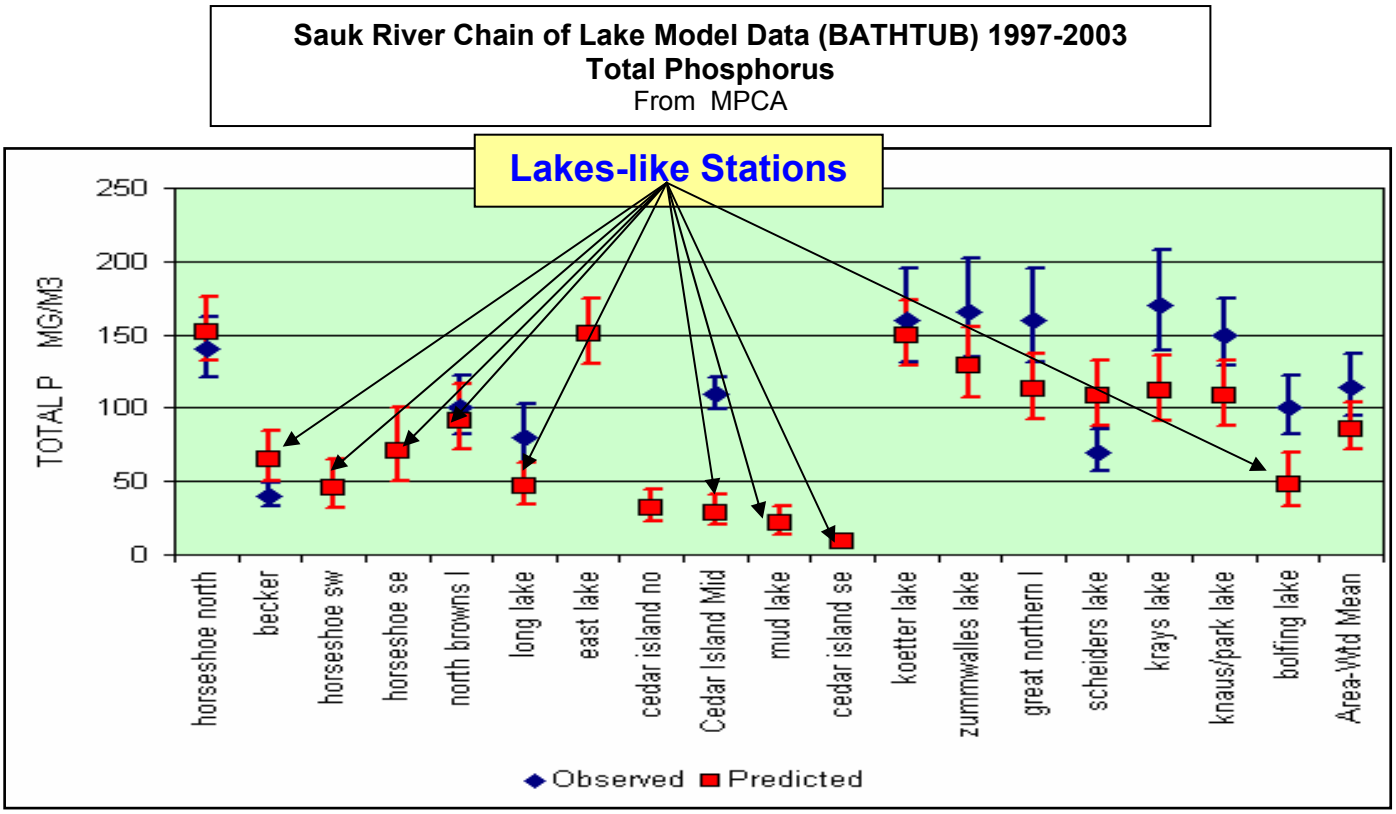
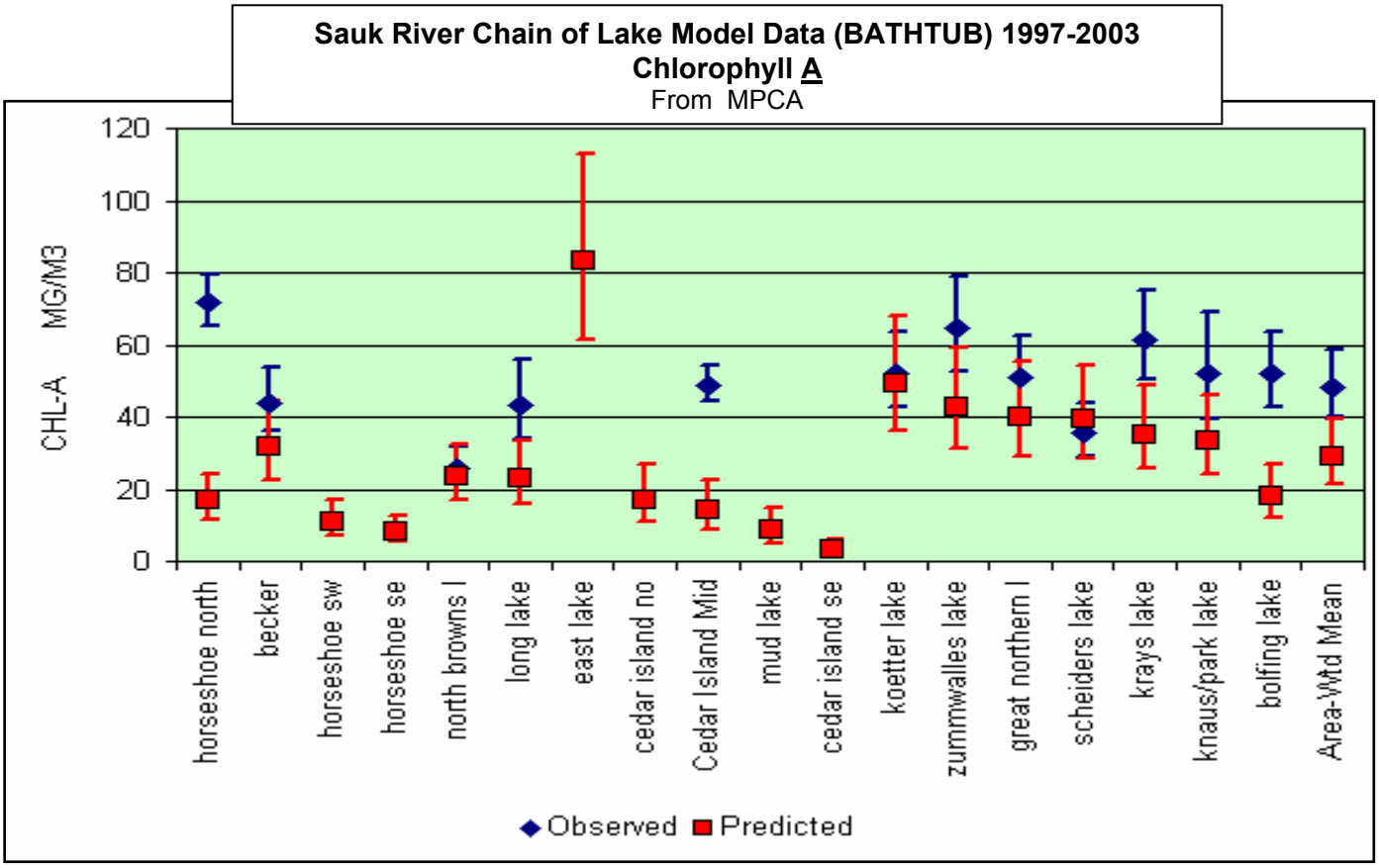


Figure 15



The MPCA 1985 Study and the 1992 Diagnostic Study recommended that on-site sewage treatment systems be reviewed and addressed to meet state standards in addition to the agricultural related nutrient concerns. Although a complete septic system survey was not completed for the Sauk River Chain of Lakes during the diagnostic studies, it was estimated that nearly 70% of the homes around the Sauk River Chain of Lakes had non-conforming or sub-standards systems based on the surveys completed for Big Birch Lake and Osakis Lake, the 1992 Groundtruth Report of the Horseshoe Lake (AW Research -1992) plus the information received from the Stearns County Environmental Service department.

The nutrient contribution from septic systems was found to be higher than expected during the 1992 Diagnostic Study and should be considered important because the form of phosphorus discharged to the lakes would be in the dissolved form, which is more readily available to aquatic vegetation. The non-conforming or sub-standard septic systems have been addressed through the Stearns County Environmental Services with financial assistance from the Sauk River Watershed District utilizing the SRF loan program.

Management Goals

SHORT AND LONG TERM WATER MANAGEMENT GOALS

The Steering Committee adopted short term goals that could be achieved within 1 to 3 years. These goals were incorporated with those recommended in the MPCA Limnological Study and the WRM Diagnostic Feasibility Study. According to these studies, the Sauk River contributes the largest percentage of total and ortho phosphorus into the Sauk River Chain of Lakes. The short term phase II actions focused largely on agricultural and shoreland concerns within the Sauk River Chain of Lakes' watershed and began longer-term education, landuse management, septic tank upgrading and monitoring efforts.

The long term goals (e.g. 5 or more years) will require more personal commitment from everyone. These goals will be achieved once the necessary improvements are made and smaller scale enhancements are carried out. The long and short term goals set for Sauk River Chain of Lakes are shown below.

Short Term Goals (1-3 years)

Sauk River Chain of Lakes

- Implement education programs
- Implement water monitoring program
- Non-degradation goal - to maintain 1992 water quality conditions, at a minimum, allowing for natural year to year variability.
- Reduce flow weighted mean average TP concentrations of the Sauk River (in-flow) to <150 ug/L.
- Reduce in-flow average total suspended solids concentrations to approximately 16,000 ug/L.
- Reduce average epilimnetic whole TP to< 90 ug/L for non-flowage lakes and <125 ug/L for flowage lakes
- Chlorophyll A 40 ug/L +/-5
- Summer transparency 5 feet +/-1ft

Long Term Goals (5 plus years)

Sauk River Chain of Lakes

- Maintain education programs and project effectiveness monitoring.
- Flow weighted mean average TP concentrations of the Sauk River (in-flow) - 100-125 ug/L.
- In-flow average total suspended solids concentrations - approximately 9,000 ug/L.
- Average summer TP concentrations 50-90 ug/L for non-flowage lakes and 90 ug/L for flowage lakes.
- Average summer Secchi transparency - greater than 2 meters
- Chlorophyll A 20ug/L +/- 5
- Achieve 90 % compliance with county ordinance septic tank rules by year 2005.

The efforts made by the residents of the upper tributaries and the Sauk River Chain of Lakes by completing on-land improvements (septic systems, feedlots, buffer strips, wetland restoration, etc) are the reason for the project's success in maintaining its water quality status. However, more is still needed to attain the goals set for the Sauk River Chain of Lakes.

Continued Management

The water quality monitoring of the Sauk River Chain of Lakes has shown that the Total Phosphorus levels have decreased, but not to the levels which more closely resemble the ecoregion concentrations. Continued efforts are needed to protect and improve the Sauk River Chain of Lakes current water quality.

- The goal for in-flow total suspended solids has not been reached (TSS concentrations of 16,000ug/L or less). To reach this goal, continued improvements are needed within the watershed of the Sauk River Chain of Lakes to reduce the sediment loading to the Chain of Lakes. Particularly the Stoney, Getchel, Unnamed and Eden Creek subwatersheds as well as public and private drainage ditches.
- The goal to reduce the in-lake total phosphorus concentrations to 50ug/L for non-flowage lakes and 90ug/L for flowage lakes has not yet been attained for all the lakes within the Sauk River Chain of Lakes. As shown in Figures 4 and 5 the Total Phosphorus concentrations are approximately 40% higher than the set goals.
- All non-conforming and substandard septic systems surrounding these lakes and adjacent to tributaries within the watershed have not yet been brought to compliance.
- Individuals and agency staff should continue to explore opportunities to provide assistance to farmers within the subwatersheds of the Sauk River and other subwatersheds of Sauk River Chain of Lakes (i.e. Sneider Creek, Adley Creek, Kinzer Creek, and Kolling Creek).
- Minimizing agricultural runoff will help to assure that long-term water quality goals are maintained.
- Continued education regarding manure management, stormwater runoff, lawn maintenance and shoreland activities.
- Encourage landowners to blend water quality protection activities into their shoreland management and landscaping activities.
- Volunteer monitoring of Secchi Disk transparency and further laboratory analysis of total phosphorus and Chlorophyll A concentrations will determine long-term trends, mark progress toward achieving long-term water quality goals and more clearly identify year to year variability inherent in the lake system.

BMP OPERATION AND MAINTENANCE PLAN:

Ag-Waste Management:
Agricultural producers, funded through the CWP and 319 programs, will be invited to attend all workshops offered by the Stearns County SWCD and the SRWD. The SRWD and other project partners will continue to work with the residents to further improve their land use management practices. In addition, The SWCD will conduct periodic visits to analyze the overall project success.

Landowners receiving cost share dollars are required to sign a contract with the SRWD. This contract states that the cooperator (grant recipient) must adopt the operation and maintenance requirements as described in

the Operation and Maintenance Plan (O&M) designed by the Stearns County NRCS, SWCD and JPA Engineer. In addition, the cooperator must submit a letter of compliance to the Stearns County SWCD every year throughout the life expectancy of the improvement structure. If the cooperator fails to comply with the O&M plan, without pre-approval from the SWCD, they agree to repay the SRWD all cost- shared dollars used for this site project.

Septic Systems
Upgrading nonconforming septic systems will continue beyond the duration of this project until all systems have been inspected and improved by the county. Individual landowners will be responsible for the upgrade of their septic system. However, the Sauk River Watershed District and county officials will continue to provide technical assistance where needed and to search for financial assistance to assist landowners in accomplishing this aspect of the project.

As septic systems are inspected and approved, the Sauk River Watershed District will record all data in the project database to track the number of systems completed and act as a progress report. If cluster systems are installed, information regarding these systems will also be recorded and stored in the project database. Landowners using the SRF program received a septic system guidebook to encourage proper operation and maintenance.

Continuing Education
Education seminars will be conducted as previously described. Attendance will be taken at all seminars to determine the number of residents interested in obtaining the information offered. After each seminar, an assessment survey will be filled out be each attendant to get feedback on the effectiveness of each seminar. In addition, those attending the seminars will be given names and phone numbers of the local environmental agencies who can provide them with additional information and assistance.

Water Quality Monitoring and Evaluation.
The purpose the monitoring plan is to track the effectiveness of the watershed management activities. Thirteen in-lake sites, five tributary sites and two river sites are currently being monitored for nutrient concentrations. Sample collection and field analysis continue to be conducted by the Sauk River Watershed District with assistance from local volunteers and members of the Sauk River Chain of Lakes Association. Local volunteers will continue Secchi disk monitoring throughout the open water season. All data will be recorded and entered in the database for final analysis. The stream and in-lake monitoring will extend beyond the project time period to monitor the effectiveness of the Sauk River Chain of Lakes Improvement Project (MNPCA CWP and EPA 319 combined project). Data collected will be recorded and stored in the project database for submittal to the MPCA.

Reporting and Project Tracking\Administration.
The Sauk River Watershed District and the Stearns County SWCD recorded all data collected throughout these projects and submitted to the MPCA. Reporting, tracking and management of the Sauk River Chain of Lakes Improvement Project was completed by the Sauk River Watershed District. Reporting, tracking and management of the “Accelerated Water Quality Program” project was done by the Stearns County SWCD for the EPA 319 grant project. Required reports and data were recorded in STORET for storage and standard retrieval.

Conclusion

The Sauk River Watershed District began monitoring the Getchel Unnamed and Stoney Creek subwatersheds and the Sauk River at the Richmond and Cold Spring sites since 1995. The lasted monitoring data concludes that Total Phosphorus flow weighted mean concentrations have declined at the Sauk River Richmond site from 223 in 1995 to176 in 2002 and 2003. The latest modeling completed by the MPCA indicates an improvement in the overall water quality of the Sauk River Chain of Lakes. However, significant efforts are needed to achieve the goals set for the Sauk River and the Sauk River Chain of Lakes for Total Phosphorus concentrations and Total Suspended Solids concentrations.

Recommendations

Water quality monitoring on the Sauk River (at Richmond) has shown that the Total Phosphorus levels have decreased from the 1992 levels and has maintained at a level more closer to the goal (<150 ug/L) set for the Sauk River (see Figure 13). Additional Total Phosphorus reduction is needed throughout the Sauk River watershed in order to reduce the in-lake Total Phosphorus concentrations in the Sauk River Chain Lakes and ultimately the Mississippi River.

The goal for Total Suspended Solids (TSS) has not been reached. The initial goal was to attain TSS concentrations of 16,000ug/L or less. The 1999-2002 summer average TSS concentrations ranged from 50,000 to 90,000 ug/L (ppb). Additional improvements are needed in the Sauk River watershed to reduce the sediment loading to the Sauk River Chain of Lakes.

One major problem is bank undercutting of the Sauk River and its tributaries due to overgrazing and high flows. Structural and non-structural erosion control projects will reduce sedimentation within the Sauk River and protect habitat within and along the river. Reducing the amount of sediment delivered to the Chain of Lakes will reduce the amount of phosphorus entering the lake as well as protecting habitat for fish and other aquatic life. Reducing the sediment load will also improve the water clarity within the Chain of Lakes. Stabilizing eroding lakeshore areas will also help to reduce phosphorus and sediment loading to the lake and protect habitat. This may be accomplished by re-establishing native shoreland vegetation, installing structural protection such as rip-rap or changing shoreland management practices.

Although many individuals have updated their septic systems during the course of the initial implementation phase of the Clean Water Partnership, there is still additional work to be done in this area. Approximately 32% of the systems around the lake still need to be improved.

The highest priority feedlots within the Sauk River watershed have been and continue to be addressed by the SRWD and the local SWCDs as funds are available. Project partners, Individuals and agency staff should continue to explore opportunities to provide assistance to area farmers within the Sauk Rive Chain of Lakes watershed. Minimizing agricultural runoff will help to assure that long-term water quality goals are maintained.

Continued education regarding lawn maintenance, manure management, septic system maintenance and shoreland protection is recommended for Sauk River Chain of Lakes residents and watershed residents. As new owners move in, they need to be aware of the ongoing efforts and become involved in these activities. The Sauk River Chain of Lakes Association can help welcome new members to the lake community and

provide information that allows residents to enjoy the lake surroundings and minimize their water quality impacts.

As shoreland property owners become more aware of the benefits of native shoreland vegetation, opportunities should be explored that encourage landowners to blend water quality protection activities into their shoreland management and landscaping activities.

There appears to have been progress made in improving water quality within the Sauk River Chain of Lakes during this implementation phase. Additional monitoring of the system is necessary to track improvement efforts and their impacts to the lake. Volunteer monitoring of Secchi Disk transparency and laboratory analysis of Total Phosphorus and Chlorophyll A concentrations will determine long-term trends, mark progress toward achieving long-term water quality goals and more clearly identify year to year variability inherent in the lake system.

References

1. Brach J. Et.al. Agriculture and Water Quality, Best Management Practices for Minnesota. Minnesota Pollution Control Agency, St. Paul, MN
2. Heiskary, S.A. and Jennifer Lindbloom. Lake water quality trends in Minnesota: Part of a series on Minnesota Lake Water Quality Assessment. 1993. Minnesota Pollution Control Agency, St.Paul, MN. 104pp
3. Heiskary and Wilson (1990). Minnesota Lake Water Quality Assessment Report (LWQA), Deriving phosphorus criteria for Minnesota lakes by ecoregion. Minnesota Pollution Control Agency , St. Paul 72pp
4. Heiskary, S. And B. Wilson. 1990. Minnesota Lake Water Quality Report, Second Edition. Minnesota Pollution Control Agency St. Paul, MN 175pp
5. Larson , S. 1980. Additions and corrections to the economic portions of the draft environmental impact statement, Bemidji Wastewater Treatment System, Beltrami County, Minnesota. Minnesota Pollution Control Agency, St. Paul, MN
6. Stearns County Comprehensive Water Plan, County of Stearns
7. Sauk River Chain of Lakes Association Historical Summary (Audrey Logsdon submittal to SRWD)
8. Todd. Revise to Heiskary, Sa, R. Anhorn, T. Noonan, R. Norrgard, J. Solstad, and M. Zabel. 1994. Minnesota lake and watershed data collection manual. Environmental Quality Board - Lakes Task Force, Data and Information Committee. Minnesota Lakes Association.
9. Vighi and Chiadani. 1985. A simple method to estimate lake phosphorus concentrations resulting from natural background loading. Water Res. 19:987-991.
10. Water Research & Management, Inc. Diagnostic - Feasibility Study Horseshoe Chain of Lakes 1992 Clean Lakes Project #S005957-01
11. Wilson B. Et.al Limnological Investigation of the Sauk River and Horseshoe Chain of Lakes, Sterans County. Minnesota Pollution Control Agency 1985 St. Paul, MN
12. Wilson, Hrubes and Evenson, MPCA Sauk River Water Quality Update May 17, 2004
13. Parson etal. Lakeshore Property Values and Water Quality: Evidence from Property Sales in the Mississippi Headwaters Region June 2003
14. Sauk River Watershed District, Sauk River Chain of Lakes CWP Phase IIA Final Report 2000