Squaw Lake TMDL

(revised August 22, 2000)

This TMDL report is for Squaw Lake, located in the Star Prairie Township, St. Croix County, Wisconsin, in the St. Croix River Basin. The lake is geographically located across portions of Sections 8, 9 and 17 of T31N, R18W of the USGS Somerset North Quadrangle. Squaw Lake is listed on the Wisconsin Department of Natural Resources' (WDNR) 1998 303(d) List of Impaired Waters. The Lake is nutrient (phosphorus (P)) impaired as a result of agriculture, internal loading and local land use, is listed as a *medium priority* water and external load sources are nonpoint source (NPS) dominated. The *designated use* for Squaw Lake is defined as a full recreation, warm water sport fishery water.

Water quality in Squaw Lake is generally poor to very poor, falling in the eutrophic to hypereutrophic category (see "Nonpoint source control Plan for the St. Croix Lakes cluster Priority Watershed Plan" (PWP) report page 35 for a complete description of physical features). Summer lake phosphorus levels are about 270 ug/l. Mats of filamentous algae cover a large portion of the lake bottom and summer algal blooms result in foul odors and an unsightly build-up of algae biomass on the shoreline. In addition, trophic conditions in the lake limit rooting depth for emergent vegetation used by the resident fish populations. As a result, these impairments impact the recreational/aesthetic value of the lake and stress sport fish populations.

Squaw Lake is not currently meeting applicable narrative *water quality criterion* as defined in NR 102.04 (1); Wis. Admin. Code:

> "To preserve and enhance the quality of waters, standards are established to govern water management decisions. Practices attributable to municipal, industrial, commercial, domestic, agricultural, land development or other activities shall be controlled so that all waters including the mixing zone and the effluent channel meet the following conditions at all times and under all flow conditions: (a) Substances that will cause objectionable deposits on the shore or in the bed of a body of water, shall not be present in such amounts as to interfere with public rights in waters of the state, (b) Floating or submerged debris, oil, scum or other material shall not be present in such amounts as to interfere with public rights in waters of the states, (c) Materials producing color, odor, taste or unsightliness shall not be present in such amounts as to interfere with public rights in waters of the state."

This criterion describes the acceptable water quality conditions and guides the WDNR in setting a numerical target pollutant concentration. The application of a narrative criterion for Squaw Lake necessitates the development of a site-specific in-water value for the purpose of this TMDL.

The site-specific value for the in-lake P concentration has been identified as 130 *ug*/L (this value is identified on page 52 of the attached PWP report and pages 4-6 of the supporting PWP Appraisal report).[1] The in-lake P concentration represents the mean growing season epilimnetic (GSE) concentration. This narrative criterion is based on the best professional judgment of the WDNR applied to site-specific conditions, using available monitoring data and modeling tools. The receiving water capacity in this situation represents cleaning-up the waterbody 'to the maximum extent practicable.' Specifically, the intent is to minimize the frequency of algal blooms and reduce nuisance conditions in the lake. The chlorophyll-a concentration in Squaw Lake responds directly to the in-lake phosphorus concentration. As P concentration rises, the chlorophyll-a concentration rises and algae biomass production increases. This cause and effect relationship is measured using a secchi disk to measure water clarity (poor water clarity results in limited emergent vegetation rooting depth and indicates the presence of significant biomass in the water column). Reducing P reduces chlorophyll-a, which results in improved water clarity and diminished algae production.

A number of models were used to estimate the P loading budget. WINHUSLE, a Wisconsin developed USLE/hydrologic runoff model, and the phosphorus export coefficients of the Wisconsin Lake Model Spreadsheet (WILMS) were used to estimate P from uplands (croplands and woodlands). BARNY, a Wisconsin adapted version of the ARS feedlot runoff model was used to estimate phosphorus from animal lots. SLAMM was used to estimate P from residential development. Field inventory data was used to estimate P from manure spreading in winter and shorelines.

WILMS was also used to assess changes in the P budget to in-lake responses for Squaw Lake. The WILMS analysis is based on factors that included: nutrient loading, watershed runoff volume, lake volume, in-lake P retention and the estimated groundwater movement through the lake (see attached WILMS summary). The model runs illustrated that P concentrations changed under different land use scenarios, i.e. installation of best management practices (BMPs).[2] Based on this mass balance concept, the model predicted in-lake P concentration based on all P loading to the water column. Table 1 lists modeled phosphorus loading to Squaw Lake as well as the load allocation (LA). (The data used to generate Tables 1, 2 & 3 can be referenced in the attached PWP plan on page 51).

Total Loading Capacity. The total loading capacity for Squaw Lake is driven by the in-lake P concentration. Nutrient concentrations above this capacity cause the designated use impairments as discussed earlier in this report. The total loading capacity for Squaw Lake was determined using an in-lake P concentration of 130 *ug*/L of phosphorus (based on trophic conditions, i.e. >150 = very poor water quality)[3]. This number is an indication

[1] Wetland restoration and nutrient management in the Squaw Lake watershed could bring the target concentration below 130 *ug*/L, but the WDNR cannot model all of these effects at this time.
[2] Conditions in Squaw Lake were worsened by the historical presence of barnyards that discharged manure piles directly into the intermittent stream during spring runoff conditions.
[3] The intent of the Department of Natural Resources and other local partners in this project is to bring about greater improvement in Squaw Lake than what is indicated by the in lake condition of 130 *u*g/l. This may be achieved through use of additional practices, such as wetland restoration and in-lake alum treatment.

of water quality and in-lake P concentration over this capacity exceeds the *water quality criterion* and triggers algal blooms that lead to use impairments.

Table 1: Squaw Lake Nonpoint Source Annual Phosphorus Budget and LA Reduction Objectives

Nonpoint Source	Inventoried Phosphorus NPS Load (lbs)	Total Load (%)	Planned Load Reduction (%)	Load Allocation (LA) (lbs)
Uplands	1224	42	25	918
Winterspread Manure (uplands)	650	22	25	488
Winterspread Manure (Dry Run)	594	20	100	0
Shoreline	7	<1	50	4
Barnyards	82	3	50	41
Residential Development	18	<1	50	9
Subtotal	**2575**	**87**		**1459**

Load Allocation (LA) for Nonpoint Sources. As illustrated in Table 1, the load allocation for Squaw Lake is estimated to be 1459 lbs/P/year.

Waste Load Allocation (WLA). The WLA for Squaw Lake is 0 as point sources are absent from the watershed. A summary of the land uses in the Squaw Lake watershed lists 100% of the 6,696 acres consumed by crops, pasture, natural area, wetland, forest, residential development and open water (Table 1-1, page 17 St. Croix County Lakes Cluster Report). The addition of future point sources is not anticipated

Natural Background Sources. The WDNR intends to address internal P loading with an alum treatment once control of the watershed (external) sources of phosphorus is achieved. The internal loading is considered background because it cannot be controlled through the conventional means used to limit the external loading. Additionally, groundwater and precipitation are considered a background source and will not be directly managed. Table 2 lists the natural background sources of P to Squaw Lake.

Table 2. Natural Background Annual Phosphorous Loading to Squaw Lake.

Natural Background P Sources	Inventoried P Load (lbs)	Percent of Total Load (%)	Planned Percent Load Reduction (%)	Load Allocation (LA) (lbs)
Internal Loading	330	11	80	66

Precipitation	34	1	0	34
Groundwater	10	<1	0	10
Subtotal	**374**	**13**		**110**

Table 3 Combined Annual Nonpoint Source and Background Loading to Squaw Lake

Category	Inventoried P Load (lbs)	Total Load (%)	Load Reduction (%)	Load Allocation (LA) (lbs)
Nonpoint Source	2575	87		1459
Background	374	13		110
Total	**2949**	**100**	**47**	**1569**

Seasonal Variation. Phosphorus is the pollutant of greatest concern for Squaw Lake as it is the primary cause of poor water quality conditions. Squaw Lake is characterized as a seepage lake with an intermittent inlet and no outlet. The in-lake modeling was based on worst-case seasonal conditions (summer) while the pollutant loading represents annual loads. The bulk of the external P load is introduced during peak spring runoff as most runoff occurs in February, March and April when the land surface is frozen and soil moisture content is highest. The goal of this TMDL is to eliminate, to the extent practicable, those land use practices that introduce significant P loads to Squaw Lake during spring runoff events. Since the P loading to Squaw Lake is primarily a seasonal occurrence. In the case of Squaw Lake, preventative measures in the watershed (over the course of the entire year) will be used to control P load.

Margin of Safety (MOS). A margin of safety has been provided through the use of conservation implicit assumptions in modeling. Conservation assumptions were used for the pollutant reduction performance of best management practices for barnyard runoff management, manure spreading management and cropland erosion control.

Public Participation. As required by s. NR 120.08 (2), Wis. Admin. Code, a public hearing on this priority lake plan was held on March 10, 1997. Public comments were incorporated into the final plan.

Reasonable Assurance. As required, the state must provide "reasonable assurance" that the TMDL will be implemented. Reasonable assurance may be provided through a variety of voluntary or regulatory means. In general, Wisconsin's section 319 Management Plan (approved by EPA in 2000) describes the variety of financial, technical and educational programs in the state. In addition, it describes the "back-up" enforcement authorities for nonpoint source management in Wisconsin. The primary state program described in the 319 Management Plan is the Wisconsin Nonpoint Source

Water Pollution Abatement Program (Section 281.65 of the Wisconsin Statutes and Chapter NR 120 of the Wisconsin Administrative Code).

Specific to this TMDL, Squaw Lake is part of a larger priority watershed project, St. Croix Lakes Cluster Priority Watershed Project, that is intended to clean-up several lakes experiencing similar impacts in adjoining watersheds. As part of a financing plan for priority watershed and priority lake projects, long-term cost sharing and local staff funding is committed to the St. Croix Lakes Cluster Priority Watershed Project.

In addition, as described in the priority watershed plan, specific sites within the Squaw Lake watershed have been designated as critical sites for enforcement under the provisions of s. 281.20 and 218.65, Wis. Stats. Landowners have three years to voluntarily enter into cost share agreements. If a landowner does not participate by the specified time, the WDNR may take enforcement action to order the installation of needed best management practices. Cost share assistance is also reduced by 50%. No new or additional enforcement authorities are proposed under this TMDL.

Implementation Plans/Monitoring. The St. Croix County Lakes Cluster Priority Watershed Plan was prepared through the cooperative efforts of the WDNR, the Department of Agriculture, Trade and Consumer Protection (DATCP), St. Croix and Polk County Land Conservation Departments (LCD), local units of government, and the St. Croix County Lakes Cluster Watershed Citizen Advisory Committee. The goal of the Program is to improve and protect the water quality of streams, lakes, wetlands and groundwater by reducing pollutants from urban and rural nonpoint sources.

Designation of a watershed as a 'priority watershed' project enables special financial support to local governments and private landowners in the watershed to reduce nonpoint source pollution. This watershed plan forms the basis for entering into cost-share and local assistance grants with agencies responsible for project implementation and will be used as a guide to implement measures to achieve desired water quality conditions. Signed cost-share agreements list the practices, costs, cost-share amounts and a schedule to install BMPs. The DNR and DATCP review the progress of the counties and other implementing units of government, and provide assistance throughout the ten-year project. The DNR monitors improvements in water quality resulting from control of nonpoint sources in the watershed. Please refer to the Summary section of the Priority Watershed Plan for Total Project Costs and Chapters III & VI for more detail on individual BMP costs and project evaluation.

Squaw Lake has been monitored on a yearly basis for more than five years during the growing season. Monitoring included temperature and dissolved oxygen, secchi depth clarity, chlorophyll *a* and total phosphorus. Ongoing monitoring is planned to continue for the future. Please reference Chapter III (pg. 69) in the attached Implementation Plan for the evaluation monitoring plan.

Attachments:

Some of the information in the following attachments may be the result of preliminary analysis. The information presented above is the most recent.

1. St. Croix County Lakes Cluster Priority Watershed Surface Water Appraisal Report (June 4, 1996).

2. Nonpoint Source Control Plan for the St. Croix County Lakes Cluster Priority Watershed Project (April 1997).

3. WILMS summary