Ann Lake and Lake Emma TMDL Implementation Plan

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Prepared for:
WRIGHT COUNTY SOIL AND WATER CONSERVATION DISTRICT

MINNESOTA POLLUTION CONTROL AGENCY

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1.0 Introduction

The purpose of this implementation plan is to address nutrient Load and Wasteload Allocations presented in the Total Maximum Daily Load (TMDL) impairments for Ann Lake (DNR #86-0190) and Lake Emma (DNR #86-0188) located in the North Fork Crow River (NFCR) HUC (07010204), Upper Mississippi River Basin in Wright County, Minnesota (Figure 1.1). The numeric water quality standards for both lakes is a summer average total phosphorus concentration of 60 µg/L, 20 µg/L chlorophyll-a, and greater than 1 meter in Secchi depth. Current water quality does not meet state standards for nutrient concentration for shallow lakes in the North Central Hardwood Forest ecoregion in either lake.

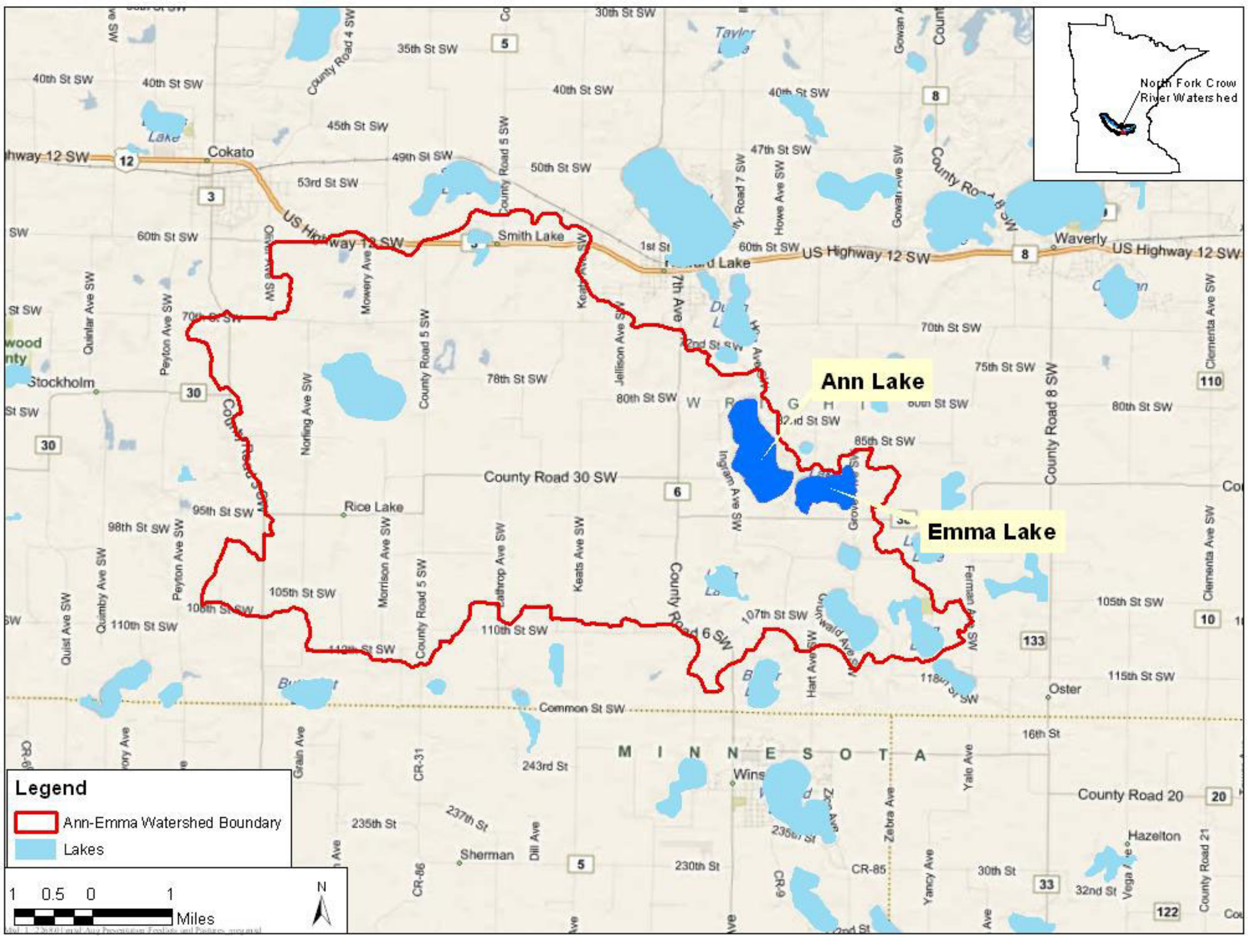

Figure 1.1. Location Map

Land use in the Ann Lake and Lake Emma watersheds is predominantly agriculture (>90%) including row crops (corn soybean rotation) and animal agriculture. Both lakes are quite shallow with an average depth less than 10 feet. Lake Emma receives water from Ann Lake via a short channel and then discharges downstream to the Crow River. Both lakes have a long history of carp and curly-leaf pondweed infestation while carp removal has occurred periodically on Ann Lake.

Nutrient budgets were developed for both lakes as well as a lake response model to set the Load and Wasteload Allocations. Phosphorus sources to Ann Lake include watershed runoff (68%) and internal sediment release of phosphorus (30%) with the remaining phosphorus coming from atmospheric deposition. Lake Emma receives most of its phosphorus from Ann Lake (74%) with the remaining phosphorus coming from internal loading (17%) and the direct watershed (9%). TMDL allocations for the lakes to meet state water quality standards were 1,591 pounds per year (81% reduction) for Ann Lake and 1,586 pounds per year (60% reduction) for Lake Emma.

The primary sources of phosphorus for Ann Lake include runoff from an agricultural watershed with both row crops and animal agriculture. Based on a Generalized Watershed Loading Function Model (GWLF), the primary source of nutrients is from animal manure. There are over 6,000 animal units in the Ann Lake watershed which produce over 1.4 million pounds of phosphorus per year. A large proportion of this manure is land applied in the Ann Lake watershed and eventually makes its way into surface waters. Nutrient management in the watershed will need to focus on manure management. Internal nutrient loading is also a significant source of phosphorus (30%) and will need to be addressed through internal load controls.

The primary source of phosphorus to Lake Emma is from Ann Lake (74%) so restoration of Ann Lake will benefit Lake Emma tremendously. Some animal agriculture occurs in the direct watershed to Lake Emma and manure management will need to occur there as well. Internal loading will also need to be addressed to meet the established TMDL.

2.0 Ann Lake and Lake Emma TMDL Summary

A key aspect of a TMDL is the development of an analytical link between loading sources and receiving water quality. To establish the link between phosphorus loading to the quality of water in the lakes, monitoring data extending back to 1990 was reviewed to better understand conditions and trends. Other data examined include fish community data compiled by the DNR, a shoreline condition survey, and aquatic vegetation data.

2.1 CURRENT WATER QUALITY

Water quality in Minnesota lakes is often evaluated using three associated parameters: total phosphorus, chlorophyll-a, and Secchi depth. Total phosphorus is typically the limiting nutrient in Minnesota's lakes meaning that algal growth will increase with increases in phosphorus. However, there are cases where phosphorus is widely abundant and the lake becomes limited by nitrogen availability. Chlorophyll-a is the primary pigment in aquatic algae and has been shown to have a direct correlation with algal biomass. Since chlorophyll-a is a simple measurement, it is often used to evaluate algal abundance rather than expensive cell counts. Secchi depth is a physical measurement of water clarity measured by lowering a black and white disk until it can no longer be seen from the surface. Higher Secchi depths indicate less light refracting particulates in the water column and better water quality. Conversely, high total phosphorus and chlorophyll-a concentrations point to poor water quality. Measurements of these three parameters are interrelated and can be combined into an index that describes water quality.

2.1.1 Total Phosphorus

Summer average total phosphorus concentrations for Ann and Emma Lake exceeded the state standard of 60 µg/L in all monitoring years (Figures 2.1 and 2.2). The highest summer average concentration for Ann Lake was measured in 2000 and reached over 500 µg/L. Summer average total phosphorus concentrations for Ann (145 – 395 µg/L) and Emma (132 – 225 µg/L) suggest both lakes consistently exceed the shallow lake eutrophication standard of 60 µg/L and indicate extremely high inputs from the watershed or in-lake sources.

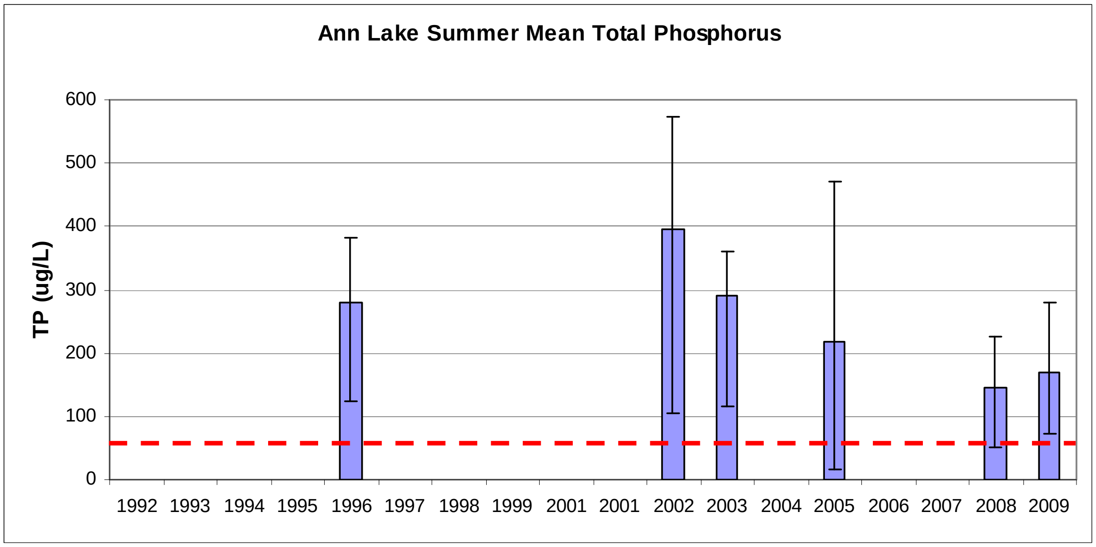

Figure 2.1. Summer (June 1 –September 30) mean total phosphorus concentrations for Ann Lake. The red dotted line indicates the current State standard for the North Central Hardwood Forest ecoregion. Error bars represent the maximum and minimum total phosphorus measurements for each season. Only sampling seasons with four or more measurements are displayed.

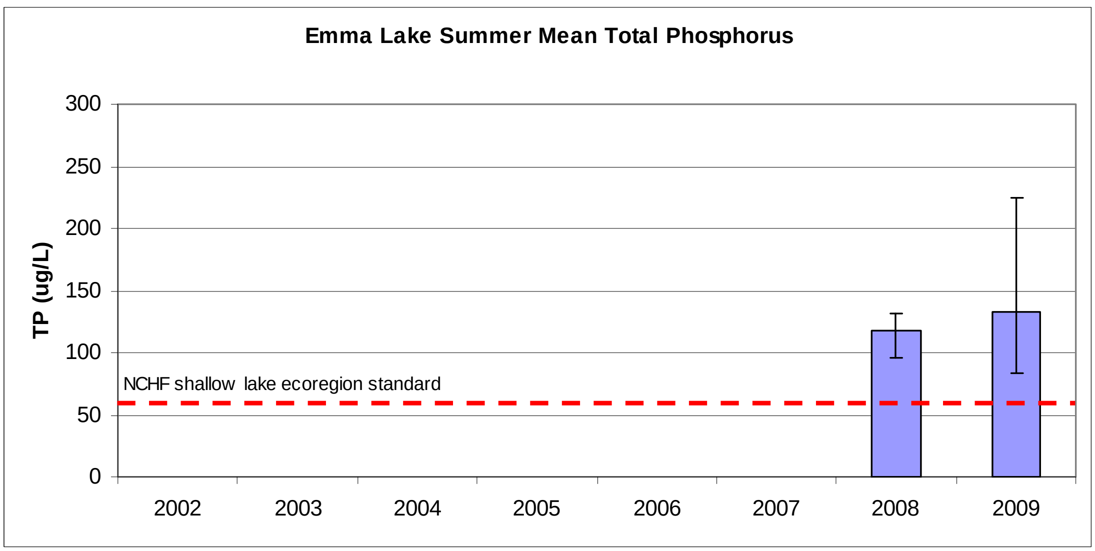

Figure 2.2. Summer (June 1 –September 30) mean total phosphorus concentrations for Lake Emma. The red dotted line indicates the current State standard for the North Central Hardwood Forest ecoregion. Error bars represent the maximum and minimum total phosphorus measurements for each season. Only sampling seasons with four or more measurements are displayed.

2.1.2 Chlorophyll-a

Average chlorophyll-a concentration in Ann Lake and Lake Emma has ranged from 25 to as high as 77 µg/L for years with four samples or more during the summer season (Figures 2.3 and 2.4). These values are approximately 1-3 times higher than the State standard. Chlorophyll-a concentrations in this range indicate a high incidence of nuisance algae blooms.

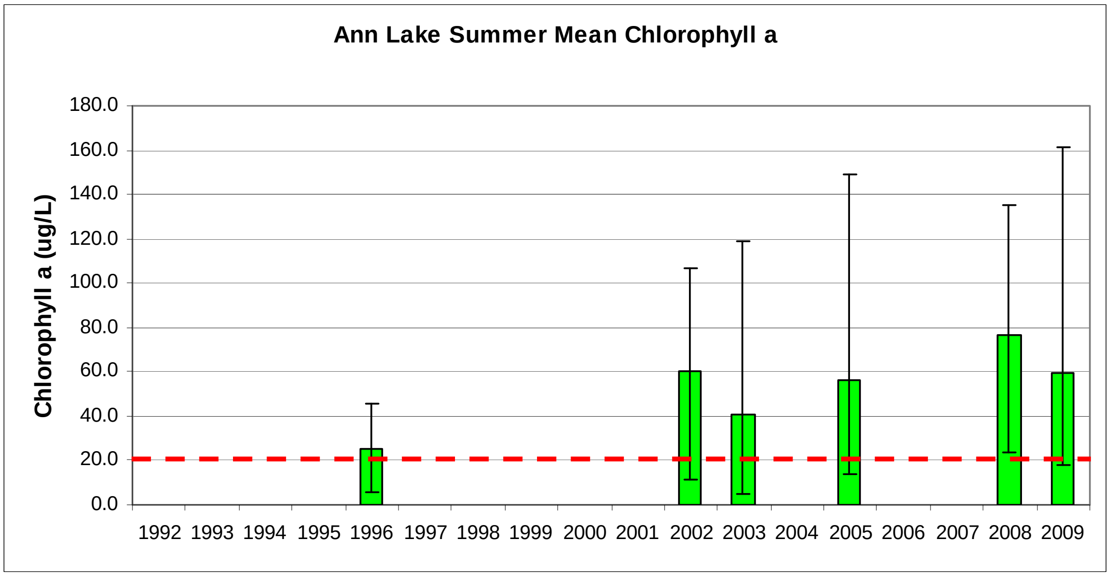

Figure 2.3. Summer (June 1 –September 30) mean chlorophyll-a concentrations for Ann Lake. The red dotted line indicates the current State standard for the North Central Hardwood Forest ecoregion. Error bars represent the maximum and minimum chlorophyll a measurements for each season. Only sampling seasons with four or more measurements are displayed.

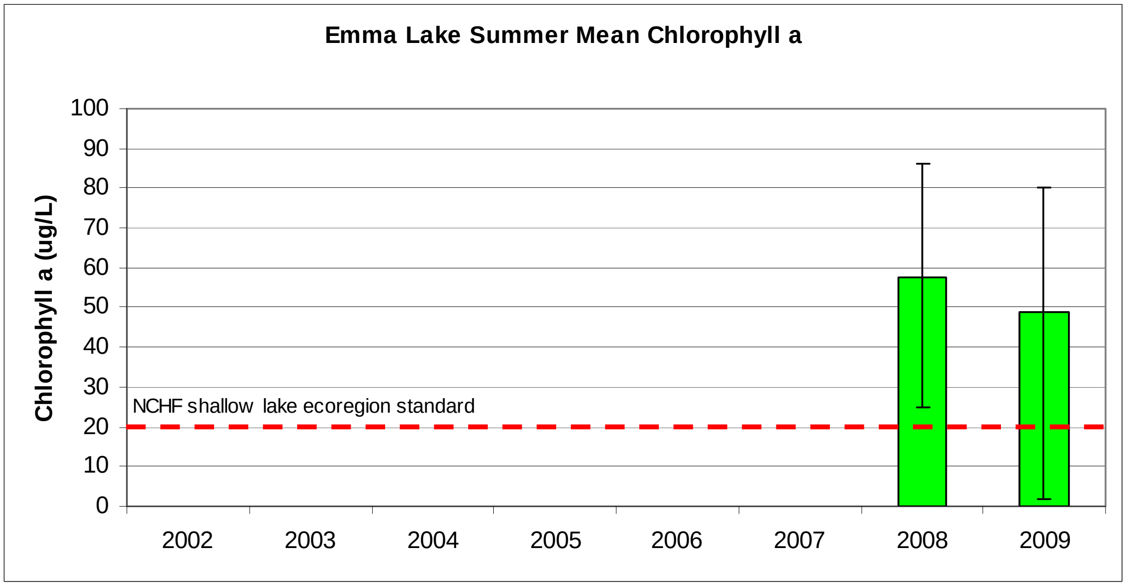

Figure 2.4. Summer (June 1 –September 30) mean chlorophyll-a concentrations for Lake Emma. The red dotted line indicates the current State standard for the North Central Hardwood Forest ecoregion. Error bars represent the maximum and minimum chlorophyll-a measurements for each season. Only sampling seasons with four or more measurements are displayed.

2.1.3 Secchi Depth

Water clarity (Secchi depth) data for Ann Lake and Lake Emma show very high inter-annual variability (Figures 2.5 and 2.6). Minimum values are consistently below the 1.0 meter Secchi standard for shallow lakes in the North Central Hardwood Forest ecoregion even though summer maximums and averages are typically at or above the standard.

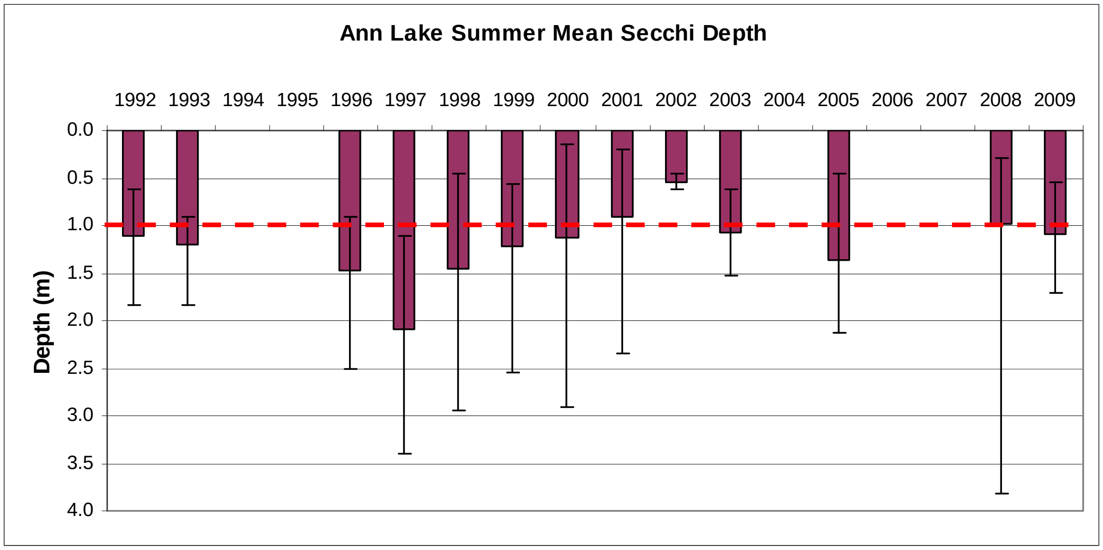

Figure 2.5. Summer (June 1 –September 30) mean Secchi depth (meters) for Ann Lake. The red dotted line indicates the current State standard for the North Central Hardwood Forest ecoregion. Error bars represent the maximum and minimum Secchi measurements for each season. Only sampling seasons with four or more measurements are displayed.

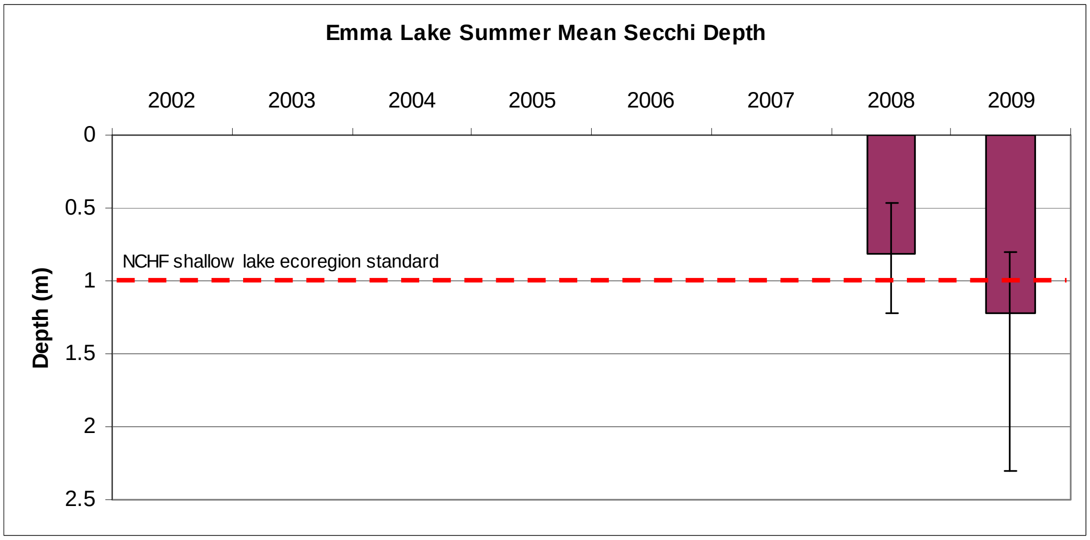

Figure 2.6. Summer (June 1 –September 30) mean Secchi depth (meters) for Lake Emma. The red dotted line indicates the current State standard for the North Central Hardwood Forest ecoregion. Error bars represent the maximum and minimum Secchi measurements for each season. Only sampling seasons with four or more measurements are displayed.

2.2 IMPAIRED WATERS AND MINNESOTA WATER QUALITY STANDARDS

Ann Lake and Lake Emma are located in the North Central Hardwood Forest ecoregion and are designated as class 2B waters. The Class 2B designation specifies aquatic life and recreation as the protected beneficial use of the water body.

Minnesota's standards for nutrients limit the quantity of nutrients which may enter surface waters. Minnesota's standards at the time of listing (Minnesota Rules 7050.0150(3)) stated that in all Class 2 waters of the State "…there shall be no material increase in undesirable slime growths or aquatic plants including algae." In accordance with Minnesota Rules 7050.0150(5), to evaluate whether a water body is in an impaired condition the MPCA developed "numeric translators" for the narrative standard for purposes of determining which lakes should be included in the section 303(d) list as being impaired for nutrients. The numeric translators established numeric thresholds for phosphorus, chlorophyll-a, and clarity as measured by Secchi depth.

The numeric target used to list these lakes was the phosphorus standard for Class 2B waters in the North Central Hardwood Forest ecoregion (60 µg/L); this TMDL presents load and wasteload allocations and estimated load reductions for the 60 µg/L target. Although the TMDL is set for the total phosphorus standard, the two other lake eutrophication standards (chlorophyll-a and Secchi depth) must also be met (Table 2.1). All three of these parameters were assessed in this TMDL to assure that the TMDL will result in compliance with state standards. Numeric standards applicable to Ann Lake and Lake Emma for chlorophyll-a and Secchi depth are 20 µg/L and 1.0 meters, respectively, as a growing season mean. All values are growing season means.

Table 2.1. Numeric targets for shallow lakes in the North Central Hardwood Forest ecoregion.

Parameters	North Central Hardwood Forest (Shallow Lakes)[1]
Phosphorus Concentration (µg/L)	60
Chlorophyll-a Concentration (µg/L)	20
Secchi disk transparency (meters)	>1.0

[1] Shallow lakes are defined as lakes with a maximum depth less than 15 feet, or with more than 80% of the lake area shallow enough to support emergent and submerged rooted aquatic plants (littoral zone).

2.3 TOTAL MAXIMUM DAILY LOAD CALCULATIONS

The numerical TMDL for Ann Lake and Lake Emma was calculated as the sum of the Wasteload Allocation, Load Allocation and the Margin of Safety (MOS) expressed as phosphorus mass per unit time. Nutrient loads in this TMDL are set for phosphorus, since this is typically the limiting nutrient for nuisance aquatic algae. This TMDL is written to solve the TMDL equation for a numeric target of 60 µg/L of total phosphorus.

2.3.1 Summary of TMDL Allocations

Table 2.2 summarizes the TMDL allocations for Ann Lake. A 5% margin of safety is explicit in the TMDL equation. An overall 81% nutrient reduction is required for Ann Lake to meet the state standard of 60 µg/L as a summer average. To achieve this TMDL, a 91% reduction in internal loading and a 79% reduction in watershed loading will need to be achieved.

Table 2.2. TMDL total phosphorus daily loads partitioned among the major sources for Ann Lake assuming the lake standard of 60 µg/L.

Allocation	Source	Existing TP Load[1]		TP Allocations (WLA & LA)		Load Reduction	Load Reduction
		(lbs/year)	(lbs/day)[2]	(lbs/year)	(lbs/day)[2]	(lbs/year)	Percent
Wasteload	Industrial and Construction Stormwater	86	0	18	0.05	68	79%
	CAFO	NA[3]	NA[3]	0	0	0	0%
Load	County Ditch 10/Direct	5,676	15.5	1,181	3.2	4,495	79%
	Atmospheric	83	0.2	83	0.2	0	0%
	Internal Load	2,481	6.8	229	0.6	2,252	91%
	MOS	--	--	80	0.2	--	--
	TOTAL LOAD	8,326	22.5	1,591	4.25	6,815	82%

[1] Existing load is the average for the years 2003,2005, 2008, 2009.
[2] Annual loads converted to daily by dividing by 365.25 days per year accounting for leap years
[3]Loads from feedlots are not permitted by rule, so zero loading was assumed in this TMDL

Table 2.3 summarizes the TMDL allocations for Lake Emma. To achieve this TMDL, a 69% reduction in internal loading and a 12% reduction in direct watershed loading will need to be achieved. Furthermore, Ann Lake will need to meet state standards because it discharges to Lake Emma, which assumes a 64% reduction in loading from Ann Lake.

Table 2.3. TMDL total phosphorus daily loads partitioned among the major sources for Lake Emma assuming the lake standard of 60 µg/L.

Allocation	Source	Existing TP Load [1]		TP Allocations (WLA & LA)		Load Reduction	Load Reduction
		(lbs/year)	(lbs/day)[2]	(lbs/year)	(lbs/day)[2]	(lbs/year)	Percent
Wasteload	Industrial and Construction Stormwater	5	0.01	4	0.01	1	20%
	CAFO	NA[3]	NA[3]	0	0	0	0%
Load	Direct Watershed	322	0.9	284	0.8	38	12%
	Atmospheric	42	0.1	42	0.1	0	0%
	Upstream Lake (Ann)	2,746	7.5	985	2.7	1,761	64%
	Internal Load	617	1.7	193	0.5	424	69%
	MOS	--	--	78	0.2	--	--
	TOTAL LOAD	3,732	10.2	1,586	4.31	2,224	60%

[1] Existing load is the average for the years 2008 and 2009.
[2] Annual loads converted to daily by dividing by 365.25 days per year accounting for leap years
[3]Loads from feedlots are not permitted by rule, so zero loading was assumed in this TMDL

3.0 Implementation Framework

The activities and BMPs identified in the implementation plan are the result of a series of Technical Advisory Committee (TAC) and stakeholder meetings led by the Wright County SWCD and the Minnesota Pollution Control Agency. Representatives from the Wright County SWCD, Lake Associations, Crow River Organization of Water and regulatory agencies met several times to discuss the TMDL requirements, TMDL results, lake characteristics, and potential Best Management Practices.

3.1 SHALLOW LAKE RESTORATION

The ecology of shallow lakes is unique, requiring a different approach to restoration than their deep counterparts. The restoration approach must account for the biological interactions occurring within the lake as well as alterations to the physical environment including changes in the nutrient balance and water levels. Following is a brief discussion on shallow lakes and proven approaches for restoring these important water resources.

3.1.1 Shallow Lake Ecology

3.1.1.1 Alternative Stable States in Shallow Lakes

Shallow lakes function quite differently from their deep counterparts, responding to both physical and biological changes in the system. This complex functioning has resulted in a popular theory for shallow lakes known as "Alternative Stable States" (Scheffer 1998). The Alternative Stable States theory suggests that shallow lakes exist in two stable states including a clear-water state and a turbid water state. The clear-water state is characterized by clear water, low algal abundance and a diverse submersed aquatic vegetation community. In contrast, the turbid water state is dominated by turbid water, high algal abundance and little or no submersed aquatic vegetation. The stability of these states is driven by several factors including nutrient levels, which is the focus of the TMDL Figure 3.1). Lakes in the clear water state provide higher quality fish and wildlife habitat as well as higher quality aesthetics. Consequently, shallow lake management is often focused on maintaining a clear water state or switching a lake from the turbid water state back to the clear water state.

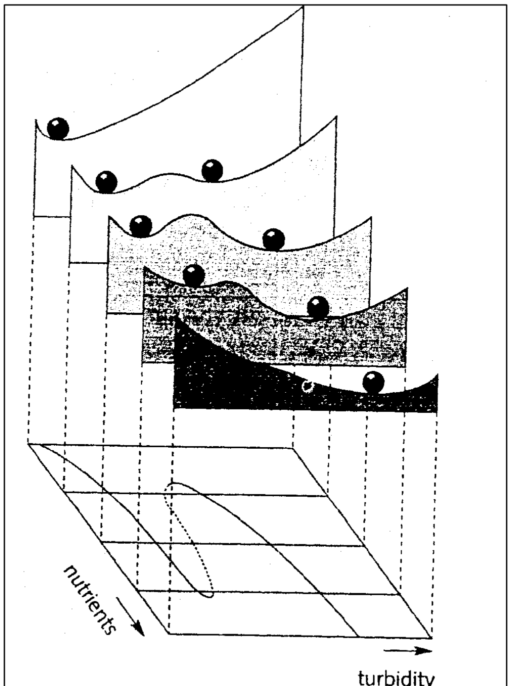

Figure 3.1. Ball and cup diagram illustrating alternative stable states in shallow lakes (Scheffer 1998). Lakes are typically more stable in one state or another depending on the nutrient concentrations and turbidity.

3.1.2 Shallow Lake Restoration

To restore a shallow lake to the clear water state, the factors driving the lake into the turbid water state must be identified and eliminated. Although this may sound like a simple task, the study of shallow lakes is a relatively new science that has only recently gained momentum in the research community. To better understand how to restore a shallow lake, the conditions selecting for the current state must be identified and managed.

To that end, Moss et al. (1996) have developed a five step approach to restoring shallow lakes (Figure 3.2). Following is a description of each of the five steps in the process. Implementation of this TMDL will follow the five step process.

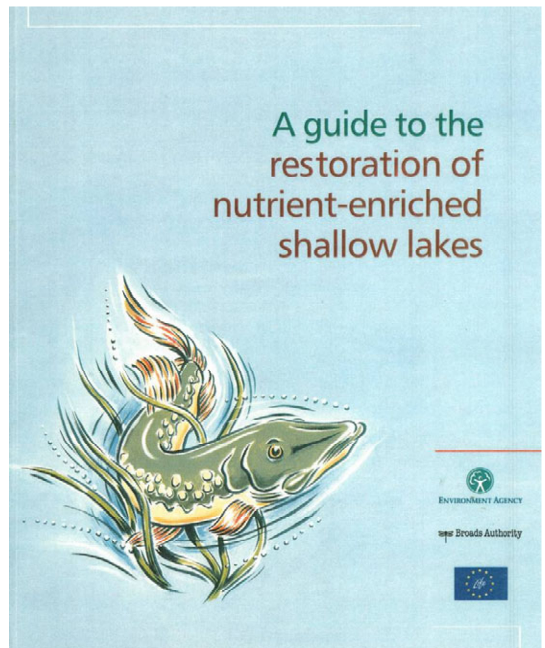

Figure 3.2. Moss's guide to shallow lake restoration.

Step 1. Forward switch detection and removal

The first step in the restoration process for shallow lakes is to identify the factors that are causing the system to be in the turbid water state. Forward switches can include altered hydrology, recreational impacts such as motorized water craft, the presence of common carp, an imbalanced fishery, or pesticides. The forward switches need to be identified and their impact mitigated prior to biomanipulation. The more effectively this can be accomplished, the higher the success potential for biomanipulation when it is undertaken. Many of the lakes in both agricultural and developed areas are negatively impacted by additional water from the ditching and draining of wetlands or increased impervious areas. Not only does this alter the hydrology of the lake, the additional water carries silt and nutrients to the lakes. A more recent problem for shallow lakes is the increased development of shorelines along shallow lakes. Shoreline development leads to increased nutrient loads and loss of vegetation as well as increases the pressure to maintain long-term stable water elevations from shoreline residents and recreational users.

Step 2. External and internal nutrient control

The alternative stable states in shallow lakes occur along nutrient enrichment gradients with higher nutrient loads pushing lakes toward a turbid, algal dominated state. However, unless inputs can be made extremely low, the desired results will not be obtained unless other forward switches acting against the establishment of plants have been eliminated. These include poorly consolidated bottom sediments, severe reductions in the natural seed bank, and rough fish.

Step 3. Biomanipulation

Biomanipulation in shallow lakes often refers to altering the fish community in a shallow lake to favor a clear water state The ultimate goal of biomanipulation is the restoration of a balanced fish community that favors the clear water state. Biomanipulation includes various forms of fish stocking or removal.

Fisheries management in shallow lakes is critical in establishing conditions favorable to obtaining and maintaining a clear water state. Fish populations can affect the invertebrate community and ultimately the nutrient cycling in the lakes. An imbalanced fishery can lead to reduced grazing on phytoplankton by zooplankton, favoring a turbid water state.

Another confounding factor in managing fisheries in shallow lakes is the presence or absence of rough fish, particularly carp. Because shallow lakes often winter kill, the fish community is typically characterized by species that are tolerant of low dissolved oxygen such as common carp and bullhead.

Step 4. Plant establishment

The presence of submersed aquatic vegetation is an important part of the ecology of a shallow lake that helps stabilize the system. Submersed aquatic vegetation protects sediments from wind resuspension, competes for nutrients with algae, and provides food and habitat for fish and wildlife. Additionally, vegetation provides food and habitat for macroinveterbrates, a food supply for both fish and wildlife. Emergent vegetation such as bulrush and wild rice are also important components of shallow lakes, providing food and habitat for fish and wildlife.

Re-establishing the plant community is not a trivial task with varied successes and potential expenses. Lakes that have been in the turbid water state for a very long time may have lost a significant portion of the seed bed or sediments may have been altered to prevent recolinization by native species. The most successful technique that has been applied in Minnesota is summer drawdown. Exposure of the sediments during the summer months increases nitrogen loss from the sediments through denitrification, consolidates the sediments, increases desiccation, and can re-invigorate the native plant seed bed. All these factors can be important in fostering a rooted native plant community.

Step 5. Stabilizing and managing restored system

Once the shallow lake has been returned to the clear water state, the challenge is to make the changes permanent in the system. The permanency will be related to the removed forward switches and the permanency of the removal. The system will likely require active management to maintain the clear water state. For example, if carp were removed from the system, the lake will need to be actively managed to prevent the reintroduction of carp or to maintain the carp population at a sufficiently low level to minimize the impacts on the lake. Managing a shallow lake to maintain a clear water state will likely require active management of the fish and plant communities as well as the hydrology of the lake.

3.1.3 Sequencing for Shallow Lake Restoration

An important aspect of shallow lake restoration is the sequence in which BMPs or restoration activities are applied to the lake and watershed. Because shallow lakes demonstrate alternative stable states (Scheffer 1998) including a turbid and a clear water state, many activities will result in minimal improvements if not undertaken prior to or after other dependent restoration activities. For example, attempting a biomanipulation such as a whole lake drawdown prior to effective nutrient controls will likely result in minimal or short lived improvements in lake water quality.

Applying these steps to Ann Lake and Lake Emma results in a sequence of restoration activities that must be accomplished in order to have a good chance of success in restoring water quality in these shallow lakes. The sequence of events will generally follow the following list. Steps 1 through 3 should be implemented concurrently prior to biomanipulation.

1. Minimize and control rough fish population
2. Minimize and control invasive aquatic plants, especially curly leaf pondweed
3. Control external nutrient loads
4. Establish biomanipulation techniques such as whole lake drawdown or fishery reestablishment
5. Reestablish native vegetation through sediment manipulation or native plant introduction
6. Establish long term management techniques for maintaining the clear water state such as periodic drawdown

This implementation strategy is focused on developing activities for addressing each of these areas and identifying areas where further investigation is needed to outline feasible restoration activities.

3.2 IMPLEMENTATION PLAN PRINCIPLES

Through the discussion of policies and practices, current activities, and ongoing research, the stakeholders developed principles to guide development and implementation of the load reduction plan. These principles, in no order, include:

1. <u>Restore Biological Integrity</u>

The stakeholders recognize the importance of a healthy biological community in the lake to provide internal controls on water clarity, especially in shallow lakes. To that end, the stakeholders agreed to work cooperatively to restore the biological communities in these lakes, including fish, plants, and zooplankton.

2. <u>Control Internal Load</u>

The stakeholders recognize that a significant portion of the phosphorus load is a result of internal loading and that the internal load must be addressed to successfully improve water quality in these lakes. Consequently, the stakeholders agreed to work cooperatively to reduce internal phosphorus loading in the lakes.

3. Implement BMPs in the Watershed
As changes to the watershed occur such as development, road construction, or changes on land use, the stakeholders will implement watershed BMPs where practical and feasible.

4. Encourage Communication
The stakeholders agreed that the stakeholder meetings themselves were a useful forum for discussion and sharing. Opportunities to share ideas and experiences to widen the knowledge base should be part of the implementation plan.

5. Foster Stewardship
The stakeholders recognize the need to develop a conservation attitude toward Ann Lake and Lake Emma and their watersheds. To develop this attitude, the stakeholders will work together to foster stewardship of the lakes and their watershed through cooperative projects, meetings, and a mutual understanding between stakeholders.

6. Communicate with the Public
Educational opportunities should take a variety of forms, and should include both general and specialized information, targeted but not limited to:

- General public
- Elected and appointed officials
- Private applicators
- Property managers

3.3 IMPLEMENTATION PLAN

Implementation of the proposed actions will be conducted in partnership by the stakeholders in the watershed. Each of the stakeholders has different mechanisms for ensuring the practices get implemented in Ann Lake and Lake Emma and their respective watersheds. The Wright County SWCD, Wright County, and CROW will implement many activities through their comprehensive plans and local ordinances. The MPCA and DNR will implement activities through regulation and monitoring as well as providing technical assistance to the stakeholders. The Ann Lake Association will implement BMPs through local partnerships with the appropriate agencies.

3.3.1 Implementation Approach

When establishing a TMDL, reasonable assurances must be provided demonstrating the ability to reach and maintain water quality endpoints. Several factors control reasonable assurance, including a thorough knowledge of the ability to implement BMPs as well as the overall effectiveness of the BMPs. This TMDL establishes aggressive goals for the reduction of phosphorus loads to Ann Lake and Lake Emma.

TMDL implementation will be implemented on an iterative basis so that implementation course corrections based on periodic monitoring and reevaluation can adjust the strategy to meet the standard. After the first phase of nutrient reduction efforts, reevaluation will identify those activities that need to be strengthened or other activities that need to be implemented to reach the standards. This type of iterative approach is more cost effective than over engineering to conservatively inflated margins of safety (Walker 2003). Implementation will also address other lake problems not directly linked to phosphorus loading such as invasive plant species (curly-leaf pondweed) and invasive fish (carp and rough fish). These practices go beyond the traditional nutrient controls and provide additional protection for lake water quality.

3.4 WRIGHT COUNTY LOCAL WATER MANAGEMENT PLAN

Wright County maintains a Local Water Management Plan that outlines action strategies designed to achieve County water resources and management goals. The scope and purpose of the plan is to:

- Identify existing and potential problems and opportunities for protection, management and development of water resources and related land resources in Wright County
- Provide high quality groundwater supplies to the Citizens of Wright County
- Position Wright County to maximize local control and funding for TMDLs
- Develop regulations, educate, and offer incentives to ensure orderly development with minimal impacts to Wright County’s water quality and
- Achieve countywide use of environmentally conscious practices by agricultural producers to protect and enhance Wright County’s natural resources.

Implementation of the scope of the plan is accomplished through the identification of goals and implementation of action items under each of the identified goals. The goals and actions are available in the County’s Comprehensive Plan (Wright County 2006). The plan is implemented in five year cycles and Wright County will continually evaluate the action items’ effectiveness in achieving the load allocations in the Ann Lake and Lake Emma TMDL. At the end of each five year period the County will evaluate the success of BMP implementation in reducing the total phosphorus concentration in Ann Lake and Lake Emma and will reconvene the Technical Advisory Committee to determine if adjustments to the Implementation Plan are necessary.

3.5 WRIGHT COUNTY SOIL AND WATER CONSERVATION DISTRICT

The mission of the Wright County Soil and Water Conservation District is to provide local leadership in the conservation and preservation of natural resources through education, enforcement, and incentive programs.

The Wright County SWCD annually develops a plan of work aimed at implementing the District’s Planning Supplement (2011-2015) and the Wright County Water Management Plan. The Wright County SWCD has identified the following objectives for Wright County:

- Assess and decrease the sediments, nutrients, pesticides and other pollutants reaching surface and groundwater; thereby, improving water quality within the County
- Reduce feedlot runoff and the resulting pollution to the surface waters of Wright County

- Continue to build databases to assess the existing quality and quantity of the surface and groundwater supply
- Reduce cropland erosion and the resulting off-site effects in high priority areas
- Encourage the maintenance of existing practices and the installation of new practices for the reduction of erosion and sediment to Wright County waters
- Enhance, protect and restore wetlands in Wright County so they provide the full value of these ecosystems
- Aid Wright County to establish a system for the assurance of well planned developments taking into account erosion and sedimentation control, stormwater deposition, on-site sewage system problems and wetland protection
- Maintain or increase the acres of forest and woodland in Wright County
- Educate the general public to support all District concerns, which will result in better stewardship of all natural resources

3.6 ANN LAKE ASSOCIATION

The Ann Lake Association is devoted to the restoration and continuing preservation of the highest water quality and environmental standards achievable for the Ann Lake basin; and to that end, it is dedicated to cooperate with any and all agencies to ensure success. The ultimate goal of the Ann Lake Association is to restore Ann Lake to the highest achievable ecological standard.

To meet that goal, several objectives of the Ann Lake Association include:

- Cooperate with all governmental units and involved agencies to speed up and maintain the process of restoring Ann Lake.
- Keep property owners informed on progress and process of lake restoration.
- Encourage "best management practices" by property owners and the general public.
- Use the influence of the Association and cooperating agencies and organizations to draw on financial support from all funding resources.
- Involve the Association in the formulation of ongoing plans for and evaluation of implementation efforts aimed at the restoration of Ann Lake for continued safe use by present and future generations.

3.7 CROW RIVER ORGANIZATION OF WATER

Portions of ten counties in Central Minnesota make up the Crow River Watershed. From the perspective of the Upper Mississippi River Basin, the Crow River is one of its major tributaries. The effects of rapid urban growth, new and expanding wastewater facilities and erosion from agricultural lands have been common concerns of many citizens, local, state and regional governments in Central Minnesota. As a result, many groups began meeting in 1998 to discuss management of the Crow River basin consisting of the North Fork and South Fork. The Crow River Organization of Water (CROW) was formed in 1999 as a result of heightened interest in the Crow River. A Joint Powers Agreement has been signed between all ten of the Counties with land in the Crow River Watershed. The CROW Joint Powers Board is made up of one representative from each of the County Boards who signed the agreement. The Counties involved in the CROW Joint Powers include Carver, Hennepin, Kandiyohi, McLeod, Meeker, Pope, Renville, Sibley, Stearns and Wright. The CROW currently focuses on identifying and promoting the following:

- Protecting water quality and quantity
- Protect and enhance fish and wildlife habitat and water recreation facilities
- Public education & awareness
- BMP implementation

In summer of 2010, the CROW began working with the Minnesota Pollution Control Agency's new Major Watershed Restoration & Protection Project (MWRPP) approach in the North Fork Crow River Watershed. The idea behind the watershed approach is to provide a more complete assessment of the water quality and facilitates data collection for the development of Total Maximum Daily Loads (TMDLs) and protection strategies. The watershed approach is to intensively monitor the streams and lakes within a major watershed to determine the overall health of the water resources, identify impaired waters, and identify those waters in need of additional protection efforts to prevent impairments. This process is different from the previous approach because monitoring efforts were concentrated in a defined area (a lake or stream reach) and addressed one impairment, whereas now, all impairments are addressed at the same time. Most importantly, this process will provide a communication tool that can inform stakeholders, engage volunteers, and help coordinate local/state/federal monitoring efforts. This process will ensure the data necessary for effective water resources planning is available, citizens and stakeholders are engaged in the process, and citizens and governments across Minnesota can evaluate the progress. The MWRPP approach will result in a Watershed Management Plan for North Fork Crow Watershed that covers the Ann Lake and Lake Emma watersheds.

3.8 ADAPTIVE MANAGEMENT

The load allocations in the TMDL represent aggressive goals for nutrient reductions. Consequently, implementation will be conducted using adaptive management principles. Adaptive management is an iterative approach of implementation, evaluation, and course correction (see Figure 3.3). It is appropriate here because it is difficult to predict the lake response to load reductions. Future conditions and technological advances may alter the specific course of actions detailed in this Plan. Continued lake water quality monitoring and course corrections responding to monitoring results offer the best opportunity for meeting the water quality goals established in this TMDL.

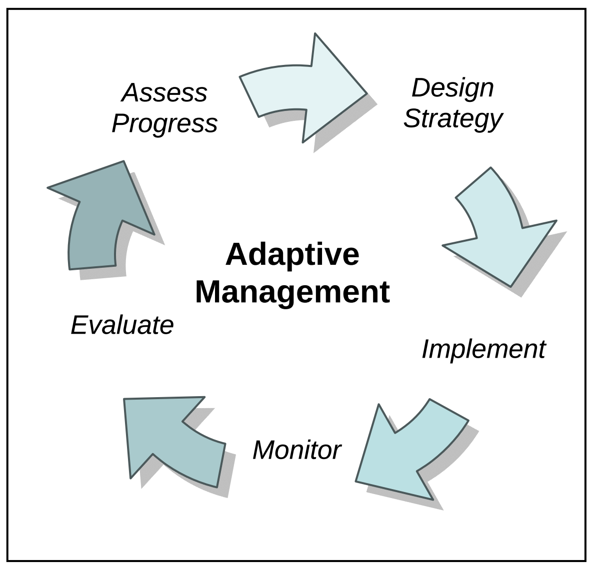

Figure 3.1. Adaptive management

4.0 Monitoring and Education

Restoration of Ann Lake and Lake Emma requires participation from all of the stakeholders, especially the land owners in the watershed and well as lake users. Consequently, education and outreach will be a key component in successfully achieving implementation goals. Additionally, because implementation of this TMDL relies heavily on adaptive management, monitoring will be an important part of the implementation plan.

4.1 GENERAL COORDINATION

4.1.1 Coordination

Implementation of the activities outlined in this plan will be the responsibility of each of the individual stakeholders. The Wright County SWCD, Wright County, and CROW will track progress toward achieving their Comprehensive Plans and ultimately the activities necessary for achieving the TMDL. The Ann Lake Association will work with Wright County, Wright County SWCD and the CROW to report activities the Association achieves related to the implementation plan.

Estimated Cost: 5 hours/month staff time
Responsible Parties: Wright SWCD, Wright County, CROW, and Ann Lake Association

4.2 EDUCATION

Another key component of any good implementation plan is education. Education will be a critical part of implementing this TMDL and includes the following tasks.

4.2.1 Lake Shore and Watershed Land Management

Work with property owners in the subwatershed to ensure proper fertilizer use, low-impact lawn care practices, and other topics to increase awareness of sources of pollutant loadings to Ann Lake and Lake Emma and encourage the adoption of good individual property management practices. The Wright County SWCD and Ann Lake Association will take the lead in education and outreach programming with participation and assistance by the county, DNR, MPCA, SWCD, and other interested agencies.

Estimated Cost: $2,000 annually
Responsible Parties: Wright SWCD, Wright County, CROW, Ann Lake Association, DNR, MPCA

4.2.2 Public Education and Outreach

The Minnesota and Wisconsin Departments of Natural Resources, the University of Minnesota Extension Service, and University of Wisconsin Extension have prepared numerous fliers and brochures on various topics relating to lake management that can be made available to target audiences at city meetings, National Night Out gatherings, and other opportunities, and links posted on the Wright County SWCD web site.

Estimated Cost: $2,000 annually
Responsible Parties: Wright County SWCD, Ann Lake Association, CROW

4.2.3 Encourage Public Official and Staff Education

There is a need for city, county and state officials and staff to understand the TMDL and the proposed implementation activities so that they can effectively make regulatory, budget and programming decisions and conduct daily business. Resources such as self-study lake management background information from Water on the Web ("Understanding Lake Ecology"), Project NEMO (Nonpoint Education for Municipal Officials), UW Extension ("Understanding Lake Data") and other sources would provide basic information about lake ecology to help staff, Councils and Commissions make informed decisions about lake management.

Estimated Cost: $2,000 annually
Responsible Parties: Wright County, Wright County SWCD, CROW

4.2.4 Demonstration Projects

Property owners may be reluctant to adopt good lake management practices without examples they can evaluate and emulate. The stakeholders will encourage new demonstration projects so property owners can see how a project or practice is implemented and how it looks. New demonstration projects might include planting native plants; planting a rain garden; restoring a shoreline; managing turf using low-impact practices such as phosphorus-free fertilizer, reduced herbicides and pesticides, and proper mowing and watering techniques; and improving drainage practices with redirected downspouts and rain barrels.

Estimated Cost: $5,000 annually
Responsible Parties: Wright County SWCD, Minnesota DNR, CROW

4.3 ONGOING MONITORING

4.3.1 Ann Lake and Lake Emma Water Quality Monitoring

Monitoring water quality to assess progress in achieving the TMDL is a critical element in the adaptive management approach identified in the TMDL. Water quality monitoring will be conducted on Ann Lake and Lake Emma annually including dissolved oxygen, temperature, total phosphorus, chlorophyll-a, secchi depth and total Kjeldahl nitrogen.

Estimated Cost: $5,000 per season
Responsible Parties: Wright County SWCD

4.3.2 County Ditch #10 Water Quality Monitoring

Monitoring the primary inflow to Ann Lake will be critical in understanding watershed loading to both Ann Lake and Lake Emma as well as evaluating the effects of management in the watershed. The Wright County SWCD maintains a monitoring station on County Ditch #10 and collects data for nutrients and flow. This station will be continued in the future to support this implementation plan.

Estimated Cost: $5,000 annually
Responsible Parties: Wright County SWCD

4.3.3 Vegetation Monitoring

Aquatic plants should periodically be surveyed on Ann Lake and Lake Emma to track changes in the plant community and monitor growth and extent of nuisance species such as curly-leaf pondweed. Routine aquatic plant surveys will be critical in understanding the overall functioning of the lake and its response to water quality changes. A curlyleaf pondweed survey should be conducted after any treatment to the lake. An overall vegetation survey need only be conducted periodically. Vegetation monitoring should be conducted every three years in conjunction with water quality monitoring.

Estimated Cost: $5,000 per season
Responsible Parties: Minnesota DNR, Wright County SWCD

4.3.4 Fish Monitoring

The Minnesota DNR routinely monitors Ann Lake and Lake Emma fish communities and maintains a fish management plan. Continuation of the fish monitoring will be sufficient to evaluate the overall fish community in Ann Lake and Lake Emma. However, a large carp population has likely historically existed in Ann Lake and Lake Emma. Therefore, specific carp monitoring should be conducted in conjunction with comprehensive, watershed-wide carp management. Monitoring may include tagging and tracking as well as mark and recapture surveys.

Estimated Cost: $5,000 per season for routine; $10,000 for carp assessment
Responsible Parties: Minnesota DNR

5.0 Watershed Activities

The primary watershed sources to Ann Lake and Lake Emma include runoff from agricultural fields receiving manure and animal agriculture because they comprise such a large proportion of the watershed. Following is a description of the approach to be taken to address each of these sources.

5.1 ANIMAL AGRICULTURE

Animal agriculture and associated manure management were identified as important nutrient sources to Ann Lake and Lake Emma (Figure 5.1). The focus of implementation will be on better management of manure and feedlots to reduce nutrient loading to surface waters. Several practices will be considered to reduce nutrient loads from land receiving animal manure including those outlined in the following sections.

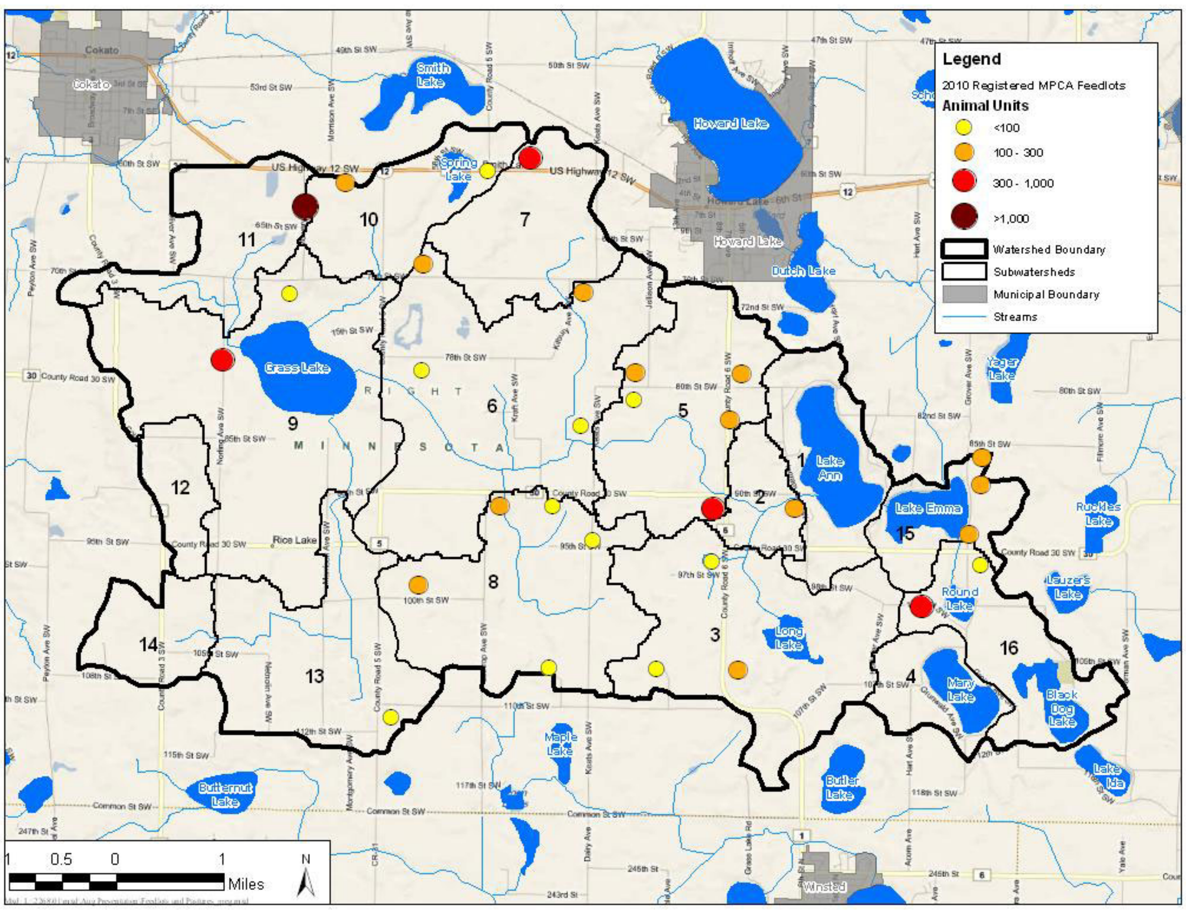

Figure 5.1. Animal units in the Ann Lake and Lake Emma watersheds based on the 2010 MPCA database.

5.1.1 Feedlot and Manure Stockpile Management Program

One of the first places to start when managing animal agriculture in the watershed is feedlots. The county is delegated to regulate all non CAFO feedlots. MPCA regulates all CAFOs. Regulating includes permitting, compliance and inspections. Feedlots that meet these regulations will not discharge significant amounts of nutrients to surface waters.

There are a variety of options for controlling feedlot and manure stockpile runoff that reduce nonpoint source nutrient loading, including:

- Move fences or altering layout of feedlot
- Eliminate open tile intakes and/or feedlot runoff to direct intakes
- Install clean water diversions and rain gutters
- Install grass buffers
- Maintain buffer areas
- Construct solid settling area(s)
- Prevent manure accumulations
- Manage feed storage
- Manage watering devices
- Total runoff control and storage
- Install roofs
- Runoff containment with irrigation onto cropland/grassland
- Vegetated infiltration areas or tile-drained vegetated infiltration area with secondary filter strips

These practices should be applied where appropriate.

Estimated Cost: Staff time
Responsible Parties: Wright County SWCD, MPCA

5.1.2 Manure Management Plans

Another important component of managing animal waste is developing manure management plans. Minnesota feedlot rules (Minn. R. ch. 7020) now require manure management plans for feedlots greater than 300 animal units that do not employ a certified manure applicator. These plans require manure accounting and record-keeping as well as manure application risk assessment based on method, time and place of application and manure and soil testing. The following BMPs will be considered in all manure management plans to reduce potential nutrient delivery to surface waters:

- Immediate incorporation of manure into topsoil
- Reduction of winter spreading, especially on slopes
- Eliminate spreading near open inlets and sensitive areas
- Erosion control through conservation tillage and vegetated buffers
- Consider changing from N based to P based MMP

The focus of these plans is to develop acceptable nutrient loads to the field to prevent nutrient saturation and eventual runoff to surface waters. Soil and manure testing are required in these plans to determine the acceptable amount of manure and associated nutrients that can be applied to the watershed.

Additional technologies can be evaluated including chemical addition to manure prior to field application to reduce phosphorus availability and mobility. These technologies can improve phosphorus retention on fields allowing for more flexibility for manure management.

An example of a fertilizer management plan using soil testing is included in Appendix A.

Estimated Cost: Staff time
Responsible Parties: Wright County SWCD

5.1.3 Buffers and Fencing along Pastures

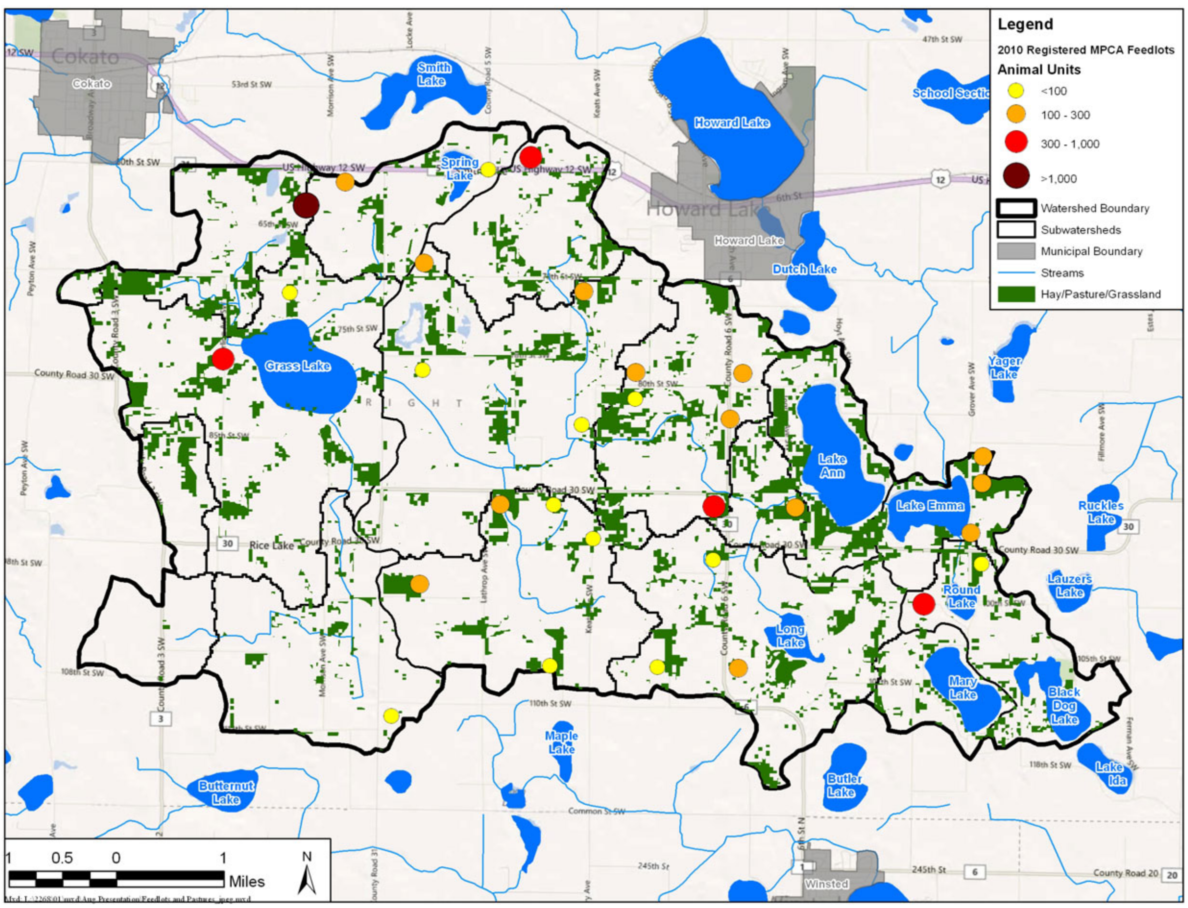

Figure 5.2. MPCA registered feedlots and pasture areas in the Ann Lake and Lake Emma watersheds based on National Agriculture Statistical Survey (NASS).

Pastures that allow animals direct access to surface waters or provide runoff directly to surface waters have a high potential to deliver nutrients to surface waters. The following livestock grazing practices are for the most part economically feasible and are extremely effective measures in reducing nutrient runoff from pastures:

- Limited stabilized animal access
- Livestock exclusion from public waters through setback enforcement and fencing
- Creating alternate livestock watering systems
- Rotational grazing
- Vegetated buffer strips between grazing land and surface water bodies

The SWCD will work with land owners to evaluate their pastures and install buffers and fencing where appropriate (Figure 5.2). The cost of installing exclusion fence and 30’ wide native buffer is about $750 per 100 linear feet, plus the cost if necessary of a stabilized animal access point. Some or all of this cost may be eligible for funding from federal and state cost-sharing programs.

Estimated Cost: $750 per 100 linear feet
Responsible Parties: Wright County SWCD

5.1.4 Tile Intakes

Manure spreading across tile intakes allows direct access of manure and nutrient rich soil to surface waters. MN Rules Chapter 7020 require a 25’ setback from open tile intakes for spreading manure that is incorporated within 24 hours. A 300’ setback from tile intakes is required for unincorporated manure. Buffering tile intakes and avoiding the spreading of manure near tile intakes can significantly reduce phosphorus loading from fields to surface waters. Tile intake buffer demonstration projects should be developed in the Ann Lake and Lake Emma watersheds. A tile intake buffer program should also be developed to buffer the majority of tile intakes in the watershed.

Estimated Cost: $200 per tile intake buffer
Responsible Parties: Wright County SWCD

5.2 SOURCES ASSOCIATED WITH DEVELOPMENT

Another important component of the watershed load is development in the watershed. Most of the development in the watershed is either directly on the lake shore or associated with roads. Significant development is not slated in either the Ann Lake or Lake Emma watershed over the next 20 years. However, there are numerous practices available for reducing runoff and nutrient loads from impervious surfaces that can be developed into rules in ordinances to make sure development, when it does occur, will not degrade water quality.

One approach to protecting water quality and quantity is the development of rules aimed at minimizing the impacts of development. The purpose of the rules is to promote, preserve, improve, and enhance the environmental quality of the natural resources within the Ann Lake and Lake Emma watersheds without preventing reasonable use and development of land. The intent of the rules is to protect the quality of the watershed from adverse effects occasioned by poorly sited development or incompatible activities and regulating land disturbances or development activities that would have an adverse and potentially irreversible impact on the water quality and on fragile environmentally sensitive land within the watershed of Ann Lake or Lake Emma.

Estimated Cost: $5,000
Responsible Parties: CROW, Wright County

5.2.1 Increase Infiltration and Filtration in the Lakeshed

Encourage the use of rain gardens, native plantings, and reforestation as a means to increase infiltration and evapotranspiration and reduce runoff conveying pollutant loads to the lake. These practices are especially encouraged for lake shore owners. The cost of this strategy varies depending on the BMP and may range from $500 for a single property owner installing an individual rain garden to retrofitting parks and open space with native vegetation rather than mowed turf at a cost of $10,000.

Estimated Cost: $5,000 annually
Responsible Parties: Wright County SWCD, Wright County, CROW

5.2.2 Shoreline Management and Restoration

Most property owners maintain a turfed edge to the shoreline (Figure 5.3). Property owners should be encouraged to restore their shoreline with native plants to reduce erosion and capture direct runoff. Shoreline restoration can cost $30-50 per linear foot, depending on the width of the buffer installed. The County will work to develop some demonstration projects as well as work with all willing landowners to naturalize their shorelines.

Figure 5.3. Examples of shoreline areas on Ann Lake where shoreline restoration and lot-level best management practices can improve water quality.

Shoreline restoration can cost $30-50 per linear foot, depending on the width of the buffer installed. Ideally about 75 percent of the residential shoreline would be native vegetation, with about 25 percent available for lake access.

Estimated Cost: $750,000
Responsible Parties: Wright County, Minnesota DNR, Ann Lake Association

5.3 WETLANDS

5.3.1 Evaluate and Prioritize Wetlands for Protection and Restoration

Wright County SWCD and Wright County should evaluate wetlands in the watershed to identify high priority wetlands for protection and restoration. Once these high priority wetlands are identified, management plans can be developed to maintain the functions and values of those wetlands. The cost of implementing wetland management is staff time from the County and SWCD.

One example of a wetland that may need to be evaluated is presented in Figure 5.4. County Ditch #10 runs through the middle of the wetland and the wetland has been modified to increase drainage. Altering the hydrology of the wetland may eliminate phosphorus discharge and improve water quality. The wetland could also be buffered from the farm fields and other practices such as limestone berms can be used to improve phosphorus retention.

Figure 5.4. An in-line wetland that could be modified to increase water storage and improve water quality. Buffers could also be added around the perimeter.

Estimated Cost: $30,000
Responsible Parties: Wright County SWCD, Wright County

5.3.2 Grass Lake Wetland Restoration

The TMDL identified the Grass Lake wetland complex as a potential source of phosphorus to Ann Lake and Lake Emma. A feasibility study needs to be completed for the wetland, however some practices that can be considered include buffers, inlet chemical treatment (limestone berms), outlet modification, and hydrologic alteration (Figure 5.5).

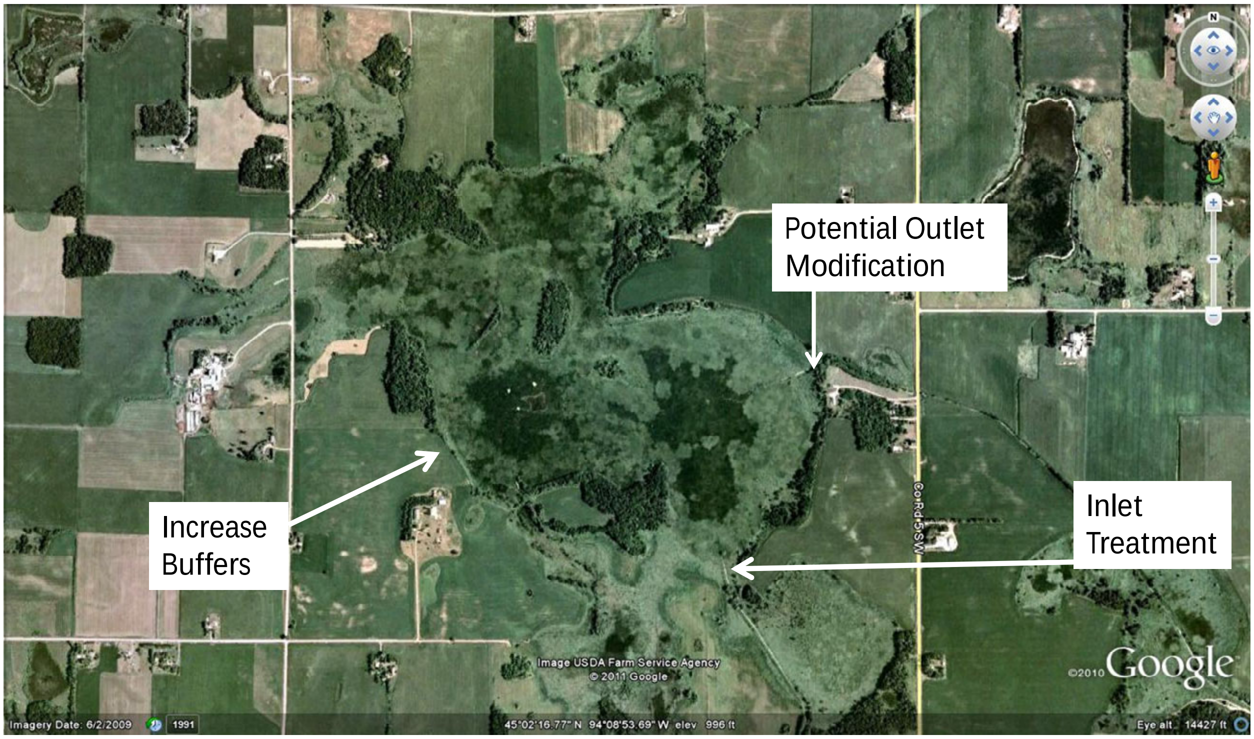

Figure 5.5. The Grass Lake wetland complex with some potential modifications to improve water quality.

Estimated Cost: $30,000 Feasibility Study; $100,000 to $300,000 implementation
Responsible Parties: Wright County SWCD, Wright County, CROW

5.4 SEPTIC SYSTEMS

Little is known about the condition of septic systems in the Ann Lake and Lake Emma watersheds. Consequently, the role of septic systems in nutrient loading to the lakes is unclear. However, it is critical that all septic systems in the watershed conform to State standards. Nonconforming septic systems have a high potential to deliver nutrients to surface waters and ultimately Ann Lake and Lake Emma. There are an estimated 130 SSTS systems in the watershed. Assuming 20% are failing, septic systems deliver approximately 71 pounds of phosphorus annually to Ann Lake and Lake Emma. The following action was identified to evaluate and control potential nutrient loads from septic systems.

5.4.1 Inspect Septic Systems in the Ann Lake and Lake Emma Watersheds

Identifying and evaluating the current condition of all the septic systems in the watershed is critical in determining their potential load to surface waters. Information such as the type and conditions of the system, proximity to surface waters or tile lines, and location in the watershed will help prioritize systems in the watershed. The Wright County SWCD and Wright County will obtain funding to identify and evaluate septic systems in the Ann Lake and Lake Emma watersheds.

Estimated Cost: $5,000 annually for 5 years; $25,000 total
Responsible Parties: Wright County SWCD, Wright County, CROW

5.4.2 Upgrade Nonconforming Septic Systems

All of the septic systems in the Ann Lake and Lake Emma watersheds will be inspected for compliance with current State standards. All failing systems as described in 7080.1500 subp.4b shall be upgraded, replaced or its use discontinued within one year of notice. The Wright County Environmental Health Office will give consideration to weather conditions as it as it establishes compliance dates. An SSTS posing an imminent threat to public safety as described in 7080.1500 subp. 4a shall be abated within ten days of notice. The system shall be upgraded, preplaced, or repaired or its use discontinued, within 6 months of notice.

Estimated Cost: $50,000 to $1 Million
Responsible Parties: Wright County SWCD, Wright County, CROW

5.5 CONSTRUCTION STORMWATER ACTIVITIES

Construction stormwater activities are considered in compliance with provisions of the TMDL if they obtain a Construction General Permit under the NPDES program and properly select, install and maintain all BMPs required under the permit, including any applicable additional BMPs required in Appendix A of the Construction General Permit for discharges to impaired waters, or meet local construction stormwater requirements if they are more restrictive than requirements of the State General Permit.

Estimated Cost: MPCA Staff Time
Responsible Parties: MPCA

6.0 In-Lake Activities

6.1 REDUCE INTERNAL LOAD AND SEDIMENT RESUSPENSION

Although internal loading is not the primary source of nutrients to Ann Lake or Lake Emma, internal nutrient loads will need to be reduced to meet the TMDL allocations presented in the TMDL document. There are numerous options for reducing internal nutrient loads ranging from simple chemical inactivation of sediment phosphorus to complex infrastructure techniques including hypolimnetic aeration.

6.1.1 Internal Load Reduction Feasibility Study

Prior to implementation of any strategy to reduce internal loading in Ann Lake and Lake Emma, a feasibility study needs to be completed to evaluate the cost and feasibility of the lake management techniques available to reduce or eliminate internal loading in lakes. Several options should be considered to manage internal sources of nutrients including, chemical treatment such as alum, vegetation management and aeration. A feasibility study should be completed to provide recommendations for controlling internal loading in Ann Lake and Lake Emma.

Estimated Cost: $30,000
Responsible Parties: Wright County, Wright County SWCD, Ann Lake Association

6.1.2 Evaluate Feasibility of Whole Lake Drawdown and Fish Removal

Once the nutrient levels are significantly reduced, a biomanipulation of Ann Lake and Lake Emma is required to force the lakes back into a clear-water state. The biomanipulation is typically accomplished through a whole lake drawdown and fish kill using a chemical poison such as rotenone. A whole lake drawdown on Ann Lake and Lake Emma may require a modification of the outlet, the use of hydraulic pumps, or the use of a siphon if sufficient grade is available. Figure 6.1 demonstrates some possible flow paths to conduct a whole lake drawdown. A feasibility study needs to be completed to evaluate the cost and methods for conducting a whole lake drawdown. It is also important to note that 75% of the lakeshore land owners need to approve the project for a whole lake drawdown to be legally permitted.

If whole lake drawdown is determined to be infeasible, other options such as the use of Solar Bee artificial circulators should be examined. Artificial mixing may decrease the algae population enough to encourage submerged aquatic vegetation growth, however this application should be considered experimental.

Figure 6.1. Potential drawdown routes for Ann Lake and Lake Emma.

6.1.3 Implement Recommendations of Feasibility Studies

Once the feasibility studies for internal load control and whole lake drawdown are completed and the preferred alternatives are identified, the selected technique needs to be implemented. The costs associated with each technique vary, however each technique requires some engineering as well as capital costs.

Estimated Cost: $250,000 to $1.5 Million
Responsible Parties: Wright County, Wright County SWCD, Ann Lake Association

6.2 OTHER PHYSICAL AND BIOLOGICAL STRATEGIES

Although controlling nutrients is a key component in restoring the beneficial uses to Ann Lake and Lake Emma, other strategies need to be implemented to provide the necessary conditions in the lakes to take full advantage of the nutrient reductions. These strategies are described below.

6.2.1 Implement Vegetation Management Plan

An aquatic vegetation management plan should be developed for Ann Lake and Lake Emma. Implementation of a plan is an important step in meeting beneficial use goals in Ann Lake and Lake Emma. Five goals which could be included in the plan are:

1. Control curlyleaf pondweed to affect water quality, restore native aquatic vegetation, improve recreational activities, and ensure continued tourism activities.
2. Provide aquatic plant identification and management information to property owners so informed decisions can be made.
3. Control nuisance aquatic plant conditions to provide improved recreational opportunities for lakeshore owners.
4. Establish stable funding for the management and restoration of aquatic plants and shoreline vegetation.
5. Improve the management of Ann Lake and Lake Emma shorelines supporting better water quality and enhancing the beauty of the lakes.

Estimated Cost: $20,000
Responsible Parties: Ann Lake Association, Minnesota DNR, Wright County SWCD

6.2.2 Manage Fish Populations

Maintaining a balanced fishery is an important aspect of any lake management plan. To accomplish this, the Minnesota DNR will monitor and manage the fish population to maintain a beneficial community. The Minnesota DNR already periodically monitors fish populations in Ann Lake and Lake Emma.

Estimated Cost: $10,000
Responsible Parties: Minnesota DNR

6.2.3 Rough Fish Assessment

Historical evidence suggests that a significant carp population exists in Ann Lake and Lake Emma although current DNR fish surveys do not demonstrate a large carp population. However, few carp have been caught during fish surveys. It is important to note that current DNR fish assessment methods do not sample carp well and in late winter 2006, a commercial fisherman removed 120,000 pounds of carp, which was 310 pounds per acre. For shallow lakes, a carp density of 120 pounds per acre or less should be targeted to avoid potential damage to the lake's ecosystem (Peter Sorensen, Personal Communication – unpublished data). Consequently, a special assessment needs to be conducted to evaluate carp in Ann Lake and Lake Emma to assess the carp population. Monitoring should include both tagging and tracking carp in the watershed as well as mark and recapture assessments.

Estimated Cost: $20,000
Responsible Parties: Minnesota DNR, Wright County SWCD, Ann Lake Association

6.2.4 Rough Fish Management Plan

Once the rough fish assessment has been completed, a watershed-wide management plan needs to be developed aimed at controlling the carp population in the watershed. A watershed-wide carp management plan would evaluate carp movement, spawning areas, and other critical habitat and prey relationships to identify management options for controlling carp reproduction. Targeted carp removal will likely be a component of any carp management plan (Figure 6.1).

Figure 6.2. Carp removal on Long Lake in the Rice Creek Watershed District (photo courtesy of Matt Kocian, RCWD).

Estimated Cost: $20,000
Responsible Parties: Minnesota DNR, Wright County SWCD, Ann Lake Association

7.0 Summary and Costs

7.1 IMPLEMENTATION ACTIVITIES

Restoration of Ann Lake and Lake Emma will require participation from all stakeholders, especially the land owners in the watershed and lake users. All of the activities identified in this plan will ultimately be the responsibility of the individual stakeholder. Many of the stakeholders ultimately responsible for implementing this plan also have numerous other responsibilities outside of Ann Lake and Lake Emma. Because of these competing interests and needs, strong leadership will be needed to ensure that each of the stakeholders are accomplishing the tasks outlined in this plan to the best of their ability. The Wright County SWCD and Ann Lake Association will lead the implementation of this plan.

A summary of the activities outlined in this plan are provided in Table 7.1. Each of the activities is sorted by the source they address and the responsible stakeholders. Following is a brief description of the overall approach for each source or activity.

7.1.1 Education and Monitoring

Education and outreach is a critical part of the implementation process for the Ann Lake and Lake Emma TMDL. Education and outreach activities will focus on land owners, lakeshore owners, public officials and lake users. Education activities will focus on land management practices such as improved pasture management and lake shore management, recreational use impacts to lakes, nutrient management, and aquatic vegetation management. The purpose of the education and outreach component of the implementation plan will be to help stakeholders understand the TMDL and how their practices affect Ann Lake and Lake Emma as well as provide outreach to public officials on the TMDL implementation plan.

The second piece of the education component of the implementation plan is the development of demonstration projects. Demonstration projects will focus on all aspects of improved land management including low impact development, shoreline management, turf management, and stormwater practices.

Monitoring is also a critical component of this TMDL since the implementation plan will occur using adaptive management. Adaptive management requires additional data to assess progress toward meeting the TMDL as well as potential course corrections based on the response of the water body. Water quality monitoring will occur for County Ditch #10, Ann Lake and Lake Emma to evaluate changes in water quality over time.

Table 7.1. Implementation Activity by Stakeholder.

Actor	General Stormwater	CAFO/Pastures	SSTS	Woodlands/Wetlands	Internal Load
Wright County	• Assess watershed impacts caused by development on receiving waters • Work with property owners to implement site level BMPs such as Low Impact Development (LID) practices especially where development is extremely close to the lake shore	• Pursue funding opportunities such as the Clean Water Legacy Act to provide funding for fencing programs and conservation easements • Promote a tour of conservation projects for Ann Lake and Lake Emma watershed land owners	• Assess all septic systems in the watershed	• Work cooperatively with other agencies to protect high priority wetlands	• Assist SWCD in Feasibility Study and internal load reduction implementation
Wright County SWCD	• Implement overlay district • Assess watershed impacts caused by development on receiving waters[1] • Work with property owners to implement site level BMPs such as Low Impact Development (LID) practices • Upgrade stormwater standards for Cass County	• Implement Feed Lot Management Ordinance for feed lot expansions • Identify key pastures and wetlands for buffers and fencing • Work with land owners to obtain funding for buffer and fencing projects • Identify and implement demonstration projects for fencing and conservation easements in the Ann Lake and Lake Emma watersheds. • Promote soil testing to help determine spreading rates for septage, animal waste and chemical fertilizers[1] • Provide technical assistance to land owners for manure and nutrient management[1] • Conduct a tour of conservation projects for Ann Lake and Lake Emma watershed land owners	• Assess all septic systems in watershed • Partner with and provide funding (Environmental Trust Fund) for local groups to assess septic systems • Work with landowners to upgrade all non-conforming systems • Provide low interest loans for land owners to upgrade noncompliant systems	• Develop a management plan for high priority wetlands[1] • Work cooperatively with other agencies to protect high priority wetlands[1]	• Prepare feasibility reports and make recommendations on internal load strategies such as chemical treatment • Implement internal load reduction strategies
Property Owners	• Implement site level Low Impact Development practices	• Develop property nutrient and manure plans where applicable • Fence pastures where applicable • Implement buffers where applicable	• Inspect and maintain septic systems to required standards	•	•
Ann Lake Association	• Promote implementation of development rules • Bring together Ann Lake and Lake Emma Stakeholders through a fair or open house • Promote implementation of site level Low Impact Development practices • Identify and develop demonstration sites for Low Impact Development practices	•	• Work with Wright County SWCD to educate land owners on septic maintenance • Partner with the Wright County SWCD and Wright County to obtain Environmental Trust funds to assess septic systems in the Ann Lake and Lake Emma watersheds	• Work with the County to identify and protect high priority wetlands in the Ann Lake and Lake Emma watershed • Implement conservation easements on high priority wetlands on lake shore lots	• Support Wright County SWCD in development of internal load feasibility report • Support Wright County SWCD in implementing internal load strategy
Minnesota DNR	• Provide technical assistance with stormwater BMPs including shoreline management	• Provide technical assistance for fencing and buffer projects	•	• Work cooperatively with other agencies to protect high priority wetlands • Provide technical assistance for wetland restoration	• Provide technical assistance for internal loading strategies

Actor	General Stormwater	CAFO/Pastures	SSTS	Woodlands/Wetlands	Internal Load
Minnesota Pollution Control Agency	• Provide technical assistance for stormwater management	• Implement CAFO program in the Ann Lake and Lake Emma watershed • Provide technical assistance for fencing and buffer projects • Provide technical assistance for CAFO and manure management	• Provide technical assistance for SSTS programs	• Provide technical assistance for wetland restoration	• Provide technical assistance for internal loading strategies

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Table 7.1, cont. Draft Implementation Activity by Stakeholder.

Actor	Aquatic Vegetation and Algae Control	Aquatic Recreation	Shorelines	Fisheries and Aquatic Life	Monitoring/ Reporting
Wright County	•	• Provide education on the potential impacts of boating on water quality	• Conduct a shoreline survey • Work with landowners to restore shorelines	•	•
Wright County SWCD	• Assist in monitoring Ann Lake and Lake Emma for exotic species	•	• Provide lakeshore revegetation assistance[1] • Promote lakeshore revegetation demonstration site on Ann Lake and Lake Emma • Identify and implement additional lake shore restoration demonstration sites	•	• Collect implementation data from stakeholders annually • Monitor Ann Lake and Lake Emma annually • Monitor CD #10 annually for flow and water quality
Property Owners	•	• Minimize impacts by avoiding sensitive lake areas	• Restore shorelines	•	•
Ann Lake Association	• Develop and implement aquatic vegetation management plan • Invasive species education • Continue working with the Minnesota DNR to control curly leaf pondweed to less than nuisance conditions	• Provide education on the potential impacts of boating on water quality	• Provide landowner education on shoreline restoration	•	•
Minnesota DNR	• Work with Ann Lake Association to develop and implement aquatic vegetation management plan • Work with the Ann Lake Association to control invasive species such as curly leaf pondweed • Monitor vegetation every 3 years • Invasive species education	• Provide education on the potential impacts of boating on water quality	• Work with landowners to develop natural shorelines • Develop and provide education materials on shoreline restoration • Develop demonstration projects for shoreline restoration	• Monitor fish population every 5 years • Complete a special assessment to evaluate the rough fish population to determine potential water quality impacts from rough fish • Implement fisheries management plan	•

Actor	Aquatic Vegetation and Algae Control	Aquatic Recreation	Shorelines	Fisheries and Aquatic Life	Monitoring/ Reporting
Minnesota Pollution Control Agency	•	•	•	•	•

7.1.2 Watershed Sources

Watershed nutrient sources to Ann Lake and Lake Emma primarily includes animal agriculture in the watershed. Animal agricultural sources mostly revolve around manure management in the Ann Lake and Lake Emma watersheds, so implementation focuses on manure management. Proposed practices include manure management plans and soil testing, buffers and fencing in pastures, and feedlot management to minimize the potential impacts of manure on surface waters.

Another potential source of nutrients that will be further evaluated is septic systems in the watershed. Little is currently known about the number and condition of septic systems in the watershed. As a part of this implementation plan, each existing system will be identified and evaluated for performance. Failing septic systems can contribute nutrients to surface waters through tile lines, overland flow, and groundwater flow if too close to surface waters.

The remaining potential sources including degraded wetlands will be managed for improved water quality and further evaluated to determine potential areas that may contribute to nutrient loads. For example, the wetlands in the watershed will be evaluated to determine their function. Through this evaluation high priority wetlands will be identified for protection and wetlands that may be contributing nutrients will be identified for restoration.

7.1.3 Internal Load and in-lake Management

Internal nutrient loading was identified as an important source to Ann Lake and Lake Emma. Consequently, the source will need to be addressed to meet the state water quality standards. There are numerous techniques available to address internal loading including chemical inactivation, hypolimnetic aeration or withdrawal, and artificial circulation. These techniques will be evaluated in a feasibility study to identify the most cost-effective and appropriate approach.

Other in-lake management focuses on the biological conditions in Ann Lake and Lake Emma including fish and aquatic vegetation. A rough fish population evaluation should be conducted on Ann Lake and Lake Emma to identify whether carp are influencing water quality in the lake.

7.2 IMPLEMENTATION SEQUENCING

An important aspect of any implementation plan is the sequence in which activities are undertaken. Typically, watershed activities are the initial focus before any internal loading projects are completed to protect the long term benefits on any internal load reduction practice. Assuming that implementation of this management plan will require 15 years, Table 7.2 outlines the appropriate sequence for restoring Ann Lake and Lake Emma.

Table 7.2. Ann Lake and Lake Emma Restoration Sequence

Cycle	Ongoing Activities	Capital Projects and Studies
0-5 years	• Coordination and education • Water quality monitoring • Feedlot and pasture management • Manure management plans • Field P testing • SSTS inspections • Develop aquatic vegetation management plan	• Demonstration projects • Fencing and buffers • Shoreline restoration • SSTS upgrades • Evaluate wetlands • Internal load feasibility study • Rough fish population assessment
5-10 years	• Coordination and education • Water quality and biological monitoring • Feedlot and pasture management • Manure management plans • Field P testing • SSTS inspections • Protect and restore wetlands • Implement aquatic vegetation management plan	• Fencing and buffers • Shoreline restoration • SSTS upgrades • Internal load reduction capital project • Rough fish management project (if necessary) • Grass Lake wetland restoration
10-15 years	• Coordination and education • Water quality monitoring • Feedlot and pasture management • Manure management plans • Field P testing • Implement aquatic vegetation management plan	• Fencing and buffers • Shoreline restoration
15+ years	• Water quality monitoring • Implement aquatic vegetation management plan	• None

7.3 COST SUMMARY

Estimated costs for each of the program elements are provided in Table 7.3. The total costs for implementing the plan ranges from $1M to $5M.

Table 7.3. Estimated costs associated with each implementation activity.

Program Element	Activity	Cost	Responsible Parties
Education	Coordination	5 hours/month	Wright County SWCD, Ann Lake Association
	Lakeshore and Land Management Impacts	$2,000 annually	Wright County SWCD, Ann Lake Association
	Lake Recreation Impacts	$2,000 annually	Wright County SWCD, Ann Lake Association
	Public Education and Outreach	$2,000 annually	Wright County SWCD, Wright County, CROW, Minnesota DNR, MPCA, Ann Lake Association
	Public Official and Staff Education	$2,000 annually	Wright County SWCD, Wright County, CROW, Minnesota DNR, MPCA, Ann Lake Association
	Demonstration Projects	$5,000 annually	Wright County SWCD, Wright County, CROW, Ann Lake Association
Monitoring	Ann Lake and Lake Emma Water Quality	$5,000 per event	Wright County SWCD
	County Ditch #10 Water Quality	$5,000	Wright County SWCD
	Vegetation Monitoring	$5,000	Ann Lake Association
	Fish Monitoring	$5,000	Minnesota DNR
Watershed Activities	Feedlot Management	Current Budget	Wright County SWCD
	Buffers and Fencing Along Pastures	$500,000	Wright County SWCD
	Manure Management Plans	$20,000	Wright County SWCD
	Manure Management Demonstration Projects		Wright County SWCD
	Increase Infiltration in Watershed	$5,000 annually	Wright County SWCD, Wright County
	Shoreline Management and Restoration	$150,000	Wright County SWCD, Wright County, Ann Lake Association
	Evaluate and Prioritize Wetlands	$30,000	Wright County SWCD, Wright County, CROW
	Inspect Septic Systems in Ann Lake and Lake Emma Watershed	$5,000 annually	Wright County SWCD, Wright County, CROW, MPCA
	Upgrade Nonconforming Septic Systems	$50,000 to $500,000	Wright County SWCD, Wright County, CROW
	Construction Stormwater	Current Program	MPCA

Table 7.3, cont. Estimated costs associated with each implementation activity.

Program Element	Activity	Cost	Responsible Parties
In-Lake Activities	Internal Load Reduction Feasibility Study	$30,000	Wright County, Wright County SWCD
	Implement Internal Load Reduction and Biomanipulation Alternative	$250,000 to $2 Million	Wright County, Wright County SWCD, CROW, Minnesota DNR, Ann Lake Association
	Implement Vegetation Management Plan	$10,000	Minnesota DNR, Ann Lake Association
	Manage Fish Populations	$10,000	Minnesota DNR
	Rough Fish Assessment and Management	$15,000	Minnesota DNR, Ann Lake Association
Total Range		$1M to $5M	

8.0 Literature Cited

Moss, B., J. Madgwick, and G. Phillips. 1996. A guide to the restoration of nutrient-enriched shallow lakes. 180 pgs.

Scheffer, M. 1998. Ecology of Shallow Lakes. 357 pgs.