Lino Lakes Chain of Lakes TMDL Implementation Plan

Wenck File #1137-12

Prepared for:

RICE CREEK WATERSHED DISTRICT

MINNESOTA POLLUTION CONTROL AGENCY

May 2010

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1.0 Introduction

The Lino Lakes Chain of Lakes Total Maximum Daily Load (TMDL) study addresses nutrient impairments in all five lakes in the chain. The goal of the TMDL is to quantify the pollutant reductions needed to meet state water quality standards for nutrients in George Watch (02-0005), Marshan (02-0007), Reshanau (02-0009), Rice (02-0008) and Baldwin (02-0013) Lakes.

The Lino Lakes chain of lakes is a regionally important water resource located in Anoka County, Minnesota, in the Rice Creek watershed, within the jurisdictional limits of the City of Lino Lakes. The lakes are heavily used recreational water bodies that support fishing and boating as well as provide aesthetic values. Four of the lakes are wholly or partially located within the Rice Creek Regional Park Reserve. The drainage area to the lake chain is 12,000 acres of suburban, regional park, undeveloped wetland, and agricultural land. The lakes are connected to each other by channels of varying lengths. George Watch, Marshan, Rice, and Baldwin Lakes are part of a longer flow-through chain of lakes receiving outflow from the Peltier Lake upstream, while Reshanau receives outflow from some smaller lakes and discharges to Rice Lake. The lake system discharges into Rice Creek, which ultimately discharges into the Mississippi River. Water quality is poor with frequent algal blooms. All the lakes in this study are shallow lakes, with maximum depths of less than 10 feet.

Peltier Lake is located upstream of this chain and is an Impaired Water for excess nutrients. A separate TMDL is being developed for that lake. Outflow from Peltier into George Watch Lake is the source of about 90 percent of the annual flow of water through the chain of lakes, and most of the external nutrient load. The two most significant sources of excess phosphorus to these lakes are the outflow from Peltier Lake and internal loading.

Wasteload and Load Allocations to meet state standards indicate that nutrient load reductions ranging from 65 to 85 percent would be required to consistently meet standards under average precipitation conditions. To achieve these reductions, Peltier Lake must achieve its TMDL goal and internal loads in the chain of lakes must be significantly reduced through a combination of aquatic vegetation and fishery management.

2.0 Lino Lakes Chain of Lakes 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 and the quality of water in the lakes, monitoring data extending back to 1990 was reviewed. Other data examined include fish community data compiled by the DNR, a shoreline condition survey conducted by a lake association, and some limited aquatic vegetation data.

2.1 STATE STANDARDS

In accordance with Minnesota Rules 7050.0150 (4), all five of the lakes meet the definition of a shallow lake and thus the shallow lake standards in Minnesota Rules 7050.0222 (4) and (4a) apply. Further, the lakes are all located in the Central Hardwood Forest ecoregion. Therefore, the typical total phosphorus endpoint for these lakes is the shallow lake standard of 60 μg/L (recently adopted in July 2008). Table 2.1 presents the total phosphorus standard in effect prior to the adoption of ecoregion shallow lake standards and used to put the lakes on the impaired waters list and the shallow lake total phosphorus standard that would typically used as an endpoint to de-list the lakes. The table also shows the proposed natural background condition of the lakes as determined by sediment core analysis, the implications of which is explained later in this section.

Table 2.1: Target total phosphorus concentration end points used in this TMDL

	Listing TP Standard (μg/L)	**TMDL Shallow Lake TP Standard (μg/L)[1]**	**Proposed TP Natural Background Condition (μg/L)**
George Watch Lake	40	60	80
Marshan Lake	40	60	80
Reshanau Lake	40	60	60
Rice Lake	40	60	80
Baldwin	40	60	80

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

Although the TMDL is set for the total phosphorus standard, two other lake response parameters are included for Minnesota's lakes including chlorophyll-a and Secchi depth (Table 2.4). All three of these parameters were assessed in this TMDL to assure that the TMDL will result in compliance with state standards.

Table 2.2: Numeric targets for Lakes in the North Central Hardwood Forest and Western Corn Belt Plain Ecoregions. This TMDL uses the North Central Hardwood Forest Ecoregion standards. However, the Western Cornbelt Plain Ecoregion is included for reference.

	Ecoregions			
	North Central Hardwood Forest		Western Corn Belt Plains	
Parameters	Shallow[1]	Deep	Shallow[1]	Deep
Phosphorus Concentration (µg/L)	60	40	90	65
Chlorophyll-a Concentration (µg/L)	20	14	30	22
Secchi disk transparency (meters)	>1	>1.4	>0.7	>0.9

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

As explained in the TMDL report, a natural background condition standard of 80µg/L has been proposed for the entire chain of lakes except for Reshanau Lake based on diatom reconstructions from Peltier Lake (Appendix A). However, at the time of this TMDL, the site-specific standard has not been approved. Upon approval of the natural background condition standard, the TMDL will revert to 80 µg/L summer average total phosphorus for all the lakes except Reshanau as outlined in Table 2.3 (Reshanau will continue to be managed to meet the CHF shallow lake standards). Concurrent with the 80 µg/L total phosphorus natural background condition standard, a natural background condition of 27 µg/L chlorophyll-a and a Secchi depth of 0.8 meters is expected. Thus, the CHF parameters should be considered interim target endpoints for four of the five lakes in the chain until the site-specific standard is adopted.

2.2 CURRENT WATER QUALITY

Monitoring data in the Lino Lakes chain of lakes suggest that the chain of lakes is a highly productive system with the poorest water quality occurring in George Watch and Marshan Lake. A brief summary of the monitoring data analyzed for the five lakes is presented below. Data on lake quality is specifically noted for 2007, a recent year for which good monitoring data was available and which was near average in precipitation:

George Watch Lake

- Historical average phosphorus concentrations vary from 147 µg/L to 428 µg/L; the concentration in 2007 was 246 µg/L,
- Historical average Chlorophyll-a concentrations vary from 35 µg/L to 128 µg/L; the concentration in 2007 was 89 µg/L,
- Historical average Secchi depth varies from 0.32 meters to 0.92 meters; the water clarity in 2007 was 0.92 meters,

- Total phosphorus, Chlorophyll-a, and water clarity in George Watch all exceed the state standards.

Marshan Lake

- Historical average phosphorus concentrations vary from 143 µg/L to 436 µg/L; the concentration in 2007 was 205 µg/L,
- Historical average Chlorophyll-a concentrations vary from 55 µg/L to 123 µg/L; the concentration in 2007 was 56 µg/L,
- Historical average Secchi depth varies from 0.26 meters to 0.80 meters; the water clarity in 2007 was 0.80 meters,
- Total phosphorus, Chlorophyll-a, and water clarity in Marshan all exceed the state standards.

Reshanau Lake

- Historical average phosphorus concentrations vary from 93 µg/L to 175 µg/L; the concentration in 2007 was 120 µg/L,
- Historical average Chlorophyll-a concentrations vary from 31 µg/L to 101 µg/L; the concentration in 2007 was 89 µg/L,
- Historical average Secchi depth varies from 0.27 meters to 0.79 meters; the water clarity in 2007 was 0.48 meters,
- Total phosphorus, Chlorophyll-a, and water clarity in Reshanau all exceed the state standards.

Rice Lake

- Historical average phosphorus concentrations vary from 188 µg/L to 264 µg/L; the concentration in 2007 was 264 µg/L,
- Historical average Chlorophyll-a concentrations vary from 62 µg/L to 91 µg/L; the concentration in 2007 was 62 µg/L,
- Historical average Secchi depth varies from 0.32 meters to 1.0 meters; the water clarity in 2007 was 1.0 meters,
- Total phosphorus, Chlorophyll-a, and water clarity in Rice Lake all exceed the state standards except for water clarity in 2007 which met the standard.

Baldwin Lake

- Historical average phosphorus concentrations vary from 205 µg/L to 232 µg/L; the concentration in 2007 was 232 µg/L,
- Historical average Chlorophyll-a concentrations vary from 70 µg/L to 104 µg/L; the concentration in 2007 was 70 µg/L,
- Historical average Secchi depth varies from 0.32 meters to 0.90 meters; the water clarity in 2007 was 0.90 meters,
- Total phosphorus, Chlorophyll-a, and water clarity in Baldwin all exceed the state standards.

2.3 REQUIRED PHOSPHORUS LOAD REDUCTIONS

This Implementation Plan details the specific activities the stakeholders in the watershed plan to undertake to attain that reduction.

2.3.1 Allocations

The focus in implementation will be on reducing the growing season phosphorus loads to the lakes. Because of the short residence times in each of the lakes, the Total Maximum Daily Loads established for these lakes are growing season loads for both the current (interim) water quality standard and the proposed natural background condition standard. No reduction in atmospheric loading is targeted because this source is impossible to control on a local basis. The remaining load reductions were applied based on our understanding of the lakes as well as output from the model.

Table 2.3 summarizes the TMDL total phosphorus loads expressed as growing season loads allocated among the major sources for each lake in the Chain of Lakes for both the 60 ug/l interim standard and the 80 ug/l natural background condition standard.

Table 2.3: TMDL total phosphorus loads expressed as growing season loads partitioned among the major sources for each lake in the chain of lakes assuming the shallow lakes standard of 60μg/L.

Lake	Allocation Type	Source	Existing Load (lb/growing season)	Shallow Lake Standard (60 μg/L)		Natural Background Condition (80 μg/L)	
				Total Annual TP Load (lb/growing season)	Percent Reduction	Total Annual TP Load (lb/growing season)	Percent Reduction
George Watch Lake	Wasteload	Stormwater Load	52	52	0%	52	0%
	Load	Watershed Load	112	112	0%	112	0%
		Upstream Lake Load	7,679	2,429	68%	3,238	58%
		Atmospheric Load	42	42	0%	42	0%
		Internal Load	9,408	1,270	87%	2,091	78%
		TOTAL LOAD	*17,292*	**3,904**	77%	**5,535**	68%
Marshan Lake	Wasteload	Stormwater Load	189	189	0%	189	0%
	Load	Watershed Load	279	279	0%	279	0%
		Upstream Lake Load	7,802	2,476	68%	3,299	58%
		Atmospheric Load	15	15	0%	15	0%
		Internal Load	3,997	218	95%	570	86%
		TOTAL LOAD	*12,282*	**3,176**	74%	**4,352**	65%
Reshanau Lake[1]	Wasteload	Stormwater Load	12	12	0%	**Not Applicable**	
	Load	Watershed Load	16	16	0%		
		Upstream Lake Load	219	153	30%		
		Atmospheric Load	6	6	0%		
		Internal Load	596	61	90%		
		TOTAL LOAD	*849*	**248**	71%		
Rice Lake	Wasteload	Stormwater Load	149	149	0%	149	0%
	Load	Watershed Load	99	99	0%	99	0%
		Upstream Lake Load	7,734	2,705	65%	3,604	53%
		Atmospheric Load	21	21	0%	21	0%
		Internal Load	5,082	767	85%	1,322	74%
		TOTAL LOAD	*13,085*	**3,741**	71%	**5,196**	60%
Baldwin Lake	Wasteload	Stormwater Load	27	27	0%	27	0%
	Load	Watershed Load	41	41	0%	41	0%

Lake	Allocation Type	Source	Existing Load (lb/growing season)	Shallow Lake Standard (60 µg/L)		Natural Background Condition (80 µg/L)	
				Total Annual TP Load (lb/growing season)	**Percent Reduction**	**Total Annual TP Load (lb/growing season)**	**Percent Reduction**
		Upstream Lake Load	7,546	2,770	63%	3,691	51%
		Atmospheric Load	10	10	0%	10	0%
		Internal Load	3,109	567	82%	912	71%
		TOTAL LOAD	*10,734*	**3,415**	68%	**4,681**	56%

2.3.2 MS4 Target Loads

NPDES Phase II permits for small municipal separate storm sewer systems (MS4) have been issued to all but one of the cities and townships that drain to the chain of lakes as well as the RCWD, Anoka and Ramsey Counties, and Mn/DOT. Only Columbus Township is not a regulated MS4. The MS4s are covered under the Phase II General NPDES Stormwater Permit – MNR040000. The unique permit numbers assigned to the cities, townships, and counties that drain to the Lino Lakes chain, are as follows:

- Lino Lakes – MS400100
- Centerville – MS400078
- Circle Pines – MS400009
- White Bear Township – MS400163
- Shoreview – MS400121
- Blaine – MS400075
- Ham Lake – MS400092
- North Oaks – MS400109
- Rice Creek Watershed District – MS400193
- Anoka County – MS400066
- Ramsey County – MS400191
- Mn/DOT Metro District – MS400170
- Minnesota Correctional Institute – Lino Lakes – MS400177

Stormwater discharges are regulated under NPDES, and allocations of nutrient reductions are considered wasteloads that must be divided among permit holders. Because there is not enough information available to assign loads to individual permit holders, the Wasteload Allocations are combined in this TMDL as Categorical Wasteload Allocations. The Load Allocation is allocated in the same manner. The relative proportions of these sources are presented in Section 5 of this report.

Although many of the sources of phosphorus in the watershed are nonpoint in nature, because they are regulated by NPDES permits, they are allocated in the Wasteload Allocation portion of this TMDL, as required by the EPA. The wasteload allocations assigned to the MS4s essentially hold each to a “no-net-increase” in phosphorus loading relative to current conditions. The discussion of the sources recognizes the fundamental nonpoint source nature of phosphorus.

Table 2.4: Target loads for MS4 permitted dischargers to the Lino Lake Chain of Lakes

Watershed	George Watch Lake TP Load (lbs/growing season)	Marshan Lake TP Load (lbs/growing season)	Reshanau Lake TP Load (lbs/growing season)	Rice Lake TP Load (lbs/growing season)	Baldwin Lake TP Load (lbs/growing season)
TMDL Stormwater Load	52	189	12	149	27
Blaine	--	20.7	--	28.5	--
Centerville	0.2	--	0.2	--	--
Circle Pines	--	--	--	15.4	7.9
Ham Lake	--	--	--	--	--
Lino Lakes	47.8	163.6	11.9	100.1	18.6
North Oaks	--	--	0.1	--	--
Shoreview	--	--	0.1	--	--
White Bear Twp.	--	--	--	--	--
Anoka County	1.7	3.9	0.2	3.5	0.8
Mn/DOT Metro District	1.8	0.9	--	1.2	--

3.0 Implementation Framework

3.1 INTRODUCTION

The purpose of this implementation plan is to outline the activities that need to be implemented to achieve the phosphorus load reductions outlined in the TMDL and the framework for implementing the plan. Special consideration is given to the shallow nature of these lakes which ultimately dictates the activities identified and the sequence in which these activities should be implemented. This framework is intended to guide all the responsible parties in selecting appropriate activities for addressing the TMDL. In addition, the framework is meant to provide opportunities for partnerships among the stakeholders to address the TMDL and achieve the nutrient load reductions.

This chapter begins with an explanation of important principles in understanding and restoring shallow lakes. It follows that section with implementation plan principles specific to the restoration of the Lino Lakes chain of lakes, then outlines the implementation approach for the project and explains the essential role that Adaptive Management will play in the implementation effort.

3.2 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.

3.2.1 Shallow Lake Ecology

3.2.1.1 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. 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.

3.2.2 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. Following is a description of each of the five steps in the process. Implementation of this TMDL will follow the five-step process.

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 indentified 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 in 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 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.

<u>Step 4. Plant establishment</u>

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 provide food and habitat for fish and wildlife. Additionally, vegetation provides food and habitat for macroinvertebrates, 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.

<u>Step 5. Stabilizing and managing restored system</u>

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.

3.2.3 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 the Lino Lakes chain of lakes 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. In the subsequent Implementation Plan, a detailed list of activities and their sequence will be developed.

3.3 IMPLEMENTATION PLAN PRINCIPLES

Through the discussion of policies and practices, current activities, and ongoing research, the stakeholders for this project identified principles to guide development and implementation of the load reduction plan. Like the shallow lake restoration principles presented in the previous section, the principles here are based on our current scientific understanding of shallow restoration and management for the Lino Lakes chain of lakes. 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 undertake measures that have a reasonable probability of success in reducing internal phosphorus loading in the lakes.

3. Retrofit BMPs in the Watershed as Opportunities Arise

Each stakeholder agreed that nutrient loading must be reduced, but that as fully developed cities, options for retrofitting BMPs were limited. Each stakeholder agreed to evaluate and include nutrient-reduction BMPs in street and highway projects, and to consider the opportunities that redevelopment offers to add or upsize BMPs.

4. Encourage Communication

The stakeholders agreed that the stakeholder meetings themselves had been 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

City staff, especially operation and maintenance staff, should be provided opportunities for education and training to better understand how their areas of responsibility relate to the protection and improvement of water quality in the lakes.

6. Communicate with the Public

Public education 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

3.4 IMPLEMENTATION APPROACH

The TMDL study and this Implementation Plan identified specific improvements to reduce external and internal phosphorus loads. These are "short-term" projects that could be accomplished in the coming 10-20 years. However, these projects alone may not be enough to achieve water quality goals in these lakes. An essential "long-term" component of this Implementation Plan is to routinely retrofit BMPs in the watershed as redevelopment or construction provide opportunities.

Numerous governing units have water quality responsibilities in the watershed, including all MS4 permit holders and the Rice Creek Watershed District. These agencies are focused on protecting water quality through implementation of their watershed and local plans as well as MS4 Stormwater Pollution Prevention Programs (SWPPPs). These plans and permits will outline the activities to be undertaken by each governing unit including best management practices and capital improvements. This implementation plan will guide the governing units in the implementation of BMPs focused on achieving the TMDL.

3.4.1 Rice Creek Watershed District

The Rice Creek Watershed District was formed in 1972 under Minnesota Watershed Law. The District is over 200 square miles in size and contains parts of 29 municipalities and townships in four counties. The District's mission is "To conserve and restore the water resources of the District for the beneficial use of current and future generations."

The District is also a watershed management organization as defined by the Metropolitan Surface Water Management Act (Chapter 509, Laws of 1982, Minnesota Statute Section 473.875 to 473.883 as amended). That law establishes requirements for watershed management plans within the Twin Cities Metropolitan Area. The law requires the plan to focus on preserving and using natural water storage and retention systems to:

- Improve water quality.
- Prevent flooding and erosion from surface flows.
- Promote groundwater recharge.
- Protect and enhance fish and wildlife habitat and water recreation facilities.
- Reduce, to the greatest practical extent, the public capital expenditures necessary to control excessive volumes and rate of runoff and to improve water quality.
- Secure other benefits associated with proper management of surface water.

Minnesota Rules Chapter 8410 requires watershed management plans to address eight management areas and to include specific goals and policies for each to serve as a management framework. To implement its approved watershed management plan, the RCWD has undertaken several activities, including administering rules and standards regulating stormwater runoff quantity and quality from development and redevelopment in the district; developing Resource Management Plans for resources in the district; and constructing improvements in the District such as a project to re-meander Rice Creek.

The RCWD has just completed the process of amending its rules and standards to incorporate more stringent stormwater management requirements. These include a new volume management standard requiring infiltration or other abstraction of the 2-year (2.8 inches in 24 hours) rain event for new development; limitations on wetland impacts; and pretreatment of new discharges to wetlands and other public waters.

3.4.2 NPDES MS4 Stormwater Permits

NPDES Phase II stormwater permits are in place for all but one of the cities and townships draining to the chain of lakes watershed as well as the Rice Creek Watershed District, Anoka and Ramsey Counties and Mn/DOT. Under the stormwater program, permit holders are required to develop and implement a Stormwater Pollution Prevention Program (SWPPP). The SWPPP must cover six minimum control measures:

- Public education and outreach;
- Public participation/involvement;
- Illicit discharge, detection and elimination;
- Construction site runoff control;
- Post-construction site runoff control; and
- Pollution prevention/good housekeeping.

The permit holder must identify BMPs and measurable goals associated with each minimum control measure.

According to federal regulations, NPDES permit requirements must be consistent with the assumptions and requirements of an approved TMDL and associated Wasteload Allocations. See 122.44(d)(1)(vii)(B). To meet this regulation, Minnesota's MS4 general permit requires the following:

> "If a USEPA-approved **TMDL(s)** has been developed, you must review the adequacy of your Storm Water Pollution Prevention Program to meet the **TMDL's Waste Load Allocation** set for storm water sources. If the **Storm Water Pollution Prevention Program** is not meeting the applicable requirements, schedules and objectives of the **TMDL**, you must modify your **Storm Water Pollution Prevention Program**, as appropriate, within 18 months after the TMDL is approved."

MS4s contributing stormwater to the lakes will comply with this requirement during the implementation planning period of the TMDL. The implementation plan will identify specific BMP opportunities enough to achieve their load reduction and the individual SWPPPs will be modified accordingly as a product of this plan.

MS4s contributing stormwater to the chain of lakes are covered under the Phase II General NPDES Stormwater Permit – MNR040000. See Section 2.3.2 for the unique NPDES Phase II permit numbers assigned to the small municipal separate storm sewer systems (MS4) that contribute drainage to the chain of lakes.

Stormwater discharges are regulated under NPDES, and allocations of nutrient reductions are considered wasteloads that must be divided among permit holders. The RCWD has agreed to take responsibility for wasteload allocations where no other MS4 has jurisdiction.

3.4.3 Implementation Framework

A schematic drawing showing the key components of the implementation effort and how they relate to each other is shown in Figure 3.1 below:

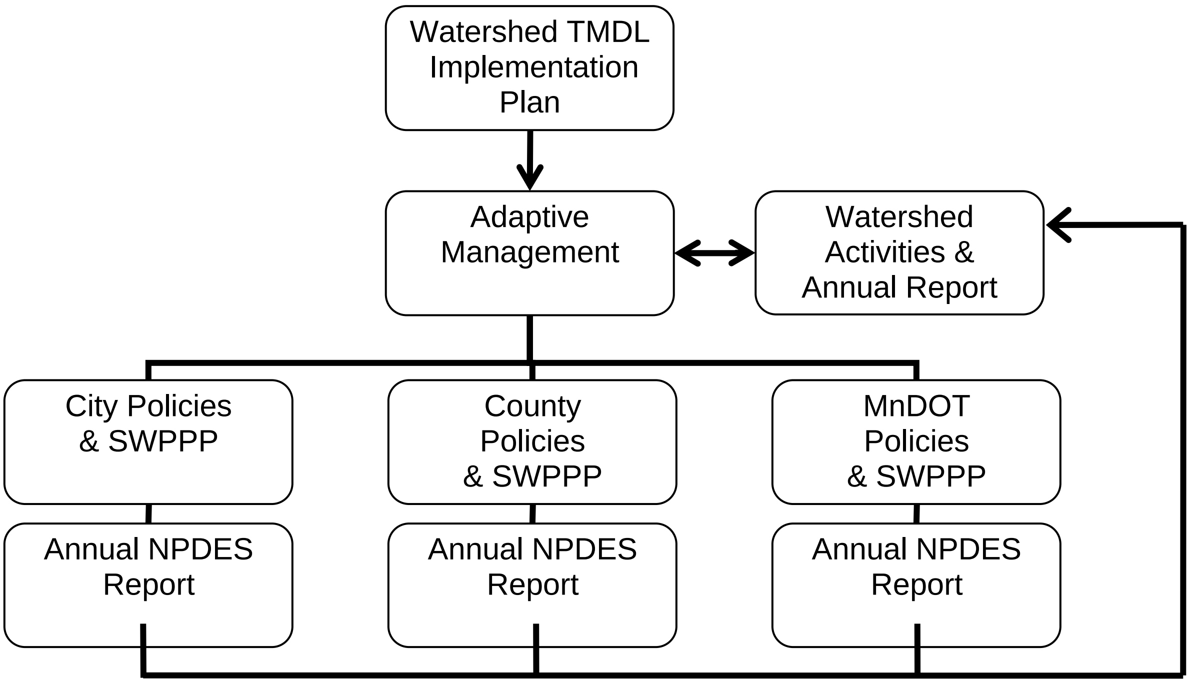

Figure 3.1 Implementation Framework

3.5 ADAPTIVE MANAGEMENT

The load allocations in the TMDL represent aggressive goals for nutrient reductions and are highly dependent on the achievement of reductions in an upstream watershed. Consequently, implementation will be conducted using adaptive management principles. Adaptive management is appropriate because it is difficult to predict the lake response that will occur from implementing strategies with the paucity of information available to demonstrate expected reductions. Future technological advances may alter the course of actions detailed here. Continued monitoring and “course corrections” responding to monitoring results are the most appropriate strategy for attaining the water quality goals established in this TMDL.

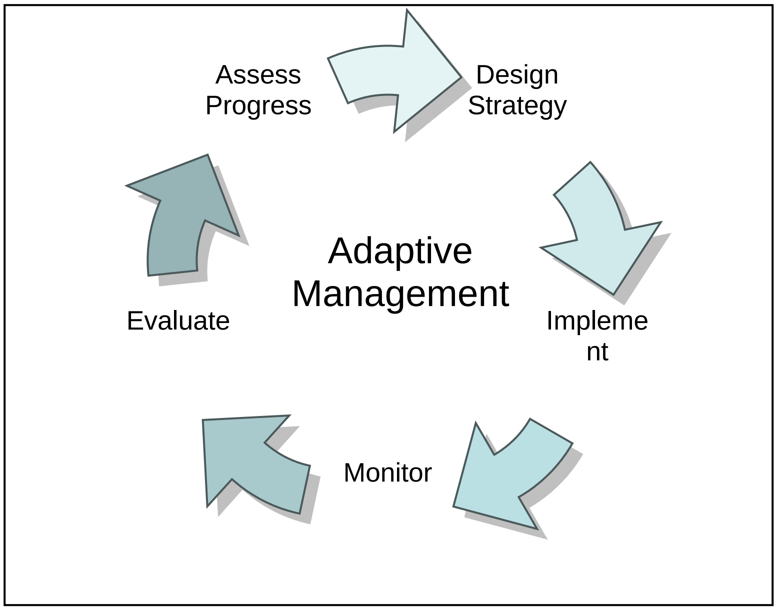

Figure 3.2 Adaptive management

Based on this understanding of the appropriate standards for lakes, this TMDL has been established with the intent to implement all the appropriate activities that are not considered greater than extraordinary efforts. If all the appropriate BMPs and activities have been implemented and any of the lakes still do not meet the current water quality standards, the TMDL will be reevaluated and the Rice Creek Watershed District will begin a process with the MPCA to develop more appropriate site-specific standards for the lake. The process will be based on the MPCA’s methodology for determining site-specific standards.

4.0 Monitoring and Education

4.1 GENERAL COORDINATION

One of the primary RCWD roles in managing the watershed is serving as a coordinator of water resource policy and activities. The RCWD will continue in that role in the implementation of this TMDL. General activities now undertaken by the RCWD will be continued or expanded as the District moves from management planning to implementation coordination. These are activities that are included as part of the District's general administrative budget and no additional cost is expected from their implementation:

- Provide advice and assistance to member cities on their implementation activities;
- Research and disseminate information on changing BMP technology and practices;
- Collect annual implementation activity data;
- Recommend activities such as vegetation or fishery management, partnering with the DNR;
- Periodically update the District's Capital Implement Program (CIP);
- Maintain the watershed SWMM and P8 models;
- Conduct public hearings on proposed projects; and
- Share the cost of qualifying improvement projects.

Estimated Cost: Highly variable; estimated at $2,000 - $10,000/year for activities (not projects)
Funding Source: RCWD general operating budget

4.1.1 Annual Report on Monitoring and Activities

An annual report on phosphorus load reduction activities is necessary under the adaptive management approach established in the TMDL. Each year the Commission will collect from the permittees in the watershed a listing of the activities undertaken in the previous year. This report will summarize those activities and provide the permittees assigned a gross wasteload allocation the necessary information for their annual NPDES reports. The report will detail BMP implementation, associated load and volume reductions, and current monitoring data to evaluate activity effectiveness. This report will be a part of the Commission's annual Water Quality Report. The format and content of the Water Quality Report is being revised to include reporting on the three stream TMDLs and 13 lake TMDLs in the watershed, including the reporting for the Lino Lakes chain of lakes.

Estimated Cost: $10,000-12,000/yr. for RCWD; $1,000-$3,000/yr. for other organizations
Funding Source: RCWD, cities, counties, MnDOT

4.1.2 Lino Lakes Resource Management Plan

The City of Lino Lakes prepared a Resource Management Plan for the City to protect and restore wetlands, lakes, streams, and other natural and water resources in the city. This Resource Management Plan takes into account full build out conditions to determine if additional preventative or mitigation actions are required to maintain or improve these resources. Implementation of this plan will help to avoid any increase in loading rates to the Chain of Lakes and meet TMDL allocations. However, as the watershed develops, the practices will need to be evaluated in accordance with the TMDL.

Estimated Cost: $2,000
Funding Source: City of Lino Lakes

4.2 EDUCATION

4.2.1 Public Education and Outreach

Educate property owners in the subwatershed about proper fertilizer use, low-impact lawn care practices, and other topics to increase awareness of sources of pollutant loadings to the lakes and encourage the adoption of good individual property management practices. Lakeshore property owners should be educated about aquatic vegetation management practices and how they relate to beneficial biological communities and water quality.

Estimated Cost: $2,000-$3,000/yr.
Funding Source: RCWD

4.2.2 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 provide basic information about lake ecology to help staff, Councils and Commissions make informed decisions about lake management.

Estimated Cost: $500
Funding Source: RCWD

4.2.3 Presentations at Meetings

Awareness of lake management can be raised through periodic presentations at meetings of lake associations, homeownership associations, block clubs, garden clubs, service organizations, senior associations, advisory commissions, City Councils, or other groups as well as displays at events such as remodeling fairs and yard and garden events. "Discussion kits" including more detailed information about topics and questions and points for topic discussion could be made available to interested parties.

Estimated Cost: $2,000-$4,000/year
Funding Source: RCWD

4.2.4 Demonstration Projects

Property owners may be reluctant to adopt good lake management practices without examples they can evaluate and emulate. 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. The estimated cost of this activity is highly variable.

Estimated Cost: Varies based on the type of activity
Funding Source: RCWD and outside grants

4.3 ONGOING MONITORING

4.3.1 Water Quality Monitoring

The RCWD will lead monitoring and tracking of the effectiveness of activities implemented to reduce nutrient loading in the watershed. The RCWD will continue to participate in the Metropolitan Council's Citizen Assisted Lake Monitoring Program (CAMP). Through this program, citizen volunteers monitor surface water quality and aesthetic conditions biweekly. This program is also a useful outreach tool for increasing awareness of water quality issues.

The RCWD will monitor lakes that are not covered by the CAMP program, at a minimum, every other year. The TMDL indicates that the water and phosphorus budgets of some several of the lakes, particularly Baldwin, are dominated by upstream lakes. If statistical analysis indicates no difference between lakes, then in-lake monitoring of some, but not all, lakes will be conducted

Estimated Cost: $1,200 per lake annually for CAMP monitoring; $5,000 per lake for more detailed effort every 4-5 years
Funding Source: RCWD

4.3.2 Internal Release Rates Assessment

Prior to developing a feasibility study for internal nutrient control, sediment release rates and chemistry will be evaluated. Sediment cores will be collected from each of the lakes and transported back to a laboratory. In the lab, the cores will be measured for phosphorus release under both aerobic and anaerobic conditions to determine release rates. Sediment chemistry has already been collected from several of the lakes.
Estimated Cost: $3,000-4,000 per lake
Funding Source: RCWD

4.3.3 Biological Monitoring

4.3.3.1 Aquatic Vegetation

A baseline aquatic vegetation survey has been completed for these lakes and will be updated every 4-5 years as part of the more detailed water quality assessment described in Section 4.3.1 above. Because these lakes are shallow, the lakes should be monitored using the point intercept method to provide repeatable surveys.

Estimated Cost: $3,000-4,000 per lake
Funding Source: RCWD

4.3.3.2 Fish and Plankton

Monitoring the fish community in shallow lakes is critical to understanding the potential effects of rough fish and an imbalanced fish community on water quality. The DNR has not historically conducted fish population surveys in the chain of lakes other than Reshanau Lake. Fish surveys will be conducted every 4 to 5 years in the lakes. Special attention should be paid to estimating the rough fish population which may require specific monitoring techniques not currently employed by the DNR in routine monitoring.

Estimated Cost: $3,000 - $5,000 per lake without DNR; <$1,000/lake if DNR does field work and organizes data
Funding Source: RCWD

4.4 NPDES TRACKING AND REPORTING

Each stakeholder will integrate BMPs into their SWPPPs required by their NPDES General Permits for stormwater discharges. Activities will be tracked and reported in their annual NPDES report. Each stakeholder will make a copy of the annual report available to the District. Additional MS4 staff time will be necessary to track and report on activities specific to this TMDL, however, it is difficult to estimate the magnitude of the additional level of effort.

Estimated Cost: $1,000 - $5,000 per MS4
Funding Source: MS4 permit holders

5.0 Watershed Activities

Restoration options for lakes are numerous with varying rates of success. Consequently, each technology must be evaluated considering our current understanding of physical and biological processes in that lake. Following is a description of potential actions for controlling nutrients in the Lino Lakes chain of lakes watershed. It is important to note that, although the Lino Lakes TMDL specifies that watershed loading be held at current conditions (i.e. no watershed load reductions are called for), any reductions to the total phosphorus load will bring the Chain of Lakes closer to meeting their goals. Whenever possible, watershed load reduction projects should be undertaken.

5.1 PELTIER OUTFLOW

Outflow from Peltier Lake is the most significant source of external load to George Watch and the downstream lakes. A separate TMDL is being prepared for Peltier Lake that will include implementation activities to reduce phosphorus load to Peltier and thus reduce in-lake TP concentration. Until Peltier Lake meets its water quality goal of 60 µg/L or the proposed natural background condition standard of 80 µg/L, it is unlikely that any of the Lino Lakes chain of lakes (with the exception of Reshanau) will be able to achieve their water quality goals. The impacts of a natural background condition standard in the Peltier – Lino Lakes Chain of Lakes can be found in Appendix A.

Reducing the total phosphorus load exported from Peltier Lake is the key external load reduction activity. Peltier Lake water quality, however, does not affect water quality in Reshanau Lake. The second key source that requires reduction is internal loading. Addressing these two sources alone should be enough to meet the TMDL.

Improving water quality in Peltier Lake will be a difficult task and will likely be a long-term process. More immediate improvements may be obtainable in the downstream chain if the outflow from Peltier Lake was first treated with alum to remove phosphorus or another chemical precipitant and the treated water then discharged to the downstream lakes. The feasibility of cost of such a system should be evaluated.

Estimated Cost: $20,000-$30,000 for feasibility study to treat Peltier Lake outflows
Funding Source: RCWD

5.2 WATERSHED NUTRIENT LOADS

5.2.1 Implement adopted RCWD rules

In February 2008, the Rice Creek Watershed District adopted major revisions to its rules and standards that will result in more stringent requirements for management of stormwater and natural resources, including:

- *Significant runoff volume control requirements for new and re-development activities*. For example, for most new development activity, the new rules require that the runoff from a 2-year (2.8 inches of precipitation in 24 hours) event be retained on site through infiltration or other volume control management techniques. This is likely to reduce the average annual runoff volume and associated pollutant loading from these parcels by over 90% compared to what it would be under conditions with no mitigation.
- *Protection of high value wetlands to prevent phosphorus export*. The revised RCWD rules revision includes standards limiting impacts to wetland hydroperiod based on wetland classification as well as requiring pretreatment of discharges to wetlands.
- *Implementation of the Resource Management Plan for the City of Lino Lakes* to protect and restore wetlands, lakes, streams, and other natural and water resources in the city. This Resource Management Plan takes into account full build out conditions to determine if additional preventative or mitigation actions will be required to maintain or improve these resources

Responsibility for management and enforcement of these regulations falls largely on the RCWD; the RCWD employs a Permits Coordinator and two Inspectors to issue and enforce permits. RCWD's cost of managing and enforcing permits are considered *in-kind*. Costs associated with mitigation activities related to permits are considered a pass through to the eventual user/owner of the development, though the benefits will accrue to the chain of lakes for activities within the chain of lakes watershed. For affected cities and the RCWD, most of the cost of implementing and enforcing the new requirements should be passed along to the developer, who will in turn in incorporate those cost into the rental or sales price for the property.

Estimated Cost: RCWD: in-kind; Permittee: Highly variable - cost will be incorporated into valuation of property
Funding Source: RCWD *ad valorem* funds; Eventual owner/renter of property

5.2.2 Targeted street sweeping

Cities will be asked to identify key areas and target those areas for more frequent street sweeping.

Newer street sweeping technologies are available that use high pressure to remove a greater percent of the small particles that can carry phosphorus to the lakes. Using these newer technologies can help improve water quality. Studies conducted in the Lakes Nokomis and Hiawatha lakesheds in Minneapolis (Wenck Associates 1998) suggest that improved street sweeping technologies and increased street sweeping frequency could reduce phosphorus loads by 7 percent.

Increased and targeted street sweeping may be most effective in those areas where impervious areas drain directly to any of the Lino Lake chain. These watersheds often have high phosphorus loads and little area available for other treatment technologies. Cities' existing sweeping policies and practices should be reviewed to determine how existing practices could be refined to improve efficiency and effectiveness as well as to identify where additional sweeping would provide the most water quality benefit.

Estimated Cost: $7,000 - $12,000 to assess existing sweeping practices, estimate costs and benefits of changing practices, and identify areas that merit intensified sweeping
Funding Source: Cities, RCWD

5.2.3 Retrofit BMPs

Street or highway reconstruction projects, park improvements, and other projects may provide opportunities to incorporate BMPs to add or increase treatment in the watershed. In addition, the Lino Lakes Resource Management Plan will include several potential retrofit BMPs, including the following by watershed:

> George Watch: Develop source control plan for areas north of Hwy 14 to prevent loading to wetlands; source control retrofits in areas draining to groundwater wetlands; evaluate the feasibility of regional infiltration projects.

> Reshanau: Reduce loading to contributing small lakes; manage the urban ditches; restore partially drained wetlands; evaluate opportunities for infiltration and volume reduction in key subwatershed.

> Marshan: Manage the urban ditches; evaluate opportunities for volume reduction and infiltration in key subwatersheds; consider flexible zoning.

> Rice: In 2009, the RCWD partnered with the Anoka County Conservation District to create the *Rice Lake Subwatershed Stormwater Retrofit Assessment*. This study identified a number of stormwater retrofit projects, assessing potential projects by expected benefit and cost. Potential projects include infiltration and bio-filtration on school and residential properties. This report will serve as a model for the general call to "investigate opportunities for volume reduction and infiltration in key subwatersheds". The Rice Lake report is included as Appendix A.

> Baldwin: Further investigate opportunities for volume reduction and infiltration in key subwatersheds.

Estimated Cost: Variable, depending on what opportunities arise. Allow $3,000-$10,000 per feasibility study
Funding Source: Cities, RCWD

5.2.4 Implement Construction and Industrial Stormwater Regulation

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. Alternatively, the activities are in compliance if they meet local construction stormwater requirements that are more restrictive than requirements of the State General Permit.

Industrial stormwater activities are also considered in compliance with provisions of the TMDL if they obtain an Industrial Stormwater General Permit or General Sand and Gravel general permit (MNG49) under the NPDES program and properly select, install, and maintain all BMPs required under the permit. Again, the activities are also in compliance if they meet local industrial stormwater requirements that are more restrictive than requirements of the State General Permit.

Implementation of these regulations is assumed to be a part of each permittee's on-going responsibility to meet state permit requirements. The costs of these activities are considered a cost of day-to-day operations, though the benefits will accrue to the chain of lakes for activities within the chain of lakes watershed.

Estimated Cost: On-going cost of compliance with state permit requirements
Funding Source: Permittees, MPCA

5.2.5 Wildlife Management

Controlling goose populations can decrease phosphorus loading as well as fecal coliform production. The University of Minnesota/ Minnesota DNR runs a goose removal program annually. If the goose population becomes too large, harvesting should be conducted to reduce the population and associated pollution.

Estimated Cost: $3,000-4,000 per removal effort
Funding Source: Cities, DNR

5.2.6 Road Salt Phosphorus Reductions

Phosphorus is often present in road salt as a stabilizing agent or an impurity. Reducing the use of road salt to limit chloride loading may also reduce phosphorus loading. Some data is available to infer those potential reductions, but more analysis should be conducted to prepare a more accurate estimate of the total load reduction that may result from reducing road salt usage in the watershed.

Estimated Cost: $3,000-$5,000 for data analysis and tech memo
Funding Source: RCWD general operating budget

6.0 In-Lake Activities

Restoration of most shallow lakes is reliant upon a major biological shift to move the lake from a turbid to a clear water state. The most effective tool for causing this shift is a whole-lake draw down. The drawdown, or biomanipulation, is typically coupled with aquatic vegetation and rough fish controls. Once enough external load controls are in place, the feasibility of a drawdown will need to be investigated. If a drawdown is not feasible, other biomanipulation techniques will need to be investigated.

All the lakes in the Lino Lakes Chain of Lakes are shallow and require in-lake management to meet state water quality standards. In-lake management refers to practices such as internal nutrient controls, fisheries management, aquatic plant management, and water level management. Each of these practices effect internal nutrient loads as well as the biological health required to maintain a clear water state.

Significant internal load reductions in all the study lakes are required to meeting the total phosphorus concentration standard. Maintenance of a sustainable internal nutrient load requires not only controlling the chemical release of phosphorus from the sediments but also controlling invasive species that can disrupt the internal lake phosphorus cycle. The two most notable invasive species are carp and curly leaf pondweed. Secondarily, a balanced fishery must be maintained to provide for additional water clarity provided by zooplankton grazing on algae.

The in-lake action plan is designed to set the appropriate conditions in the lakes to maintain a clear water state. This includes the removal of forward switches and biomanipulation. Several of the practices will be undertaken concurrently leading up to a biomanipulation. However, the biomanipulation will be a key step in restoring a clear water state in the chain of lakes.

The following list of in-lake management practices are prescribed to address internal loading as a result of chemical phosphorus release, the effects of curly leaf pondweed, and rough fish, most notably carp.

6.1 INTERNAL NUTRIENT LOAD REDUCTIONS

The primary option for the control of internal load is likely to be rough fish removal, curly leaf pondweed control and drawdown if possible. Drawdown may be required to reconsolidate sediments to prevent wind re-suspension as well as to reinvigorate the native plant community. Integrated plans will be developed for each lake to manage the aquatic vegetation, fish, and zooplankton communities to reduce nutrient loads and maintain a level of water clarity that is desirable both aesthetically and for maintenance of a diverse aquatic vegetation community.

6.1.1 Lake Level Management Study

As explained in the TMDL document, these shallow lakes would benefit from periodic lake level manipulations. A feasibility study should be developed to investigate possibilities such as lake level control structures to direct flow from or into various basins. Periodic drawdowns would be beneficial in consolidating sediments, restoring desirable aquatic vegetation, and reducing rough fish populations. Winter drawdowns are effective for managing invasive aquatic species such as curly-leaf pondweed, but also have side benefits of sediment consolidation and native plant establishment. Summer drawdowns are more widely used to reinvigorate native aquatic plant communities and are expected to be more effective after invasive species controls are in place.

Estimated Cost: $20,000 to $30,000 for feasibility study
Funding Source: RCWD

6.1.2 Develop and Implement Rough Fish and Fisheries Management Plan

Although rough fish have been recognized as having severe negative consequences for shallow lakes for a long time (Crivelli, 1983; Parkos, 2003), little is known about their life cycles and history, management and control. Current strategies have been focused on removal and have had limited or short-term success. There has recently been a renewed interest in controlling carp and new research is being conducted on carp populations at the University of Minnesota and Iowa State University. The research has been focused on a better understanding carp reproduction, habitat use, and management techniques. Because our understanding of carp management is still young, identifying management techniques is often difficult and does not always result in the desired outcomes.

A key step in the restoration of the Lino Lakes chain will be rough fish control. To have the greatest chance of success, a rough fish management plan should be established for the chain of lakes. Minimally, the management plan should include:

1. Collection of carp population data to identify the severity of the carp infestation
2. Monitoring of carp movement to identify source areas as well as critical habitat areas
3. Identification of carp management techniques such as better removal techniques, source area control (carp barriers), and key habitats or predator information

A secondary activity will be to partner with the DNR to monitor and manage the fish populations in the chain of lakes to maintain a beneficial community. As the aquatic vegetation changes to a more desirable mix of species, it may be possible to restore a more balanced fish community that includes both panfish and top predators. Options to reduce rough fish populations will be evaluated, and the possibility of fish barriers explored to reduce rough fish access to spawning areas and to minimize rough fish migration between lakes.

Estimated Cost: $10,000 – $20,000 for development of plan, once fish population surveys and analyses are completed.
Funding Source: RCWD

6.1.3 Aquatic Vegetation Management Plan

Another key aspect of establishing a clear water state in shallow lakes is the establishment of native vegetation. Once again, the science behind the management of aquatic vegetation is still quite young. Our understanding of the requirements to establish native vegetation is limited resulting in a need for a management plan and experimental management techniques.

The aquatic vegetation management plan should minimally include:

1. Evaluation of the current and historical vegetation community
2. Identification of resource-specific management techniques and endpoints for invasive aquatic vegetation
3. Identification of key habitat needs for re-establishing native vegetation including water quality and sediment chemistry
4. Evaluation of hydrologic controls on plant establishment including drawdown

Curly-leaf pondweed is present in all lakes and is at nuisance levels in some. Senescence of the curly-leaf pondweed in summer can be a significant source of internal phosphorus load that often results in a mid- to late summer nuisance algal bloom. Vegetation management, such as several successive years of chemical treatment, will be required to keep this exotic invasive species at non-nuisance levels.

Chemical control (endothall) of curlyleaf pondweed has been sponsored by the RCWD on Reshanau Lake since 2005. Control efforts began by treating a small number of acres at a relatively high concentration. In 2006, after the development of a Lake Vegetation Management Plan (LVMP), lake-wide treatments at lower concentrations began. Since that time, curlyleaf density has declined from 625 stems/m^2 to 10 stems/m^2. As a result, chemical treatment was suspended in 2010. Future treatments are expected to be necessary, although it is thought that they may be reduced in size or will be bi-annual.

Chemical control efforts, like those on Reshanau, are not expected on other lakes in the Chain for several reasons. First, all the lakes, with the exception of Reshanau, are designated as “Natural Environment Lakes” by the DNR; the DNR prohibits chemical control of aquatic plants on Natural Environment Lakes. Second, except for Reshanau, residence times on the Chain of Lakes is short (see Table 3.1 in the TMDL report). Herbicide/plant contact time is essential for effective treatment but may be difficult in the majority of the Chain.

Estimated Cost: $10,000 - $15,000 development of overall vegetation management plan, once plant surveys and analyses are completed; Reshanau: $2000 every 5 years to update LVMP
Funding Source: RCWD

6.1.4 Shoreline Management and Restoration

While much of the shoreline on four of the lakes is natural, Reshanau is edged with single-family homes. Most property owners maintain a turfed edge to the shoreline. The implementation plan will encourage property owners to restore their shoreline with native plants to reduce erosion and capture direct runoff, and to limit removal of beneficial vegetation that is perceived to be a nuisance or undesirable.

Residential property shoreline totals about 17,000 linear feet on the four lakes, with the balance of the shoreline riparian wetlands. Ideally about 75 percent of the residential shoreline would be native vegetation, with about 25 percent available for lake access. Accomplishing this goal would require restoration of about 12,750 feet of shoreline and can cost $30-50 per linear foot, depending on the width of the buffer installed. The RCWD maintains a grant program ("Water Quality Cost-Share") that residents can utilize to fund 50% of shoreline improvement costs. The program will be advertised to lakeshore residents.

Estimated Cost: $385,000 – $640,000 for planning/design/execution of restoration effort
Funding Source: Private property owners, cities, RCWD grant funds

7.0 Summary and Costs

While the RCWD will coordinate implementation of the Lino Lakes chain of lakes TMDL, individual stakeholders ultimately will implement the identified BMPs. Not all stakeholders will undertake all these activities. Each stakeholder is in a unique position to implement BMPs. For example, street and highway reconstruction can provide opportunities to retrofit or enhance treatment, but some streets and highways may not require reconstruction for years or even decades. BMPs requiring new equipment or accessories are dependant upon the individual stakeholder's ongoing equipment replacement schedule. Other activities must be integrated into ongoing maintenance responsibilities as the budget allows. Those activities for which the MS4 permittees will take the lead will be incorporated into their NPDES Stormwater Pollution Prevention Plans (SWPPPs), and implementation actions will be reported annually

Table 7.1 summarizes the implementation activities for this TMDL and shows both estimated cost ranges for each element as well as responsible parties. Table 7.2 summarizes the implementation activities assigned each party. Refer to Section 3 of this report for information regarding sequencing and lead agencies.

Table 7.1: Summary of Implementation Elements with Estimated Cost Ranges and Responsible Party

Category	Project	Cost	Responsible Party
1. General Coordination	a. General coordination of TMDL implementation	$2,000-$10,000/yr. for activities	RCWD
	b. Annual report on monitoring and activities; BMP tracking	$10,000-$12,000/yr. for RCWD; $1,000-$2,000/yr. for cities, counties, MnDOT	RCWD; cities, counties, MnDOT
	c. Implement Lino Lakes Resource Management Plan	$2,000/yr. initially for Lino Lakes	Lino Lakes; RCWD
2. Education	a. Public education and outreach	$2,000-$3,000/yr.	RCWD
	b. Encourage public official and staff education	$500/yr.	RCWD
	c. Presentations at meetings	$2,000-$4,000/yr.	RCWD
	d. Demonstration projects	Highly variable, project opportunity driven	RCWD; Cities
3. Monitoring	a. Water quality monitoring	$500-700/yr. per lake for CAMP; $5,000/lake/yr. for detailed monitoring every 4-5 yrs.	RCWD
	b. Internal release rate assessment	$3,000-$4,000/lake	RCWD
	c. Aquatic vegetation survey	$3,000-$4,000/lake	RCWD
	d. Fish and plankton survey	$3,000-$5,000/lake	RCWD

Category	Project	Cost	Responsible Party
	e. NPDES tracking and reporting	$1,000-$5,000 per MS4	Cities, counties, and MnDOT
4. Watershed Activities	a. Peltier outflow nutrient reduction feasibility study	$30,000	RCWD
	b. Implement revised RCWD rules	Highly variable;	RCWD, regulated parties
	c. Implement BMPs as opportunities arise including infiltration and filtration	Highly variable; $3,000 - $10,000/feasibility study	Cities; RCWD
	d. Implement construction and industrial stormwater requirements	Cost born by permittees	Construction and Industrial NPDES permittees
	e. Target street sweeping strategy	$7,000 - $12,000	RCWD, cities
	f. Wildlife management	$3,000-$4,000 per control effort	Cities
	g. Road salt phosphorus reduction assessment	$3,000-$5,000	RCWD, cities
5. In-lake activities	a. Lake level management study	$20,000-$30,000	RCWD
	b. Rough fish and fisheries management plan	$10,000-$20,000	RCWD, DNR
	c. Aquatic vegetation management plan	$10,000-$15,000	RCWD
	d. Chemical inactivation of sediments feasibility study		RCWD
	e. Shoreline management and restoration	$385,000-$640,000	RCWD, cities, private property owners

Table 7.2: Implementation Activity by Stakeholder

Party	Stormwater	Non-stormwater External Load	Internal Load	Aquatic Vegetation	Aquatic Life	Monitoring/ Reporting
RCWD	• Coordination of TMDL implementation • Support implementation of Lino Lakes Resource Management Plan • Provide focused education and outreach • Indentify and implement demonstration projects • Implement new RCWD stormwater rules and standards • Implement BMPs to reduce loads as opportunities arise	• Peltier Lake outflow treatment feasibility study • Implement goose management in watershed where appropriate • Develop street sweeping strategy • Develop road salt associated phosphorus reduction strategy	• Complete lake level management study • Evaluate need and feasibility of alum treatment	• Develop and implement aquatic plant management plan, including control of curly leaf pondweed. • Evaluate feasibility, benefits, costs of drawdown for all lakes • Identify and implement shoreline restoration projects	• Coordinate development and implementation of fisheries management plan, including control of rough fish •	• Collect implementation data from stakeholders annually • Prepare annual report on monitoring and activities • Continue CAMP citizen water quality monitoring • Conduct periodic in- depth lake monitoring including plankton • Conduct aquatic vegetation, fish, and plankton surveys every 4-5 years • Measure internal phosphorus release rates
Cities	• Help implement revised RCWD rules. • Implement Lino Lakes Resource Management Plan • Identify and implement demonstration projects • Implement BMPs to reduce loads as opportunities arise • Conduct routine pond inspections and maintain to preserve performance • Sweep streets at least twice annually • Reduce phosphorus applied as part of winter road maintenance activities where feasible	• Implement goose management in watershed where appropriate	•	• Implement shoreline restoration projects	•	• Report implementation activities to the Rice Creek Watershed District • Comply with requirements to modify NPDES SWPPPs

Party	Stormwater	Non-stormwater External Load	Internal Load	Aquatic Vegetation	Aquatic Life	Monitoring/ Reporting
Mn/DOT	• Sweep streets at least once annually • Implement BMPs to reduce loads as opportunities arise • Reduce phosphorus applied as part of winter road maintenance activities where feasible					•
Counties	• Sweep streets at least twice annually • Implement BMPs to reduce loads as opportunities arise • Reduce phosphorus applied as part of winter road maintenance activities where feasible					•
Property Owners	• Implement BMPs to reduce loads as opportunities arise			• Implement shoreline restoration projects		

8.0 Literature Cited

Crivelli, A. 1983. The destruction of aquatic vegetation by carp: A comparison between Southern France and the United States. Hydrobiogia. 106.

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

Parkos, J., V. Santucci, and D. Wahl. 2003. Effects of adult common carp (Cyprinus carpio) on multiple trophic levels in shallow mesocosms. Canadian Journal of Fisheries and Aquatic Sciences. 60.

Pitt, R. 1998. Small storm hydrology and why it is important for the design of stormwater control practices. Advances in Modeling the Management of Stormwater Impacts. Volume 7.

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

Wenck Associates Inc. 1998. Lakes Nokomis and Hiawatha Diagnostic Feasibility Study – Internal Phosphorus Load Estimates. Internal Technical Memorandum.