Twin and Ryan Lakes TMDL Implementation Plan

Shingle Creek WMC
Brooklyn Center
Brooklyn Park
Crystal
Minneapolis
Minneapolis Parks
New Hope
Robbinsdale
Mn/DOT
Hennepin County

Wenck File #1240

Prepared for:

SHINGLE CREEK
WATER MANAGEMENT COMMISSION

MINNESOTA
POLLUTION CONTROL AGENCY

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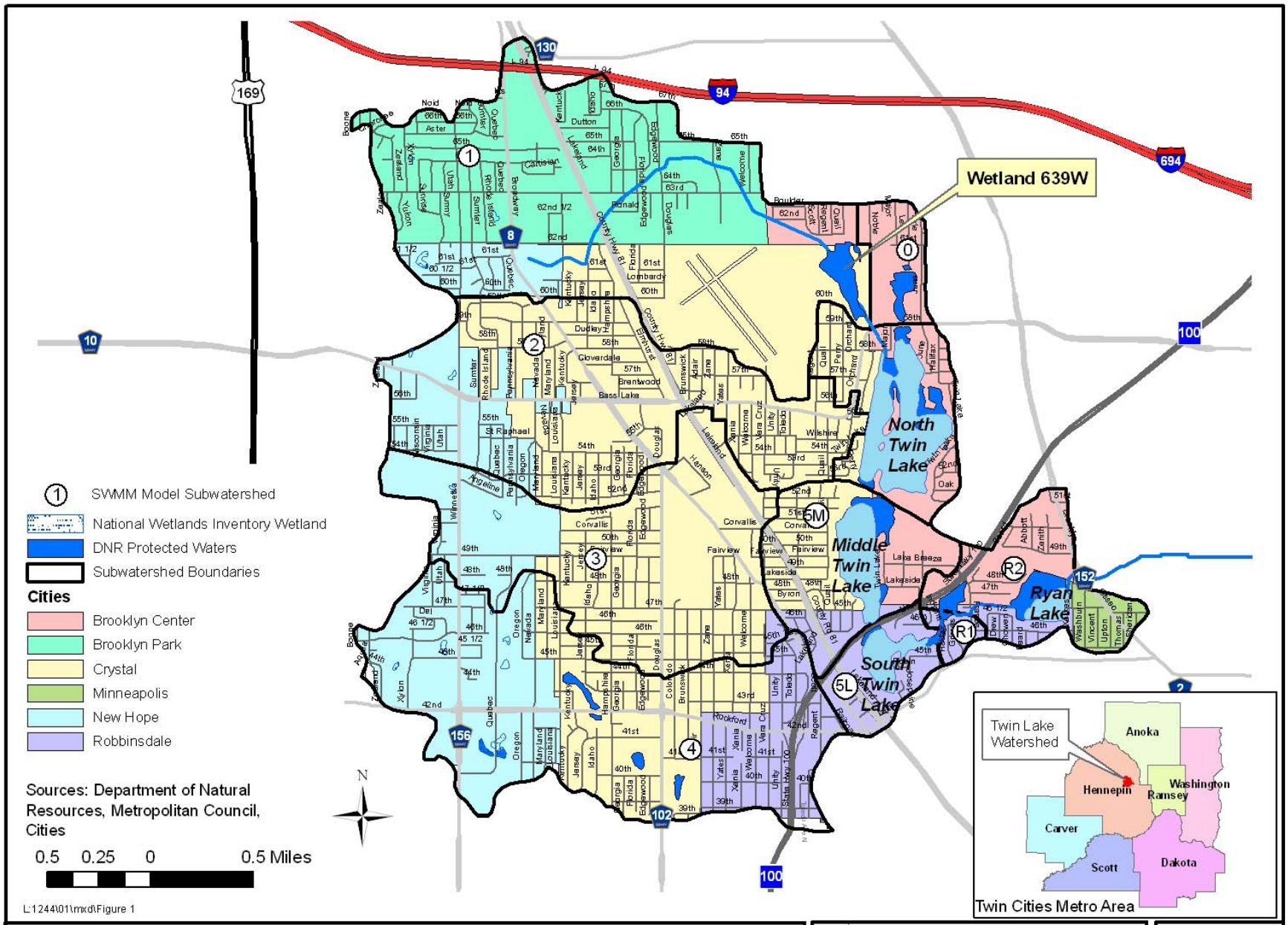
1.0 Introduction

The Twin and Ryan Lakes Nutrient Total Maximum Daily Load (TMDL) study addresses a nutrient impairment in the Twin Lake chain of lakes, a regional water resource located in Hennepin County, Minnesota, in the Shingle Creek watershed, specifically in the cities of Brooklyn Center, Crystal, Minneapolis, and Robbinsdale.

The Shingle Creek Watershed Management Commission (SCWMC) in cooperation with the Minnesota Pollution Control Agency (MPCA) has completed a Total Maximum Daily Load (TMDL) analysis to quantify the phosphorus reductions needed to meet State water quality standards for nutrients in South Twin (27-0042-01), Middle Twin (27-0042-02), North Twin (27-0042-03) and Ryan (27-0058-00) Lakes (see Figure 1) in accordance with Section 303(d) of the Clean Water Act. South Twin Lake is more commonly known as Lower Twin Lake, while North Twin Lake is more commonly known as Upper Twin Lake. The TMDL and Implementation Plan were prepared in cooperation with the six cities with land located in the Twin Lake subwatershed as well as Hennepin County and the Minnesota Department of Transportation (Mn/DOT).

The final step in the TMDL process is the development of an Implementation Plan that sets forth the activities the cities, Hennepin County, and Mn/DOT will undertake to reduce phosphorus loading to the four lakes. This Implementation Plan provides a brief overview of the TMDL findings; describes the principles guiding the Implementation Plan; discusses sequencing, timing, responsible parties, and other implementation general strategies; and describes the proposed implementation activities.



TWIN AND RYAN LAKES NUTRIENT TMDL

Municipal and Street Location Map

Wenck Associates, Inc. 1800 Pioneer Creek Center
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JULY 2007

Figure 1

2.0 Twin and Ryan 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 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 conducted by a lake association, and some limited aquatic vegetation data. A key source of data was previous monitoring and diagnostic studies of Twin Lake and a large wetland complex to the north of North Twin Lake, DNR public waters wetland 639W (see Figure 1).

2.1 CURRENT WATER QUALITY

Monitoring data suggest that the chain is a highly productive system, with the greatest water quality problems occurring in North Twin Lake. Table 1 summarizes historic water quality data for the four lakes. North Twin, the uppermost lake in the chain, is hypereutrophic, and both internal and watershed loading appear to be significant sources of phosphorous. The majority of phosphorous in Middle Twin is from water coming from North Twin and from the watershed. South Twin Lake is a eutrophic lake where internal loading has the potential to increase algal productivity throughout the season. Ryan Lake, the last in the chain, is a deep, mesotrophic lake that has relatively good water quality for an urban lake.

Table 1. Water quality by lake, 1990-2004.

Lake	Summer Average		
	Total Phosphorus (µg/L)	**Chlorophyll-a (µg/L)**	**Secchi Depth (m)**
North Twin Lake	122	48	0.5
Middle Twin Lake	51	23	1.25
South Twin Lake	92	58	0.8
Ryan Lake	49	6	1.7
Current State Standard	***<40***	***<14***	***>1.4***

Source: ***2007 Twin and Ryan Lakes TMDL Report.***

2.2 MEETING STATE STANDARDS

The four lakes in this chain were listed as Impaired Waters because they have excess levels of nutrients that could lead to severe nuisance blooms of algae. Nutrient loads in this TMDL are set for phosphorus, since this is typically the limiting nutrient for nuisance aquatic plants. A water quality standards rules revision is in progress in Minnesota. The proposed rules would establish different standards for deep and shallow lakes, taking into account nutrient cycling differences between shallow and deep lakes and resulting in more appropriate standards for Minnesota lakes.

Two sets of end points were evaluated in the TMDL. The numeric target used to list these four lakes was the current total phosphorus standard of 40µg/L. However, South Twin and North Twin are shallow lakes and would be subject to the proposed target of 60µg/L once the proposed standards are approved. Therefore, the TMDL assumes that the current water quality standards will apply and will guide the implementation plan and necessary reductions until the proposed standards have been adopted. At such time as the State adopts the proposed standards, the standards in Table 2 will apply. The TMDL presents load and wasteload allocations and estimated load reductions for both scenarios.

Table 2. Target total phosphorus concentration end points used in the TMDL.

	Current TP Standard (µg/L)	Proposed TP Standard (µg/L)
North Twin Lake	40	60
Middle Twin Lake	40	40
South Twin Lake	40	60
Ryan Lake	40	40

2.3 REQUIRED PHOSPHORUS LOAD REDUCTIONS

Wasteload and load allocations to meet State standards indicate that nutrient load reductions ranging from 0-76 percent would be required to consistently meet standards under average precipitation conditions. This Implementation Plan details the specific activities the stakeholders in the watershed plan to undertake to attain that reduction.

2.3.1 Allocations

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 in the TMDL are combined as gross wasteload allocations (see Table 3) assigned to all permitted dischargers in the contributing lakeshed. The load allocation is also allocated in the same manner. Each stakeholder has agreed to implement Best Management Practices (BMPs) to the maximum extent practicable. This collective approach allows for higher reductions for some stakeholders with greater opportunity and lesser reductions for those with greater constraints.

Table 3. Wasteload allocation by NPDES permitted facility for each lake.

NPDES Permit Number	North Twin	Middle Twin	South Twin	Ryan
MS400006-Brooklyn Center	Gross WLA	Gross WLA	Gross WLA	Gross WLA
MS400007-Brooklyn Park	Gross WLA	Gross WLA	Gross WLA	Gross WLA
MS400012-Crystal	Gross WLA	Gross WLA	Gross WLA	Gross WLA
MN0061018-Minneapolis	N/A	N/A	N/A	Gross WLA
MS400039-New Hope	Gross WLA	Gross WLA	Gross WLA	Gross WLA
MS400046-Robbinsdale	N/A	Gross WLA	Gross WLA	Gross WLA
MS400138-Hennepin	Gross WLA	Gross WLA	Gross WLA	Gross WLA
MS400170-MnDOT	N/A	Gross WLA	Gross WLA	Gross WLA

N/A = Not applicable – does not drain to lake.

2.3.2 Implementation Focus

The focus in implementation will be on reducing the annual phosphorus loads to the lakes through structural and nonstructural BMPs. Load allocations by source are provided in Table 4 and Table 5 for average precipitation conditions. If North Twin Lake met the standard for shallow lakes in the North Central Hardwood Forests ecoregion, the reduction of its outflow load would result in the remaining lakes in the chain complying with the State standards. However, lakes are uniquely dynamic systems. A dry year may result in increases in internal loading counteracting the effects of reduced flow and loading from upstream. As a result, implementation will address not only North Twin Lake, but also stormwater discharges to the other basins as well as internal loading where appropriate. The TMDLs established here are protective of the water quality standards for each of the basins.

Table 4. TMDL allocations expressed as annual loads for North Twin, Middle Twin, South Twin, and Ryan Lakes assuming current standards (40 µg/L) for North and South Twin Lake.

Critical Conditions	Lake	Wasteload Allocation (kg/yr)[1]	Load Allocation (kg/yr)	Margin of Safety	TMDL (kg/yr)
Average Precipitation Year	North Twin Lake[2]	118	55	Implicit	173
	Middle Twin Lake	150	63	Implicit	213
	South Twin Lake	179	15	Implicit	194
	Ryan Lake	170	43	Implicit	213
Wet Precipitation Year	North Twin Lake[2]	210	55	Implicit	265
	Middle Twin Lake	263	63	Implicit	326
	South Twin Lake	276	15	Implicit	291
	Ryan Lake	298	23	Implicit	321
Dry Precipitation Year	North Twin Lake[2]	100	55	Implicit	155
	Middle Twin Lake	127	63	Implicit	190
	South Twin Lake	176	15	Implicit	191
	Ryan Lake	162	43	Implicit	205

[1]The wasteload allocation is allocated to NPDES-permitted facilities in accordance with Table 3.
[2]The load allocation includes 15% of the stormwater load due to loading from wetland 639W.

Table 5. TMDL Allocations expressed as annual loads for North Twin, Middle Twin, South Twin, and Ryan Lakes assuming shallow lake standards(60 µg/L) for North and South Twin Lake.

Critical Conditions	Lake	Wasteload Allocation (kg/yr)[1]	Load Allocation (kg/yr)	Margin of Safety	TMDL (kg/yr)
Average Precipitation Year	North Twin Lake[2]	192	85	Implicit	277
	Middle Twin Lake	141	63	Implicit	204
	South Twin Lake	258	45	Implicit	303
	Ryan Lake	170	43	Implicit	213

Critical Conditions	Lake	Wasteload Allocation (kg/yr)[1]	Load Allocation (kg/yr)	Margin of Safety	TMDL (kg/yr)
Wet Precipitation Year	North Twin Lake[2]	335	85	Implicit	420
	Middle Twin Lake	263	63	Implicit	326
	South Twin Lake	405	45	Implicit	450
	Ryan Lake	278	43	Implicit	321
Dry Precipitation Year	North Twin Lake[2]	165	85	Implicit	250
	Middle Twin Lake	130	63	Implicit	193
	South Twin Lake	252	45	Implicit	297
	Ryan Lake	167	43	Implicit	210

[1]The wasteload allocation is allocated to NPDES-permitted facilities in accordance with Table 3.
[2]The load allocation includes 15% of the stormwater load due to loading from wetland 639W.

3.0 Implementation Plan

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 Shingle Creek Watershed Management Commission. Representatives from cities, Mn/DOT, Hennepin County and regulatory agencies met several times to discuss the TMDL requirements, TMDL results, shallow lake characteristics, and potential BMPs. In addition, the City of Brooklyn Center prepared a detailed diagnostic study and Management Plan that included extensive public input from lake residents. A summary implementation plan for the TMDL document was developed using this input, distributed to stakeholders for review and posted on the SCWMC website www.shinglecreek.org for public review and comment. This Implementation Plan expands upon that summary plan with more detail.

3.1 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. Restore Biological Integrity

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. Control Internal Load

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. 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 opportunities such as redevelopment 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 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

3.2 IMPLEMENTATION PLAN

The stakeholders agreed that implementation should be a joint effort, with the SCWMC taking responsibility for ongoing coordination, general education and monitoring activities and the NPDES permittees taking responsibility for BMP implementation. The cities, Hennepin County, and MnDOT would be expected to incorporate these BMPs into their Storm Water Pollution Prevention Plans (SWPPP) and NPDES Minimum Measures, and to annually assess progress toward advancing the implementation principles detailed above in Section 3.1. The stakeholders will annually report to the SCWMC their annual activities, and the Commission will summarize those activities into its own Water Quality Annual Report. This framework is illustrated in Figure 2 below.

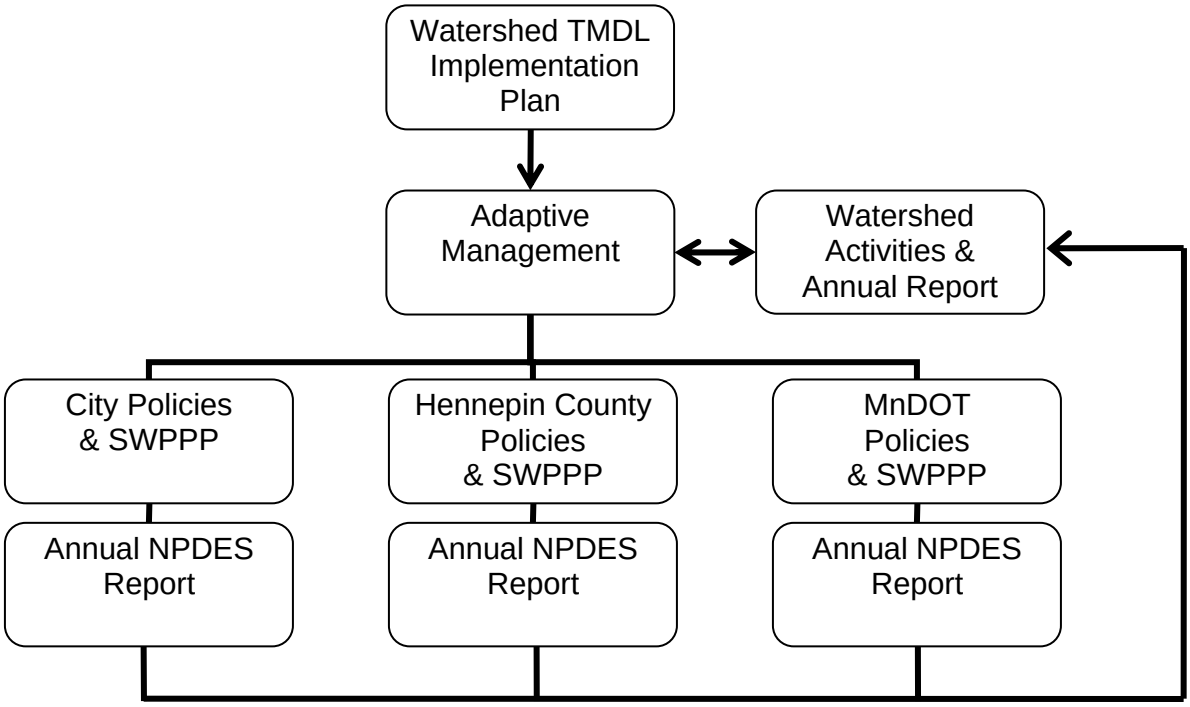

Figure 2. Implementation Framework.

3.2.1 Implementation Approach

The impairments to Twin and Ryan Lakes developed over time as the watersheds draining to them urbanized. As the watershed developed, the native prairie and savanna was cleared and wetlands ditched and filled to support farming. Over the past century the farms and remaining undeveloped land were converted to urban and suburban uses, increasing the volume of runoff and the amount of pollutants conveyed to the lakes and the lakes slowly degraded. Just as this degradation took many years, improvement will also take many years through ongoing retrofit of the watershed with BMPs as well as eventual redevelopment of existing land uses with lower-impact development and stormwater treatment.

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

As the road authorities cycle through their street and highway reconstruction programs, it is now routine to include treatment BMPs such as stormwater detention ponds and underground treatment devices where possible. Mn/DOT incorporated several ponds into the reconstruction of TH 100 that provide treatment not only for previously-untreated highway runoff but also previously-untreated neighborhood drainage. Brooklyn Center included underground treatment devices in a neighborhood street reconstruction project adjacent to Middle Twin, and Crystal is considering incorporating rain gardens into a neighborhood street reconstruction project on its side of Middle Twin. Robbinsdale installed an in-line treatment system as part of a road reconstruction project to treat previously untreated runoff discharging into Middle Twin Lake. Hennepin County is retrofitting CSAH 81 (Bottineau Boulevard) with stormwater treatment as that highway is reconstructed in phases, also providing treatment for neighborhood runoff draining through the highway system. These incremental reductions will over time add up to a significant external load reduction.

Another long-term type of external load reduction is redevelopment. Much of the watershed draining to these lakes developed prior to the development of Shingle Creek Watershed rules and standards and subsequently there is currently little or no treatment of stormwater. As these areas redevelop over time, the new development will be required to abstract some stormwater and treat the balance of the runoff before discharging it to the lakes. Some cities use redevelopment as an opportunity to provide even more treatment by "upsizing" treatment above and beyond the minimum required by the rules or to create new regional treatment opportunities.

The initial emphasis of implementation will be on controlling external loading, which is the highest priority. However, at some point in the future enough external load reduction will have occurred so that it will become feasible to turn to controlling the internal loads. An important part of that strategy is restoring and maintaining biological integrity and associated impacts to water quality through management of the aquatic plant community, fishery, and macroinvertebrate and zooplankton assemblages. However, biological manipulation cannot provide all the internal load reduction that would be required. More detailed study is required to

evaluate whether chemical treatment with alum, hydraulic drawdown, or other means of reducing internal loading are feasible.

The following sections discuss the general BMP strategies that were identified in the TMDL process to reduce phosphorus load, restore ecological integrity, and meet state water quality goals for these lakes; the general sequence of implementation activities; and the stakeholders responsible for leading implementation of each identified activity.

3.2.2 Implementation Strategies

BMP strategies for each lake as identified in the TMDL are listed below and described in more detail in Sections 4 and 5 of this Plan.

Strategies For All Lakes

- Evaluate adequacy of existing rules and standards for runoff water quality treatment and volume management and revise if necessary
- Add BMPs as opportunities arise to decrease runoff from the watershed and increase stormwater treatment
- Increase infiltration and abstraction in the watershed
- Increase frequency of street sweeping in sensitive areas
- Conduct aquatic plant surveys and prepare management plans
- Encourage shoreline restoration to improve runoff filtration

Strategies for North Twin Lake

- Initial focus on reducing external loads
    - Add water quality treatment in watershed 3
    - Monitor and maintain existing ponds to sustain removal effectiveness
    - Retrofit with offline underground treatment devices
- Restore DNR wetland 639W
- Internal load management
    - Remove and control rough fish
    - Prepare drawdown feasibility study
    - Conduct lake drawdown and/or apply alum treatment

Strategies for Middle Twin Lake

- Reduce external load through BMPs as opportunities arise

Strategies for South Twin Lake

- Initial focus on reducing external loads
    - Add water quality treatment in watershed 4
    - Monitor and maintain existing ponds to sustain removal effectiveness
    - Retrofit with offline underground treatment devices
- Internal load management
    - Alum treatment may be feasible

Strategies for Ryan Lake

- Initial focus on reducing external loads
    - Increase treatment in lakeshed
    - Monitor and maintain existing treatment to sustain removal effectiveness

    - Increase rain gardens, filtration in lakeshed
    - Shoreline restoration and maintenance
- Internal load management
    - Biological management

3.2.3 Sequencing

Some of the above activities may be undertaken immediately, while others would be implemented as opportunities arise. In general implementation will proceed according to the following sequence of activities:

First Five Years

- Continue monitoring and information gathering
- Evaluate rules and standards
- Evaluate ways to refine street sweeping practices to maximize pollutant removal
- Identify opportunities for BMP retrofit
- Implement specific BMP projects as funding allows:
    - Wetland 639W Restoration
    - Crystal Twin Oak Pond
    - New Hope Wincrest Pond
    - New Hope 45th Avenue Pond
- Implement BMP retrofits as opportunities arise, especially in subwatersheds 3 and 4
- Implement BMP and restoration demonstration projects as opportunities arise

Second Five Years and Subsequent Permit Cycles

- Continue monitoring
- Evaluate progress towards goals
- Amend Implementation Plan as necessary based on progress
- Implement BMP retrofits as opportunities arise to continue to reduce external loading
- When sufficient external load controls are in place, prepare feasibility studies for internal load reduction strategies such as drawdowns and chemical treatment
- Implement internal load reduction BMPs

3.2.4 Stakeholder Responsibilities

The primary stakeholders in this Plan are the Shingle Creek Watershed Management Commission (SCWMC), the cities draining to the lake chain, Hennepin County, and MnDOT. In addition, property owners in the watershed have a role to play in implementing BMPs on their private properties. The Education program will provide both residential and non-residential property owners and managers with information on BMPs that would have the most impact on improving water quality.

Table 6 shows which stakeholder will be responsible for implementing the various implementation activities identified in this Plan.

3.3 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). 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 monitoring and course corrections responding to monitoring results offer the best opportunity for meeting the water quality goals established in this TMDL.

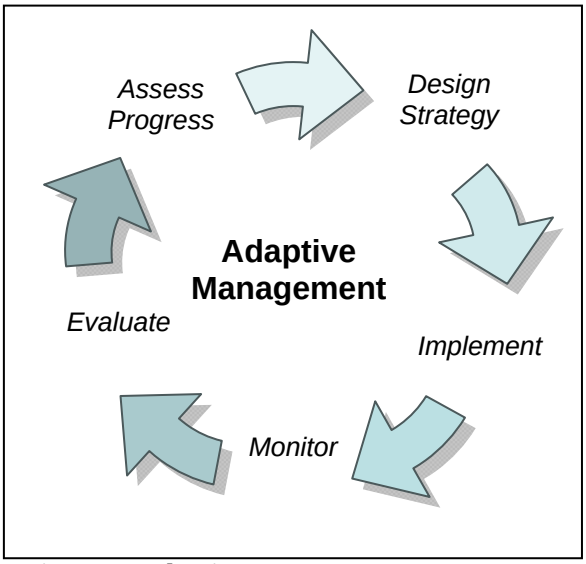

Figure 3. Adaptive management

Table 6. Implementation Activity By Stakeholder.

Actor	Stormwater	Non-stormwater External Load	Internal Load	Aquatic Vegetation	Aquatic Life	Monitoring/ Reporting
SCWMC	• Evaluate watershed rules and standards • Evaluate volume management standards • Provide focused education and outreach • Solicit and fund Demonstration Projects • Prepare grant applications • Evaluate ways to refine street sweeping practices		• Prepare feasibility reports and make recommendations on internal load strategies for North, South, and Ryan Lakes, such as chemical treatment and/or lake drawdown	• Evaluate and make recommendations for curly leaf pondweed management in all lakes • Evaluate feasibility of drawdown for North and South Twin Lake • Identify potential shoreline restoration projects	• Evaluate and make recommendations for rough fish removal for North Twin Lake • Evaluate rough fish barriers in North Twin Lake	• Continue CAMP citizen water quality monitoring • Conduct periodic in- depth lake monitoring • Monitor aquatic vegetation every five years • Collect implementation data from stakeholders annually • Prepare annual report on monitoring and activities
Cities	• Evaluate potential water quality pond and other BMP projects in watersheds 3 and 4 • Implement BMPs to reduce loads as opportunities arise • Conduct routine pond inspections for maintenance • Sweep streets at least twice annually	• Restore wetland 639W • Implement goose management in watershed	• Implement internal load reduction strategies	• Implement curly leaf pond weed management • Implement shoreline restoration projects	• Implement rough fish removal in North Twin Lake	• Report implementation activities to SCWMC annually
Mn/DOT	• Sweep streets at least once annually • Implement BMPs to reduce loads as opportunities arise					• Report implementation activities to SCWMC annually
Hennepin County	• Sweep streets at least twice annually • Implement BMPs to reduce loads as opportunities arise					• Report implementation activities to SCWMC annually
Property Owners	• Implement BMPs to reduce loads as opportunities arise					

4.0 Watershed Commission Activities

The SCWMC has agreed to take the lead on general coordination, education, and ongoing monitoring. The Commission will also collect annual NPDES reports and other information from the stakeholders and compile BMP activities undertaken by all parties. This information will be incorporated into the Commission's annual Water Quality Report. The following activities will be conducted by the SCWMC.

4.1 GENERAL COORDINATION

4.1.1 Coordination

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

- Providing advice and assistance to member cities on their implementation activities;
- Researching and disseminating information on changing BMP technology and practices;
- Collecting annual implementation activity data;
- Recommending activities such as vegetation or fishery management, partnering with the DNR;
- Periodically updating the Commission's Capital Implement Program (CIP);
- Conducting public hearings on proposed projects; and
- Sharing the cost of qualifying improvement projects.

Estimated Cost: Ongoing activity
Funding Source: General operating budget, county levy for project share

4.1.2 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 responsible for the gross wasteload allocation with necessary information for their annual NPDES reports. The report will detail BMP implementation, associated load and volume reductions where known, 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.

Estimated Cost: $10,000-12,000
Funding Source: General operating budget (currently budgeted at about $5,000)

4.1.3 Rules and Standards

The Commission has directed its Technical Advisory Committee (TAC) to review and if necessary revise the current rules to address the effectiveness of the regulatory program in meeting the TMDL requirements. As a part of this process, the Commission will review the current pollutant removal performance standard, and will consider expanding the current infiltration requirement into a more broad volume management rule that will reduce runoff to the lakes, thereby reducing the associated phosphorus loads. That work is expected to be complete and revised standards considered by the end of 2008.

Estimated Cost: $2,000
Funding Source: General operating budget for Management Plan activities (current budget is $3,000)

4.1.4 Establish Performance Standards

As a part of this and other TMDL Implementation Plans each stakeholder will be implementing various BMPs to reduce phosphorus load and stormwater volume. Stakeholders will report load reductions made by each BMP to the Commission, which will track progress toward meeting load reductions throughout the watershed.

Stakeholders will have varying levels of information and data about these BMPs. In some cases estimating the load reduction will be part of the BMP design process. For example, load reductions for a new or enhanced pond can be calculated using standard modeling techniques. However, many other types of BMPs such as rain gardens, reforestation, reductions in impervious pavement, etc. have an impact that is more difficult and time-consuming to calculate. The Commission has directed its Technical Advisory Committee (TAC) to review literature and other data and establish standardized performance values for various BMPs. For example, a typical residential rain garden might be credited with reducing phosphorus by X kilograms annually. Or, an underground treatment device of Brand X would be assigned specific removal efficiencies. The MPCA is exploring establishing such standards, as are other watershed management organizations. The TAC will work in partnership with the MPCA to establish such standards for Shingle Creek. That work is expected to be complete and revised standards considered by the end of 2008.

Estimated Cost: $3,000
Funding Source: General operating budget for Engineering Administration activities (current budget is $41,000)

4.2 EDUCATION

4.2.1 Public Education and Outreach

The Commission operates an ongoing education and outreach program that is managed by the standing Education and Public Outreach Committee (EPOC). The EPOC is a group comprised of city staff, Commissioners, and watershed resident volunteers that develops and implements educational materials and programming.

The Twin Lake Homeowners Education Survey conducted several years ago found that over 90 percent of the property owners surveyed knew that phosphorus is a common cause of lake pollution, but only 27 percent used phosphorus-free fertilizer. The Commission in Fall 2007 is undertaking a more extensive professional opinion survey to better understand what people know and how public education and outreach can most effectively communicate how individual property owners can impact water quality through the implementation of individual Best Management Practices in the watershed.

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, block club and National Night Out gatherings, and other opportunities, and links posted on the Commission's and cities' web sites. The EPOC has also developed specialty brochures focused on groups such as apartment and small commercial building managers.

Estimated Cost: Ongoing activity
Funding Source: General operating budget for Education activities (current budget is $28,700)

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 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: $500
Funding Source: General operating budget for Education activities (current budget is $28,700)

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. The Commission's annual education budget assumes staff attendance at three presentations or events such as staffing booths at events

Estimated Cost: $1,000
Funding Source: General operating budget for Education activities (current budget is $28,700)

4.2.4 Demonstration Projects

Property owners may be reluctant to adopt good lake management practices without examples they can evaluate and emulate. A few demonstration projects have been completed in the watershed through outside grants or from the Commission's Education and Implementation Grant program, including a shoreline restoration project in a park on Middle Twin Lake in Brooklyn Center and a shoreline restoration and a rain garden in a park on Ryan Lake in Minneapolis. The Commission will encourage demonstration projects so property owners can see how a project or practice is implemented and how it looks. Examples 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. The Commission annually budgets $20,000 for grant matching and small projects. The Commission will evaluate appropriate activities and develop guidelines for funding demonstration projects from this budget.

Estimated Cost: Varies based on the type of activity
Funding Source: General operating budget for grant match/demonstration projects (current budget is $20,000)

4.2.5 Feasibility Studies

The Commission will lead the preparation of feasibility studies evaluating internal load management strategies such as chemical treatment or lake drawdown. These studies and resulting recommendations will be prepared in consultation with the Commission's Technical Advisory Committee (TAC).

Estimated Cost: $10,000 – 30,000 each
Funding Source: Member cities by cooperative agreement

4.3 ONGOING MONITORING

4.3.1 Water Quality Monitoring

The SCWMC will lead monitoring and tracking of the effectiveness of activities implemented to reduce nutrient loading in the watershed. The Commission 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. Each year four to six lakes in the Shingle Creek watershed are monitored in this manner. This program is also a useful outreach tool for increasing awareness of water quality issues. The estimated cost of this monitoring is $6,500 annually, and is included in the Commission's existing Monitoring budget

Estimated Cost: $6,500 annually
Funding Source: Monitoring budget for CAMP monitoring (current budget is $6,500)

The Commission will also periodically (every 4-5 years) conduct a more detailed analysis of water quality, collecting biweekly data on surface, water column, and bottom conditions. This data will provide a more detailed picture of lake response to BMP activities and will help determine necessary "course corrections" as part of the Adaptive Management philosophy guiding this Implementation Plan.

As described in Section 4.1.1 above, the Commission annually publishes a Water Quality Report that compiles and interprets monitoring data from the lakes, streams, and wetlands in the watershed. The monitoring data collected by the commission and other agencies will be analyzed to determine the linkage between BMP implementation and water quality and biotic integrity in Twin and Ryan Lakes, and to assess progress toward meeting the total maximum daily load and in-lake phosphorus concentration goals. This detailed monitoring is not part of the Commission's existing Monitoring budget. As the Commission completes its current cycle of management planning in 2009 with the Wetland Management Plan, that annual budget ($15,000) will be reallocated to more extensive lake monitoring.

Estimated Cost: $7,000 – 10,000 per lake
Funding Source: Reallocated operating budget for management plans (current budget is $15,000)

4.3.2 Other Monitoring

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. Zooplankton sampling has not been conducted and should be periodically completed to assess overall biologic conditions. The estimated cost of this monitoring is $2-3,000 per lake. Neither type of monitoring is routinely part of the Commission's existing Monitoring budget. As the Commission completes its current cycle of management planning in 2009 with the Wetland Management Plan, that annual budget ($15,000) will be reallocated to more extensive lake monitoring.

Estimated Cost: $3,000-4,000 per lake
Funding Source: Reallocated operating budget for management plans (current budget is $15,000)

The Commission will work together with the DNR to determine the optimum strategy for monitoring the fish community.

Estimated Cost: To be determined
Funding Source: To be determined

5.0 Stakeholder Activities

While the SCWMC will coordinate implementation of the Twin and Ryan Lakes TMDL, individual stakeholders ultimately will be responsible for implementing the identified BMPs. Table 6 in Section 3 of this report shows the responsible parties for each of the stakeholder activities. Not all stakeholders will undertake all these activities. Those activities for which the stakeholders are responsible will be incorporated into their NPDES Stormwater Pollution Prevention Plans (SWPPPs), and implementation actions will be reported annually.

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.

The following are the general BMP implementation activities that will be most effective in restoring water quality in the lakes to state standards and an estimate of their cost. Refer to Section 3 of this report for information regarding sequencing and responsible parties.

5.1 REDUCE EXTERNAL LOAD

5.1.1 DNR Wetland 639W Restoration

DNR wetland 639W is the source of an estimated one-third of the external phosphorus load to North Twin Lake. Restoring the wetland to a phosphorus sink or at a minimum eliminating export of phosphorus from the wetland can have a significant impact on the water quality in North Twin Lake and downstream lakes. Restoration alternatives include diversion of stormwater around the wetland, an alum or ferric chloride treatment plan, alum treatment to the wetland or de-channelization and increased storage in the wetland.

Estimated Cost: $700,000 to $750,000
Funding Source: Cities, SCWMC through county levy, grant funds

5.1.2 Add Treatment in the Watershed

External phosphorus loads are high in Subwatersheds 3 and 4 (see Figure 1), and additional treatment options will be sought in those subwatersheds as opportunities such as street reconstruction projects and development and redevelopment arise. Treatment options include but are not limited to:

- New or enhanced stormwater ponding;
- Infiltration basins and devices and other types of abstraction such as native vegetation or reforestation;
- In-line or off-line treatment manufactured devices; and
- Rain gardens and biofiltration.

Specific projects planned by cities in the coming five years include:

- Twin Oak Pond (City of Crystal)
- Wincrest Pond (City of New Hope)
- 45th Avenue Ponds (City of New Hope)

Other projects would be implemented as opportunities arise, such as through street reconstruction projects and redevelopment.

The Commission's Technical Advisory Committee (TAC) has been charged to review the existing water quality standards for new development and redevelopment, which require NURP-level treatment for total phosphorus and total suspended solids removal. The TAC will evaluate whether those standards should be enhanced or revised to provide a higher level of treatment. That work is expected to be complete and revised standards considered by the end of 2008.

Estimated Cost: $290,000-Wincrest Pond; $550,000-45th Avenue Pond; $75,000-Twin Oak Pond
Funding Source: Cities, SCWMC through county levy, grant funds

5.1.3 Increase Infiltration in Watershed

The TAC has been charged to review the existing infiltration requirement on new development and redevelopment, which is to infiltrate 0.5" of runoff from new impervious surface. The TAC will evaluate whether that standard should be enhanced or revised as a more broad volume management standard. That work is expected to be complete and revised standards considered by the end of 2008. In addition, cities will work with developers to incorporate Low Impact Development principles into development and redevelopment as appropriate, and the Commission's education program will provide information to property owners on methods of reducing runoff and increasing infiltration on their individual properties. Finally, cities will incorporate infiltration into city improvement projects where possible as opportunities arise.

Estimated Cost: City staff level of effort to be determined
Funding Source: Cities, Commission's education program

5.1.4 Shoreline Management and Restoration

Restore shoreline areas with native vegetation and lakescaping where opportunities present themselves. The SCWMC and the City of Brooklyn Center completed a shoreline restoration at Twin Lake Park on Middle Twin Lake, while the Victory Neighborhood Association in Minneapolis in completing an ongoing shoreline restoration on Ryan Lake. Shoreline restoration can cost $30-50 per linear foot, depending on the width of the buffer installed. 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.

Estimated Cost: $385,000 – $640,000
Funding Source: Private property owners, cities, grant funds

5.1.5 Wildlife Management

Controlling goose populations can decrease phosphorus loading as well as fecal coliform production. Several cities in the watershed have participated in the annual University of Minnesota/ Minnesota DNR goose removal program. 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
Funding Source: Cities, DNR

5.1.6 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.

Estimated Cost: $100,000 to 200,000 per new sweeper
Funding Source: Cities

Increased street sweeping frequency may be most effective in the direct watersheds to the three Twin Lake basins. These watersheds had surprisingly 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: $65-85 per mile of additional sweeping
Funding Source: Cities

5.1.7 Road Salt Reductions

Shingle Creek, to which the Twin Lake subwatershed ultimately drains, is an Impaired Water due to high concentrations of chloride. A TMDL approved by the EPA in 2007 identified road salt for ice control as the primary source of this chloride. Various BMPs to significantly reduce sodium chloride loading to Shingle Creek are identified in that TMDL's Implementation Plan. 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 for data analysis
Funding Source: SCWMC general operating budget

5.2 REDUCE INTERNAL LOAD

5.2.1 Chemical Treatment

One of the most effective controls for internal phosphorous loading in lakes is the chemical addition of alum. Alum applications will be most effective in North and South Twin Lake but could also potentially be applied to Ryan Lake.
Estimated Cost: $200,000-North; $75,000-South; $50,000-Ryan
Funding Source: Cities, SCWMC through county levy, grant funds

5.2.2 Lake Drawdown

Restoration of 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. North Twin Lake is the most likely candidate for a full drawdown, although it may also be possible to drawdown South Twin or Ryan. Once sufficient 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.

Estimated Cost: $200,000 to $300,000
Funding Source: Cities, SCWMC through county levy, grant funds

5.3 BIOLOGIC INTEGRITY MANAGEMENT

5.3.1 Aquatic Plant Management

The SCWMC recognizes the importance of a healthy biological community in meeting water clarity goals, especially in shallow lakes. Aquatic plant management is a key aspect in maintaining a healthy shallow lake. To establish and maintain a healthy lake system, an aquatic plant management plan will be established and followed that includes invasive species management (notably curly leaf pondweed).

Estimated Cost: $3,000 for management plan and $4-5,000 per year/lake treated
Funding Source: Cities, lake associations

5.3.2 Rough Fish Management

Another factor affecting internal phosphorus release and plant establishment is the presence of carp. The rough fish population in Twin Lake is incredibly high, approximately 10 times the upper 10^{th} quartile of all DNR sampled lakes. Carp controls include removal and controlling access to spawning areas.

Initial removal of rough fish could be quite extensive. Additionally, access to the two North Twin Lake wetland complexes should be restricted to prevent spawning. This action includes design and installation of carp barriers as well as a significant initial effort for carp removal focusing on North and South Twin Lakes.

Estimated Cost: $25,000 to $50,000
Funding Source: Cities, lake associations, grant funds, DNR

Biannual removal maintenance will be required to effectively control carp populations. This action includes carp removal biannually, focusing on North and South Twin Lakes.

Estimated Cost: $2,000 to $5,000 annually
Funding Source: Cities, lake associations

5.4 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 Commission, which will then incorporate that information into the Commission's annual Water Quality Report. 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: City staff level of effort to be determined
Funding Source: Cities

Literature Cited

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

Wenck Associates Inc. 2004. Twin Lakes Diagnostic Study. Wenck Report 1244-01-01.

Wenck Associates Inc. 2004. Twin Lakes Management Plan. Wenck Report 1244-01-02.

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