Bald Eagle Lake Nutrient TMDL
Implementation Plan

Wenck File #1137-16

Prepared for:

RICE CREEK WATERSHED DISTRICT

MINNESOTA POLLUTION CONTROL AGENCY

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Table of Contents

Tables

Figures

Appendices

1.0 Introduction

The Bald Eagle Lake Nutrient Total Maximum Daily Load (TMDL) Implementation Plan addresses nutrient impairments in Bald Eagle Lake (62-0002), which is located primarily in White Bear Township in Ramsey County, Minnesota, but also extends into the City of Hugo in Washington County and the City of Lino Lakes in Anoka County in the Upper Mississippi River watershed (Figure 1.1). It is a highly-used recreational water body with an active fishery and significant aesthetic values. The lake was placed on the State of Minnesota's 303(d) list of impaired waters in 2002 for impairment of aquatic recreation. The lake has a surface area of about 1,017 acres and a fully-developed watershed of about 10,835 acres, or just under 17 square miles. The lake is impaired by high concentrations of total phosphorus resulting in severe algal blooms. Average summer total phosphorus concentrations range from approximately 50 μg/L to greater than 100 μg/L; the lake has consistently exceeded the state eutrophication standard of 40 μg/L for almost 30 years.

The Rice Creek Watershed District (RCWD or District) has completed a TMDL analysis for the Minnesota Pollution Control Agency (MPCA) to quantify the phosphorus reductions needed to meet State water quality standards for nutrients in Bald Eagle Lake in accordance with Section 303(d) of the Clean Water Act. The TMDL and Implementation Plan were prepared in cooperation with the local governments and other stakeholders.

The final step in the TMDL process is the development of an Implementation Plan that sets forth the activities that will be undertaken to reduce phosphorus loading to the lake. This Implementation Plan provides a brief overview of the TMDL findings, describes the principles guiding this Implementation Plan, describes the proposed implementation activities, and discusses sequencing, timing, and lead agencies and organizations for the activities.

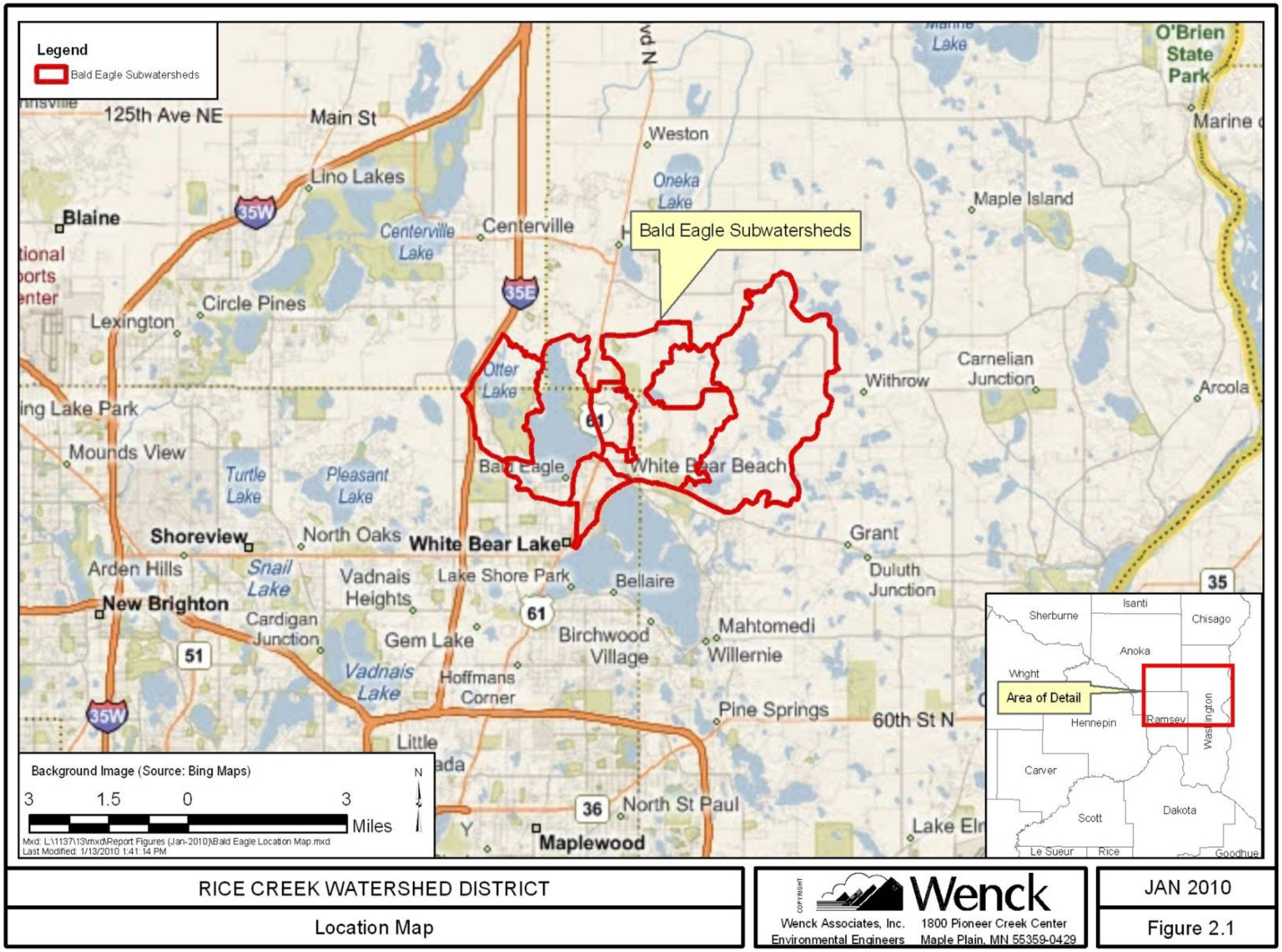

Figure 1.1. Bald Eagle Lake location.

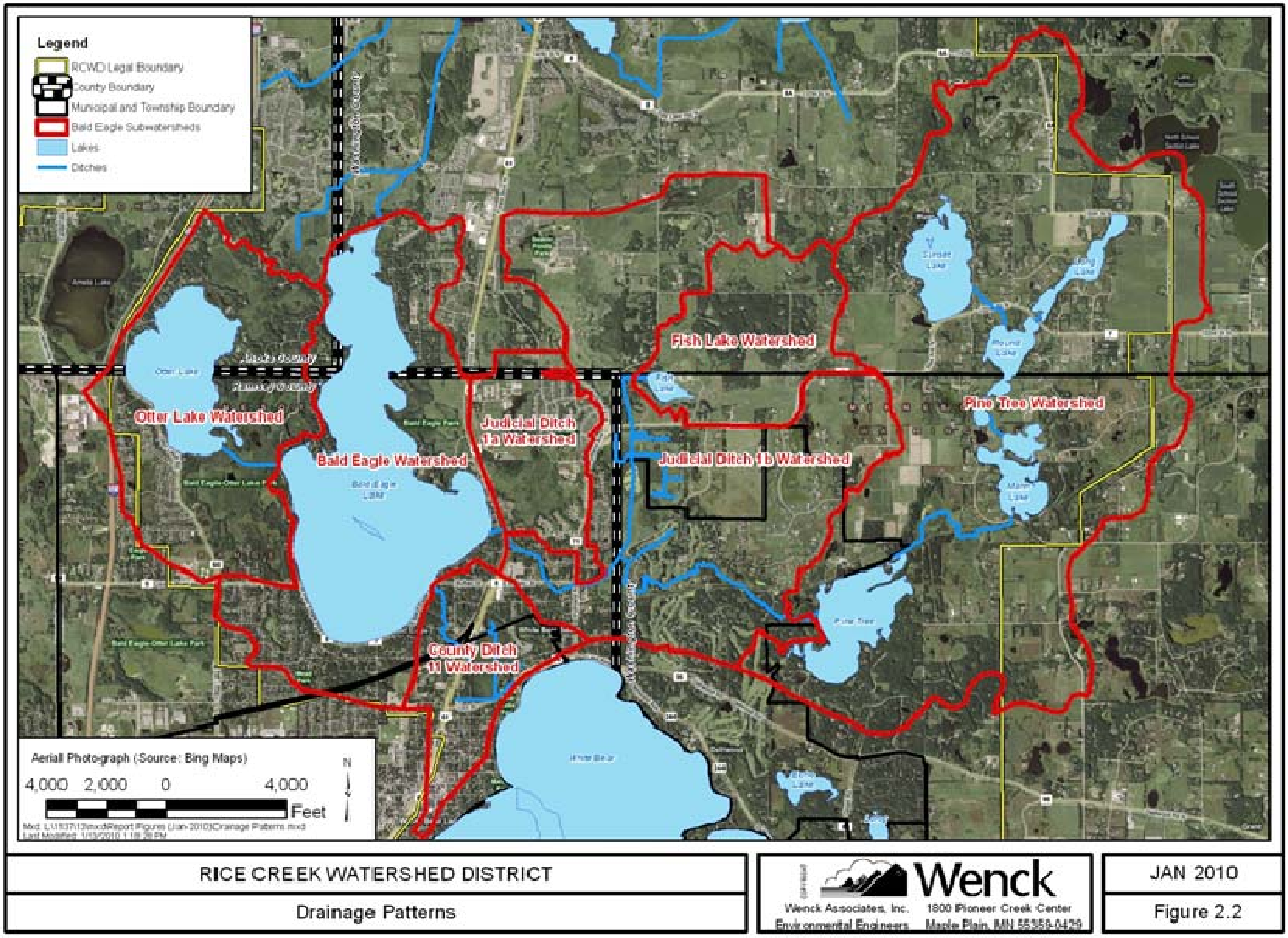

Figure 1.2. Bald Eagle Lake drainage area.

2.0 Bald Eagle Lake TMDL Summary

Bald Eagle Lake is a 1,071-acre lake located in the northeast portion of the Twin Cities Metropolitan Area in Ramsey County and about 10 miles north of the City of St. Paul (Figure 1.1). Public access is via a county-owned park along State Highway 61 on the east shore of the lake. The lake's maximum depth is 39 feet and about 61% of the lake is less than 15 feet deep or littoral (shallow enough to support emergent and submerged rooted aquatic plants).

Bald Eagle Lake supports a variety of recreational uses, including open water and ice fishing, swimming, and boating.

2.1 CURRENT WATER QUALITY

Historic water quality is presented in Figures 2.1, 2.2, and 2.3. Bald Eagle Lake does not meet state standards for total phosphorus concentration, chlorophyll-a, or clarity as measured by Secchi depth. The highest summer average concentration was measured in 2000 and reached over 120 µg/L (Figure 2.1). Excluding 2000, summer average total phosphorus concentrations have ranged from 48 µg/L to 101 µg/L between the early 1980s and 2007, suggesting that the lake has consistently exceeded the state eutrophication standard of 40 µg/L for almost 30 years.

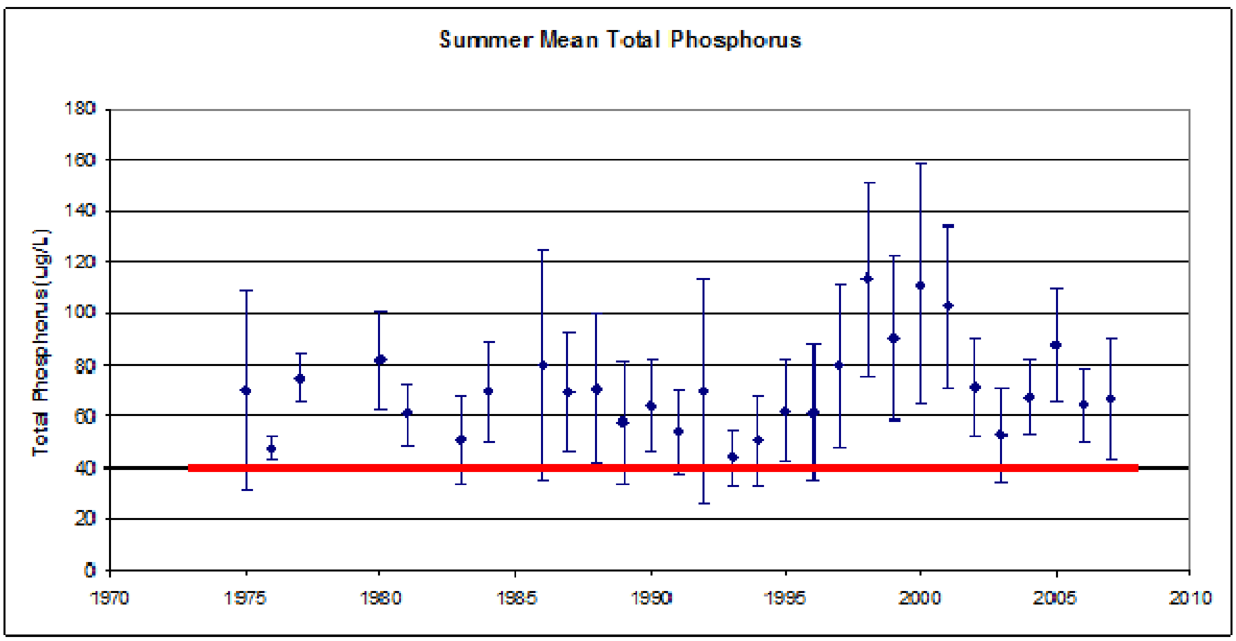

Figure 2.1. Summer (June 1 –September 30) mean total phosphorus concentrations for Bald Eagle Lake. Note: The red line indicates the current State standard for the North Central Hardwood Forest ecoregion.

Between the mid-1980s and 2007, chlorophyll-a concentrations in Bald Eagle Lake ranged from just over 16 to as high as 51.8 µg/L for years with four samples or more during the summer season (Figure 2.2). Recent chlorophyll-a concentrations range from 24 to 45 µg/L, which are still about 2-3 times the State standard of 14 µg/L. Chlorophyll-a concentrations in this range indicate a high incidence of nuisance algae blooms.

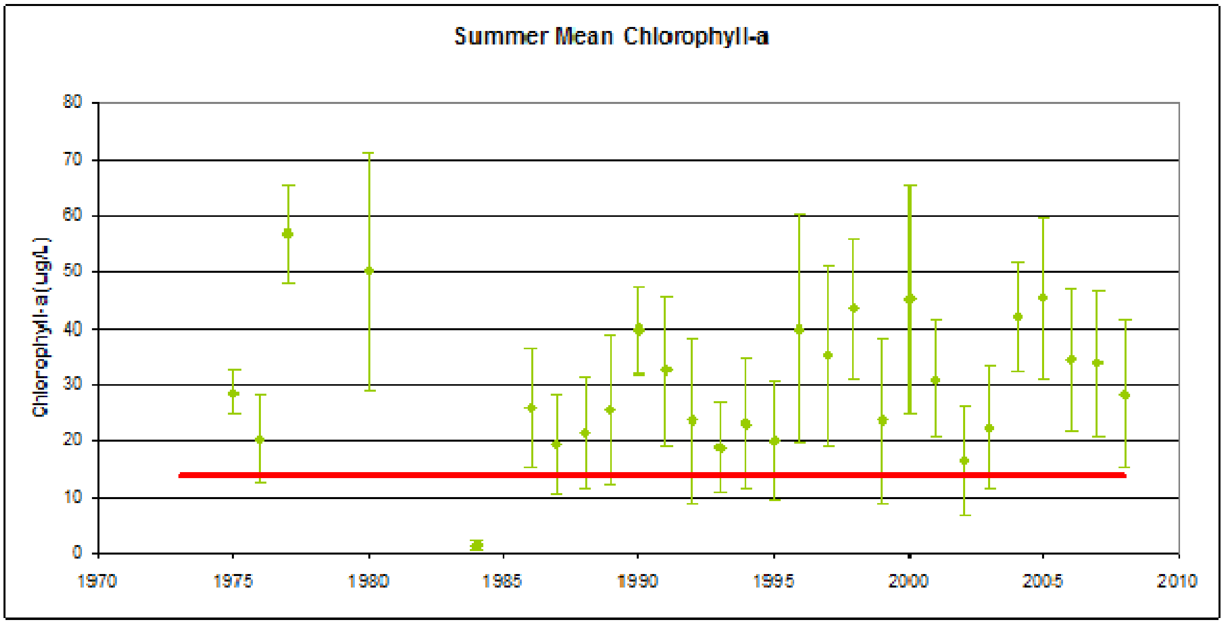

Figure 2.2. Summer (June 1 –September 30) mean chlorophyll-a concentrations for Bald Eagle Lake.
Note: the red line indicates the current State standard for the North Central Hardwood Forest ecoregion.

Water clarity (Secchi depth) followed the same trend as TP and chlorophyll-a and has not met the state standard over the past 30 years (Figure 2.3). There is no apparent trend in the Secchi depth data, suggesting that the lake has demonstrated similar water clarity over the past 30 years.

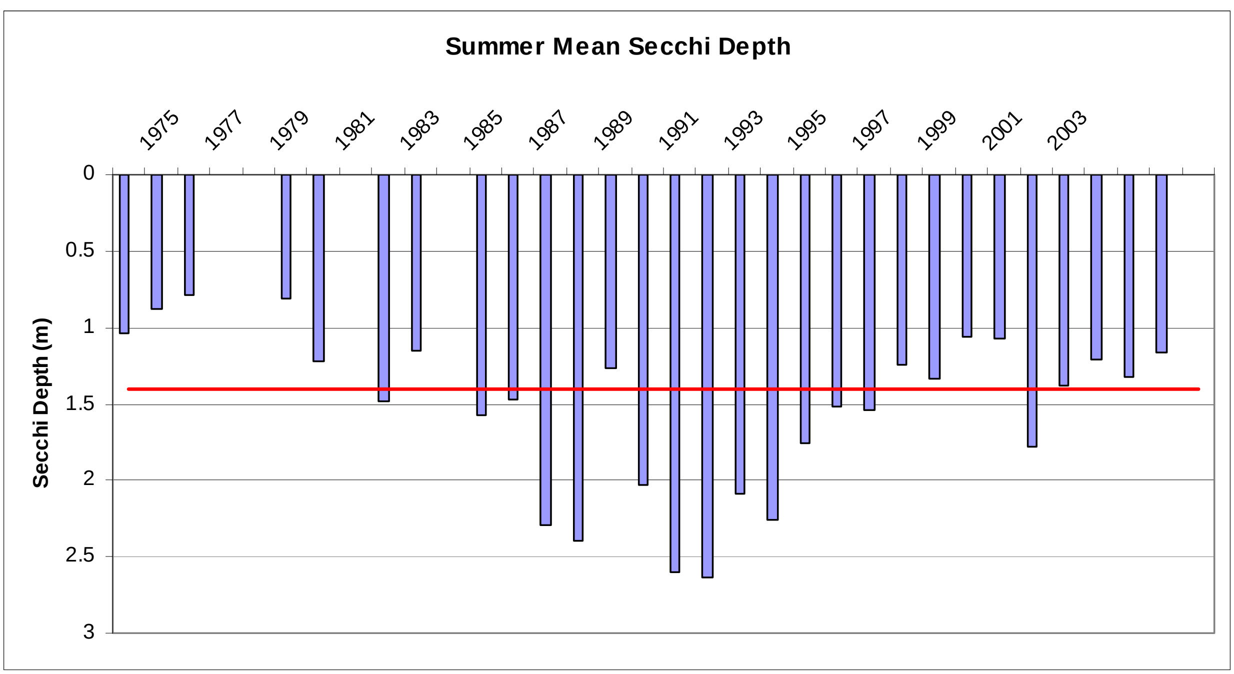

Figure 2.3. Summer (June 1 –September 30) mean Secchi depth (meters) for Bald Eagle Lake.
Note: The red line indicates the current State standard for the North Central Hardwood Forest ecoregion.

2.2 PHOSPHORUS LOAD SOURCES

Nutrient loading to Bald Eagle Lake is fairly evenly split between internal and external loading. The primary internal load source is sediment-phosphorus release. The primary external load is from runoff coming from subwatershed JD1 (see Figure 1.2), which represents about 75 percent of the land area of the watershed. However, it is important to note that reductions in nutrient loadings from JD1 may be more difficult to achieve because inflow concentrations are fairly low, typically between 100 and 200 µg/L. Conversely, stormwater inputs from both subwatershed CD11 and the direct drainage area are estimated to have higher concentrations, typically between 300 and 400 µg/L. Both of those subwatersheds contain urbanized areas of White Bear Lake, White Bear Township, and Hugo.

2.3 REQUIRED PHOSPHORUS LOAD REDUCTIONS

Wasteload and load allocations to meet State standards indicate a phosphorus load reduction of 58% would be required to consistently achieve a total phosphorus concentration of 40 µg/L, which would meet the state standard. This Implementation Plan details the specific activities the stakeholders in the lake's watershed plan to undertake to attain that reduction.

2.3.1 Allocations

Many TMDLs have a Wasteload Allocation (WLA) that includes permitted discharges such as industrial point and regulated stormwater discharges. The Load Allocation (LA) in TMDLs includes phosphorus loading from non-permitted sources, such as runoff from land not subject to stormwater regulations, internal loading or atmospheric deposition. Certain stormwater discharges are regulated under the State of Minnesota's National Pollutant Discharge Elimination System (NPDES) Program, and are considered wasteloads that must be divided among permit holders. Entities with coverage under the Municipal Separate Storm Sewer System (MS4) General Permit, with authorization to discharge stormwater in the Bald Eagle Lake watershed, are shown in Table 2-1 below. Because there is not enough information available to assign loads to individual permit holders, the Wasteload Allocations are combined in the TMDL as Categorical Wasteload Allocations (WLA) (Table 2-1) assigned to all permitted dischargers in the contributing lakeshed. Each permittee has committed to implementing Best Management Practices (BMPs) to reduce nutrient loading in Bald Eagle Lake.

Table 2-1. Bald Eagle Lake Nutrient TMDL total phosphorus wasteload allocation by NPDES permitted facility.

<table>
<tr><th>Permit Type</th><th>Permit Name</th><th>Permit Number</th><th>Existing WLA TP Load (lbs/year)</th><th>WLA (lbs/year)</th><th>Percent Reduction</th></tr>
<tr><td>MS4 Stormwater</td><td>Lino Lakes</td><td>MS400100</td><td rowspan="10">1,158</td><td rowspan="10">719</td><td rowspan="10">38</td></tr>
<tr><td>MS4 Stormwater</td><td>White Bear Lake</td><td>MS400060</td></tr>
<tr><td>MS4 Stormwater</td><td>White Bear Twp.</td><td>MS400163</td></tr>
<tr><td>MS4 Stormwater</td><td>Hugo</td><td>MS400094</td></tr>
<tr><td>MS4 Stormwater</td><td>Grant</td><td>MS400091</td></tr>
<tr><td>MS4 Stormwater</td><td>Dellwood</td><td>MS400084</td></tr>
<tr><td>MS4 Stormwater</td><td>Washington Co.</td><td>MS400160</td></tr>
<tr><td>MS4 Stormwater</td><td>Ramsey Co.</td><td>MS400191</td></tr>
<tr><td>Industrial Stormwater</td><td>No current permitted sources</td><td>n/a</td></tr>
<tr><td>Construction Stormwater</td><td>Various</td><td>Various</td></tr>
<tr><td>MS4 Stormwater</td><td>Mn/DOT</td><td>MS400170</td><td>36</td><td>22</td><td>38</td></tr>
</table>

Some portions of the MS4 communities are not covered under NPDES permits, specifically areas not served by stormwater conveyances owned by the MS4. Consequently, the permitted and nonpermitted areas are split between the wasteload and load allocation categories. Also, the allowable phosphorus load export on a per acre basis is set equally between the land uses falling in the wasteload and load categories. To account for future growth in the watershed, land use projections for 2020 are used as shown in Figure 2.4 (data source: Metropolitan Council). Only upland, developed and developable land areas were used to assign land areas between the load and wasteload allocations. Furthermore, only land areas below Fish and Pine Tree Lake were used because the upstream lakes are explicitly accounted for in the TMDL table. Those 2020 land use areas designated as agriculture, open space, parks and recreation, mixed use, and rural residential were assigned to the load allocation. All other 2020 land use areas were assigned to the wasteload allocation. The total developed and developable land area was 3,517 acres with 1,956 and 1,561 acres falling within the wasteload and load categories, respectively.

It may be necessary to transfer load in the future. This can occur in the following situations:

1. New development occurs within a regulated MS4. Newly developed areas that are not already included in the WLA must be given additional WLA to accommodate the growth. This will involve transferring LA to the WLA.

2. One regulated MS4 acquires land from another regulated MS4. Examples include annexation or highway expansions. In these cases, the transfer is WLA to WLA.

3. One or more non-regulated MS4s become regulated. If this has not been accounted for in the WLA, then a transfer must occur from the LA.

4. Expansion of an urban area encompasses new regulated areas for existing permittees. An example is existing state highways that were outside an Urban Area at the time the TMDL was completed, but are now inside a newly expanded Urban Area. This will require either a WLA to WLA transfer or a LA to WLA transfer.
5. A new MS4 or other stormwater-related point source is identified and is covered under a NPDES permit. In this situation, a transfer must occur from the LA.

Load transfers will be based on methods consistent with those used in setting allocations in the TMDL. In cases where WLA is transferred from or to a regulated MS4, the permittees will be notified of the transfer.

The pollutant load from construction stormwater is considered to be less than 1 percent of the TMDL and difficult to quantify. Consequently, the WLA includes pollutant loading from construction stormwater sources. 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, or meet local construction stormwater requirements if they are more restrictive than requirements of the State General Permit. Industrial stormwater activities are 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. There are no known municipal or industrial wastewater dischargers in the watershed.

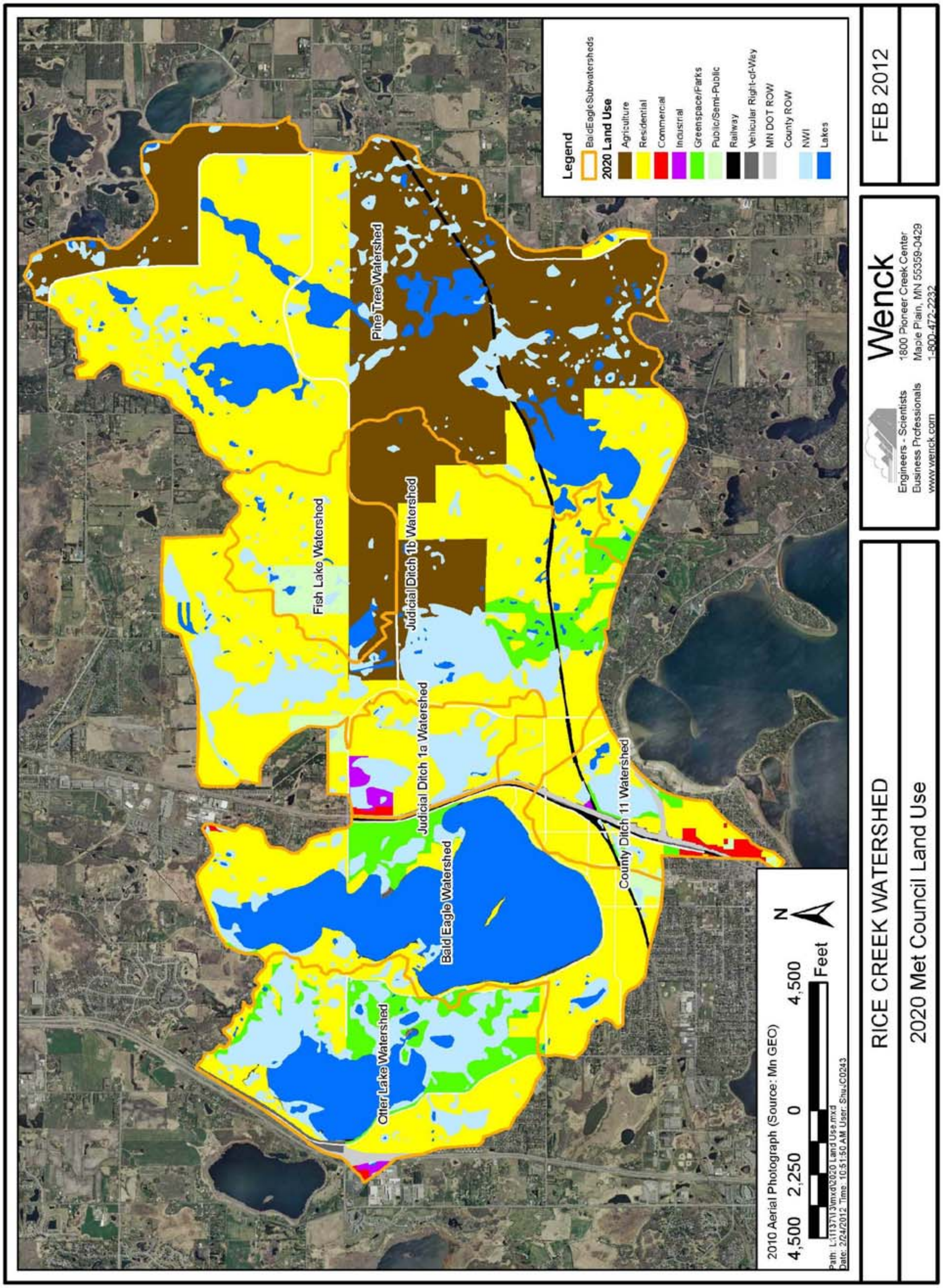

Figure 2.4. 2020 Met Council land use.

For planning purposes, *target loads* were developed for each of the MS4 permittees in the Bald Eagle Lake watershed (Table 2-2). To come up with the target loads, land area considered upland developed or developable was divided based on municipal boundaries. These areas were then used to divide the assigned categorical wasteload allocation among the stormwater permit holders in that particular watershed. Due to a lack of detailed watershed monitoring data, target loads and existing loads should be considered rough approximations for use in planning purposes only.

Table 2-2. Target loads for individual MS4 permit holders in the Bald Eagle Lake watershed.

Major Subwatershed	Municipality /Agency	WLA Land Area	Existing Categorical Wasteload	Existing Individual Loads	Categorical Wasteload Allocation	Individual Wasteload Targets	Individual Wasteload Target Reduction
		%	(pounds/year)				
Bald Eagle Direct	Hugo	10.4%	394	124	244	77	47
	White Bear Lake	1.9%		23		14	9
	White Bear Twp.	18.2%		217		135	82
	Mn/DOT	0.3%		4		2	1
	Ramsey County	2.2%		27		16	10
County Ditch 11	White Bear Lake	10.1%	244	123	152	77	46
	White Bear Twp.	7.1%		84		52	32
	Mn/DOT	2.2%		24		15	9
	Ramsey County	1.2%		14		9	5
Judicial Ditch 1	Hugo	17.4%	556	207	345	129	79
	White Bear Twp.	26.9%		323		200	123
	Mn/DOT	0.9%		8		5	3
	Ramsey County	1.0%		12		7	5
	Washington County	0.5%		5		3	2
	TOTAL		1194	--	741	--	453

2.3.2 Implementation Focus

The focus in implementation will be on reducing the annual phosphorus loads to Bald Eagle Lake through structural and nonstructural BMPs. The load and wasteload allocations are shown in Table 2-3. No reduction in atmospheric loading is targeted because this source is impossible to control on a local basis.

Table 2-3. Bald Eagle Lake TMDL total phosphorus allocations expressed as daily and annual loads. The wasteload allocation is allocated to NPDES-permitted facilities in accordance with.

Allocation	Source	Existing TP Load [1]		TP Allocations (WLA & LA)		Load Reduction
		(lbs/year)	**(lbs/day)[2]**	**(lbs/year)**	**(lbs/day)[2]**	**(lbs/year)**
Wasteload	Stormwater	1,194	3.3	741	2.0	453 (38%)
Load	Watershed Runoff	938	2.6	582	1.6	356 (38%)
	Upstream Lakes	135	0.4	133	0.4	2 (<1%)
	Atmosphere	254	0.7	254	0.7	0
	Internal Load	1,991	5.5	180	0.5	1,811 (91%)
MOS		**--**	**--**	**Implicit**	**Implicit**	**--**
TOTAL LOAD		**4,512**	**12.4**	**1,890**	**5.2**	**2,622 (58%)**

[1] Existing load is the average for the years 2002-2008.
[2] Annual loads converted to daily by dividing by 365.25 days per year accounting for leap years

3.0 Implementation Plan

3.1 TMDL AND IMPLEMENTATION PLAN PROCESS

The activities and Best Management Practices (BMPs) identified in this Implementation Plan are the result of a series of Technical Advisory Committee (TAC) and stakeholder meetings led by the Rice Creek Watershed District (RCWD). The TAC included stakeholder representatives from local cities, Minnesota Department of Natural Resources (DNR), the Metropolitan Council, the United States Geological Survey (USGS), the Board of Water and Soil Resources, Ramsey County Public Works, and the Minnesota Pollution Control Agency. All meetings were open to interested individuals and organizations. Technical Advisory Committee meetings to review the Bald Eagle Lake were held on July 9, 2009 and September 24, 2009.

The general TMDL approach and general results of TMDLs were presented to lakeshore owners and interested individuals. Presentations were used to introduce topics such as lake ecology, pollution sources, and the TMDL process. Findings of the TMDL study and associated management options also were presented. Meetings were held on January 28, 2009 and March 11, 2010.

This Implementation Plan was available to local cities, counties, and other implementation partners for review and comment.

3.2 IMPLEMENTATION PLAN PRINCIPLES

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

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

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

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

It is recognized that a significant portion of the phosphorus load in Bald Eagle Lake is a result of internal loading and that the internal load must be addressed to successfully improve water quality. Consequently, the stakeholders agreed to work cooperatively to reduce internal phosphorus loading in the lake.

3. <u>Retrofit BMPs in the Watershed</u>

The local communities, counties, and Mn/DOT, as the regulated MS4s in the watershed discharging to Bald Eagle Lake, have agreed that nutrient loading must be reduced. 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. Foster Stewardship

Local staff, especially maintenance staff, will 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 lake.

5. 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
- Lakeshore residents
- Lake users
- Property owners and managers

The primary means of communication with lakeshore property owners will be through the Bald Eagle Area Association (BEAA). A very active lake association, the BEAA maintains strong membership, and provides opportunities for public meetings and education.

3.3 IMPLEMENTATION PLAN

Implementation will be a joint effort, with the RCWD taking responsibility for ongoing coordination, general education and monitoring activities and the NPDES permittees taking responsibility for BMP implementation. The MS4s will incorporate BMPs into their Storm Water Pollution Prevention Programs (SWPPP) and NPDES Minimum Measures, and will work with the RCWD to periodically assess progress toward advancing the implementation principles detailed above. This framework is illustrated in Figure 3.1.

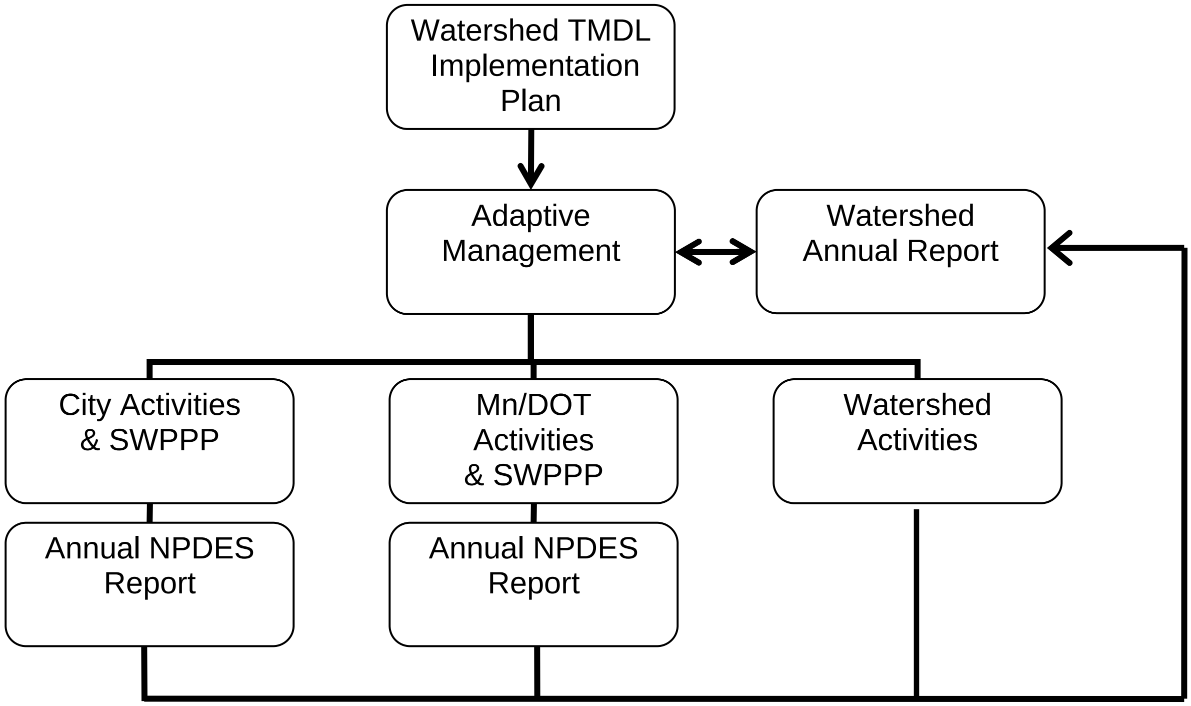

Figure 3.1. Implementation framework.

3.3.1 Implementation Approach

The impairment to Bald Eagle Lake developed over time as the watershed draining to the lake changed from predevelopment to agriculture and then ultimately urbanized. As the watershed became more populated, much of the native landscape was cleared to support farming. Over the past century many of those farms and undeveloped land were converted to residential and other developed use, increasing the volume of stormwater runoff and the amount of pollutants conveyed to the lake, slowly degrading water quality. Just as this degradation took many years, improvement will 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. However, it is likely that it will take several decades to see any significant redevelopment in this subwatershed.

The TMDL study and this Implementation Plan identify general improvements to reduce external and internal phosphorus loading. Some of these actions are nonstructural and could be undertaken at any time, such as increased street sweeping or shoreline restoration, and some are structural actions that would be completed as part of a construction or redevelopment project. These are "short-term" projects that could be accomplished in the next 10-20 years. However, these projects alone will not be sufficient to achieve water quality goals for this lake. An essential "long-term" component of this Implementation Plan is to routinely retrofit BMPs into the fully-developed areas of the watershed as redevelopment or construction activities provide opportunities.

As the local communities, the county and Mn/DOT cycle through their street and highway reconstruction programs, it is now routine to include treatment BMPs such as stormwater detention ponds, infiltration basins and underground treatment devices where possible. In fact, road reconstruction triggers the need for an RCWD permit; such permits require treatment of stormwater (infiltration, filtration, or ponding). These incremental reductions will add up over time to a significant external load reduction.

Another long-term type of external load reduction is redevelopment. The watershed draining to the lake developed prior to the enactment of RCWD stormwater management rules and standards and subsequently there is currently minimal treatment of stormwater. As this area redevelops over time, the redevelopment will be required to reduce some stormwater runoff and treat the balance of the runoff before discharging it to the lake. Depending on the nature of the redevelopment, it may be possible to provide even more load reduction by “upsizing” treatment above and beyond the minimum required by the rules or to create new regional treatment opportunities. Like road reconstruction, redevelopment is subject to RCWD rules, which require stormwater treatment.

The TMDL baseline modeling period is 2002 through 2008. Benefits from BMPs and other water quality treatment devices existing in the Bald Eagle Lake watershed *prior* to 2008 are implicitly accounted-for in the TMDL modeling.

3.3.2 Implementation Strategies

Implementation in the early stages will focus on controlling both external and internal loading. Some internal load management activities could be initiated early in the Implementation Program. Feasibility work must be completed to evaluate the most effective means of reducing internal loading.

The following sections discuss the general BMP strategies that were identified in the TMDL process to reduce phosphorus loading, restore ecological integrity, and meet state water quality standards for the lake; the general sequence of implementation activities; and the stakeholders who would take the lead in implementing each activity. BMP strategies are listed below and described in more detail in Sections 4 and 5 of this Plan.

<u>External Load Best Management Practice (BMP) Strategies</u>

- Add targeted and opportunistic BMPs to decrease runoff from the watershed and increase stormwater treatment
- Increase infiltration and abstraction in the watershed
- Increase the frequency of street sweeping
- Encourage shoreline restoration to improve runoff filtration

<u>Internal Load Best Management Practice (BMP) Strategies and Monitoring</u>

- Conduct aquatic plant, fish, zooplankton, and phytoplankton surveys
- Prepare and implement an aquatic vegetation management plan
- Restore a balanced fishery

- Evaluate potential internal load management projects and implement the most feasible

3.3.3 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 implementation activities and monitoring/evaluation activities:

First Five Years

- Continue monitoring the lake and inflows.
- Continuously update the watershed hydrologic, hydraulic, and pollutant loading models.
- Evaluate the feasibility of internal loading control options including a whole-lake alum treatment, hypolimnetic aeration or withdrawal with possible alum injection, and implement the most feasible option(s).
- Evaluate ways to refine street sweeping practices to maximize pollutant removal and implement these practices.
- Provide cost-share funding to implement priority BMP retrofits by local governments, property owners, and other partners.
- Encourage lakeshore property owners to plant native buffers on their shoreline.
- Continue to provide technical assistance and grant funds to property owners interested in implementing stormwater BMPs on their property.
- Work with golf course owners and managers to evaluate storm water management on their property.
- Implement BMP and restoration demonstration projects as opportunities arise.

Second Five Years

- Continue monitoring the lake and watershed inputs.
- Work with SWCDs and agricultural property owners and producers to implement BMPs on their property.
- Evaluate progress toward goals including identifying BMPs and activities that were implemented and subsequent water quality improvement.
- Amend the Implementation Plan as necessary based on progress.
- Continue to implement BMP retrofits as opportunities arise.

After Ten Years

- Continue monitoring the lake and watershed inputs.
- Evaluate progress toward goals including identifying BMPs and activities that were implemented and subsequent water quality improvement.
- Amend the Implementation Plan as necessary based on progress.
- Incorporate BMPs into Highway 61 improvements as feasible.

3.3.4 Stakeholder Responsibilities

The primary stakeholders in this Plan are the local communities and Mn/DOT. In addition, property owners in the watershed have a role to play in implementing BMPs on their private properties. The RCWD Education and Outreach program will provide property owners and managers with information on BMPs that would have the most impact on improving water quality.

3.4 ADAPTIVE MANAGEMENT

The wasteload and load allocations in the TMDL are aggressive goals for nutrient reduction. Implementation will be conducted using adaptive management principles. Adaptive management is an iterative approach of implementation, evaluation, and course correction (see Figure 3.2). It is appropriate here because it is difficult to predict the lake response to load reductions. Future conditions and technological advances may alter the specific course of actions detailed in this Plan. Continued lake water quality monitoring and course corrections responding to monitoring results offer the best opportunity for meeting the water quality goals established in this TMDL and Implementation Plan.

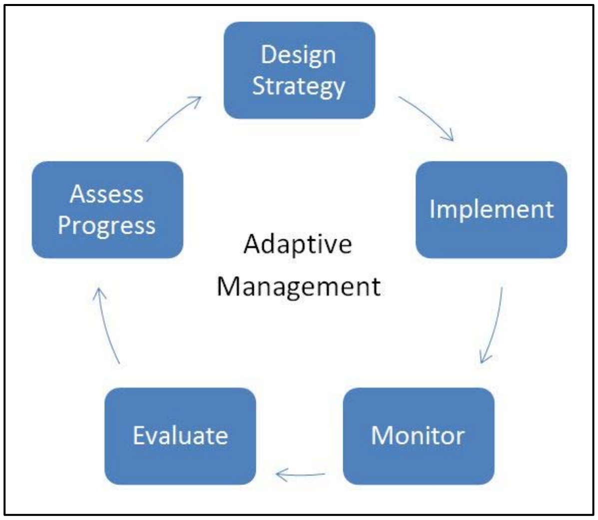

Figure 3.2. Adaptive Management

3.4.1 Interim Milestones

Lakes may take years to respond to phosphorus load reduction activities in the watershed and make progress toward the in-lake water quality standards. Interim measures to assess the progress of this TMDL include the following:

- Number and types of new Best Management Practices retrofit into the watershed;
- Frequency and extent of additional priority street sweeping undertaken each year;
- Number of redevelopment projects in the watershed that incorporate new or oversized load reduction and volume management;
- Completion of aquatic vegetation, fish, and zooplankton surveys; and
- Number of informational pieces made available to property owners in the watershed on small BMP practices, lakeshore restoration, and other nutrient load reduction and habitat improvement practices

These milestones will provide information about documenting the progress towards achieving the TMDL likely even before we are able to show improvement in the water quality of Bald Eagle Lake. Monitoring of lake water quality is discussed in Section 4.3.

4.0 Implementation Activities

The RCWD will lead the TMDL Implementation Plan. A variety of stakeholders, including the District, local communities, and individual property owners and managers will implement watershed-wide activities and those that are specific to a subwatershed, city, neighborhood, or property. This section describes various activities that will be undertaken to reduce nutrient loads and runoff volume to Bald Eagle Lake. Section 5 provides a summary of those activities, the stakeholders who will implement them, a timeframe for implementation, and the estimated cost and load reductions that could be achieved.

4.1 WATERSHED DISTRICT ACTIVITIES

4.1.1 Coordination of Efforts

One of the primary District roles in managing the watershed is serving as a coordinator of water resource policies and activities. The District will continue in that role in the implementation of this TMDL. General activities now undertaken by the District will be continued or expanded as the TMDL is implemented.

- Provide advice and assistance to local communities on their implementation activities;
- Research and disseminate information on changing BMP technology and practices;
- Recommend activities such as vegetation or fishery management, partnering with the DNR;
- Periodically update the Capital Improvement Program (CIP);
- Maintain the watershed models;
- Conduct public hearings on proposed projects; and
- Share the cost of certain improvement projects.

Estimated Cost: Ongoing activity
Funding Source: General operating budget

4.1.2 Maintain Rules Regulating Development and Redevelopment

The Rice Creek Watershed District recently revised its rules and standards to adopt more stringent stormwater management rules. The rules revision requires new development to incorporate Better Site Design principles into site plans, and to retain on site through infiltration or other volume management the runoff from a 2-year (2.8 inch in 24 hours) rain event. Small events convey the majority of the annual phosphorus and sediment load (Pitt 1998) to downstream receiving waters. Redevelopment is also required to provide volume management. Adoption of this volume management rule limits new phosphorus and sediment loading to the lakes. The District will keep abreast of regulatory trends and consider future rule revisions if necessary.

Estimated Cost: Ongoing activity
Funding Source: General operating budget

4.1.3 Maximize Load Reduction through Development and Redevelopment

As redevelopment occurs, areas with little or no treatment will be required to meet current water quality standards. It may be possible to "upsize" water quality treatment BMPs for both development and redevelopment projects to increase treatment efficiency beyond the minimum required by the rules. RCWD will work in partnership with the local communities and developers to maximize the amount of load and volume reduction achieved on development and redevelopment projects.

Estimated Cost: Ongoing activity
Funding Source: General operating budget

4.1.4 Better Site Design

As described above, the new RCWD rules require Better Site Design minimizing new impervious surface and management of new runoff volumes on new development and redevelopment. On existing development, the use of rain gardens, native plantings, and reforestation should be encouraged as a means to increase infiltration, evapotranspiration, and filtration of runoff conveying pollutant loads to the lakes.

Estimated Cost: Staff time
Funding Source: Developers

4.1.5 Public Education and Outreach

The District operates an ongoing education and outreach program. RCWD initiated the popular and award-winning Blue Thumb-Planting for Clean Water program that has been adopted by numerous cities, counties, and watershed management organizations across the state. The education and outreach program undertakes diverse activities to 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. The program also includes education for lakeshore property owners about aquatic vegetation management practices and how they relate to beneficial biological communities and water quality.

Because Bald Eagle Lake is a highly-used recreational lake, there is a potential for the recreation activities to have an impact on the water quality in the lake. To address these potential impacts, educational materials will be developed for lake users to make them aware of the potential impacts to the lake.

Estimated Cost: $2,500
Funding Source: General operating budget

4.1.6 Cost Share Assistance

The RCWD has in place two grant programs to assist property owners, local governments, and other interested parties in implementing load and volume reducing activities. The Water Quality BMP Cost Share Grant Program is oriented to residential property owners and can fund 50% of certain projects to a maximum of $5,000. The program provides residents with technical and financial assistance to install BMPs to reduce erosion and stormwater runoff and filter excess nutrients. Typical BMPs include, but are not limited to, installing rain gardens, stabilizing shorelines with native plants, restoring wetlands, controlling erosion and installing permeable paving. The Urban Stormwater Remediation Cost-Share Program assists counties, cities, townships, school districts, libraries, and other public and private entities located within the RCWD to incorporate water quality improvements that are not required by a permit. This program can fund up to 50% of projects to a maximum of $50,000.

Estimated Cost: Varies based on the type of activity
Funding Source: Approximately $190,000 in 2011 for Water Quality BMP Cost Share and $175,000 for Urban Stormwater Remediation.

4.1.7 Monitoring

The Rice Creek Watershed District maintains a monitoring program that includes flow and water quality monitoring for key subwatersheds. The RCWD currently monitors continuous flow and water quality at the outlet of Judicial Ditch 1, and will continue to do so as the Bald Eagle TMDL is implemented. Whenever possible, stormwater water quality samples will also be collected from the County Ditch 11 and direct watershed outfall locations. This monitoring would be done in conjunction with implementation activities (i.e. "effectiveness monitoring").

Currently, in-lake water quality samples, along with measures of physical lake characteristics (temp, DO, etc), are collected by Ramsey County Public Works. Samples are collected from two locations in the lake, and at varying depths, on a bi-monthly basis. Ramsey County plans to continue sampling throughout and after the TMDL implementation process.

Estimated Cost: Approximately $3,500 annually
Funding Source: Annual operating budget

4.2 WATERSHED-WIDE EXTERNAL LOAD REDUCTIONS

4.2.1 Publicly Owned and Institutional Properties BMP Retrofits

There are a number of publicly-owned and institutional properties in the watershed, including parks, schools, churches and open spaces (see Figure 4.1). Each of these properties should be evaluated to determine a) opportunities to incorporate small-scale BMPs to treat and or/infiltrate runoff from on-site facilities; and b) if there are any opportunities to treat and/or infiltrate runoff from off-site, such as boulevard rain gardens to capture a portion of street runoff. These small practices could range in cost from $2,500 for a small, on-site rain garden to $25,000 or more for a large bioinfiltration basin treating off-site runoff. Figure 4.2 shows the general infiltration potential within the Bald Eagle Lake watershed. Focusing efforts in those areas with the best infiltration potential would provide the greatest load and volume reductions, although this does not discount the benefit of implementing practices elsewhere.

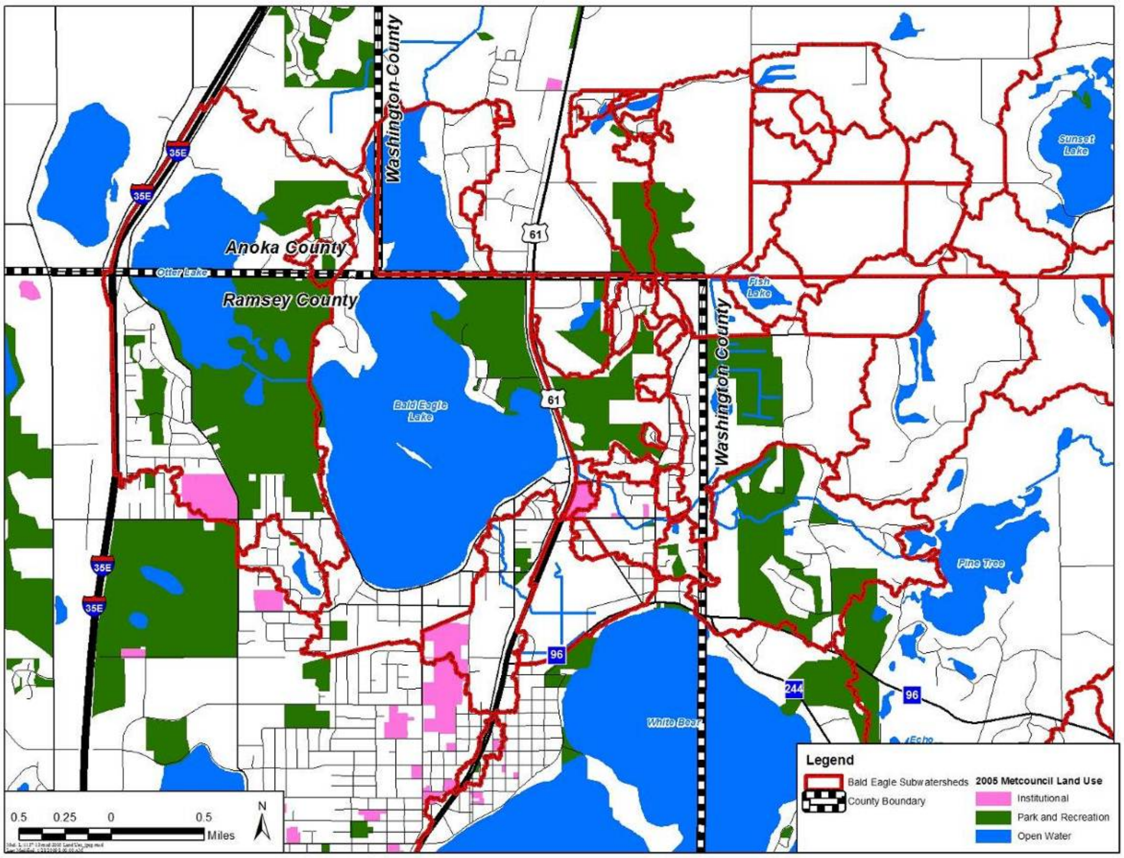

Figure 4.1. Public and institutional properties in the Bald Eagle Lake watershed.

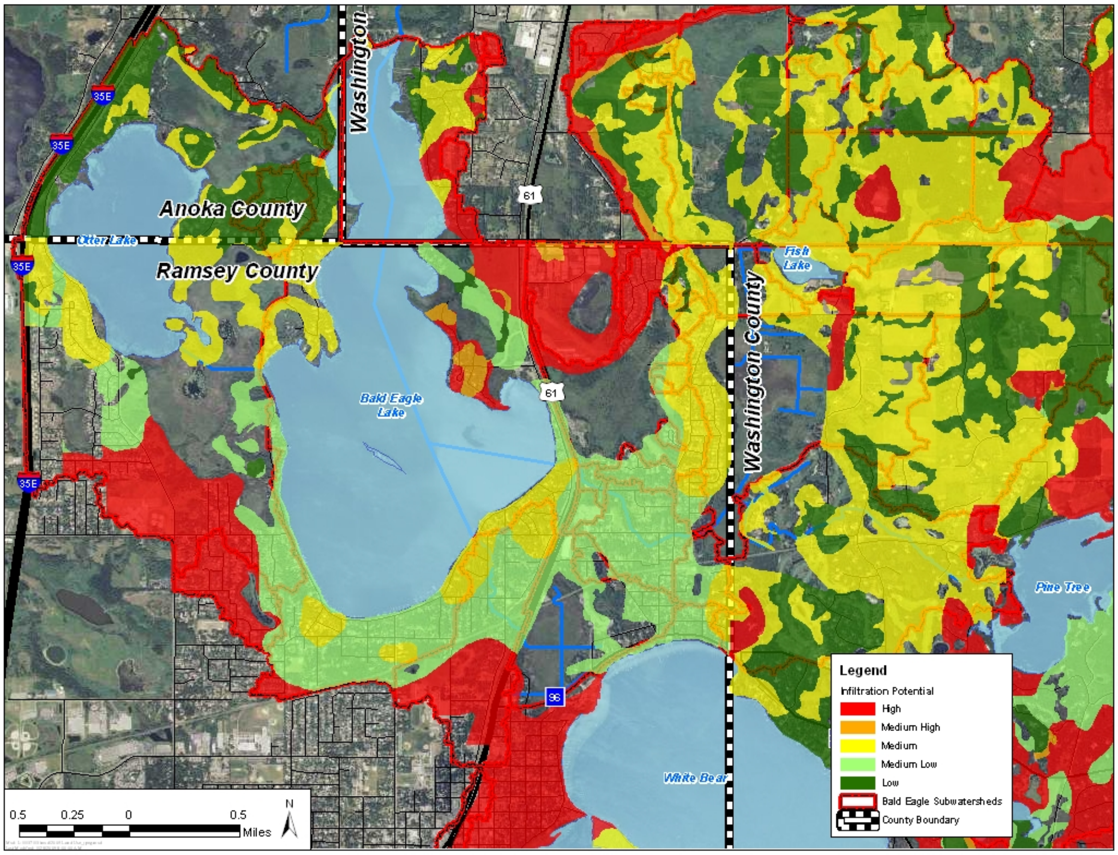

Figure 4.2. General infiltration potential in the Bald Eagle Lake watershed.

4.2.2 Encourage Residential Rain Gardens and Bio-Filtration Gardens

Residents will be encouraged to apply to the RCWD's Water Quality Cost-Share program to install rain gardens on private properties. The cost of individual rain gardens can range from $200 to $2,000, depending on size and whether labor is performed by the property owner or is contracted out. Figure 4.3 shows the residential areas with the greatest infiltration potential. Efforts should be focused in those areas to maximize benefit. In areas where infiltration potential is limited, soil amendments and under-drains (drain tile) could be used to trap particulate phosphorus. New technologies, such as iron-enhanced sand, could be utilized to trap dissolved phosphorus.

Parameter	Value	Units
Total area of residential	376.74	Acres of residential
Percent of runoff to treat	15%	
Total number of rain gardens needed to treat 15%	189	Number of rain gardens
15% of total annual runoff volume (average 1998-2008)	51	Acre-feet
Load reduction assuming 300 µg TP/L runoff	41	Pounds TP annually
Total overall goal cost	$75,600 - $189,000	

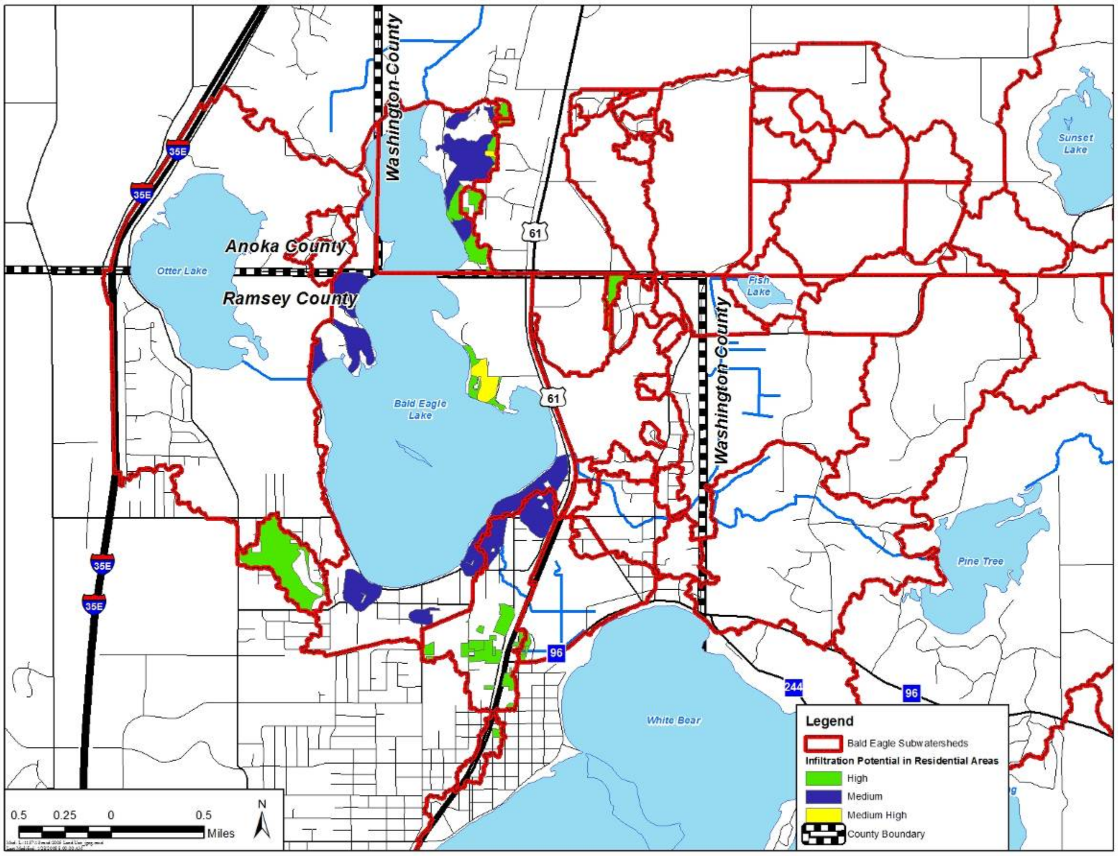

Figure 4.3. Residential areas in the Bald Eagle Lake watershed with the greatest infiltration potential.

Estimated Cost: $75,600 - $189,000
Funding Source: Property owners, cities, RCWD Cost Share

4.2.3 Add Stormwater Treatment through Street and Highway Projects

Street or highway reconstruction or maintenance projects may provide opportunities to incorporate BMPs to add or increase treatment in the watershed. As most of these projects will be retrofit projects, likely BMPs to be considered will be bioinfiltration swales, manhole sumps and other in-line treatment structures, reduced pavement widths, tree trenches, sand filters, and other BMPs that can be fit into tight rights of way. These types of improvements range in cost from $5,000 for a vegetated swale to $50,000 or more each for proprietary underground treatment structures. The RCWD will use its “Urban Stormwater Remediation Cost-Share” program to subsidize projects.

Estimated Cost: Varies by BMP
Funding Source: Cities/counties, RCWD Cost Share

4.3 JD 1 SUBWATERSHED LOAD REDUCTIONS AND MONITORING

4.3.1 Golf Course Management Plans

There are three golf courses located in the JD 1 subwatershed (Figure 4.4). A storm water management plan should be developed for each of the golf courses that details current drainage systems and runoff and loading characteristics as well as the current management practices. The goal of these plans should be to develop and implement management practices and activities, including potentially physical improvements such as regrading, ponding, and bio-infiltration, that work toward zero discharge of runoff and nutrient and sediment load. Some specific golf course BMPs might include the development of improved fertilizer application and management programs, stormwater reuse for irrigation, and pond/ditch vegetative buffers.

Several golf course BMP program templates exist, including manuals developed by the States of Connecticut (CDEP, 2006) and Florida (FDEP, 2007).

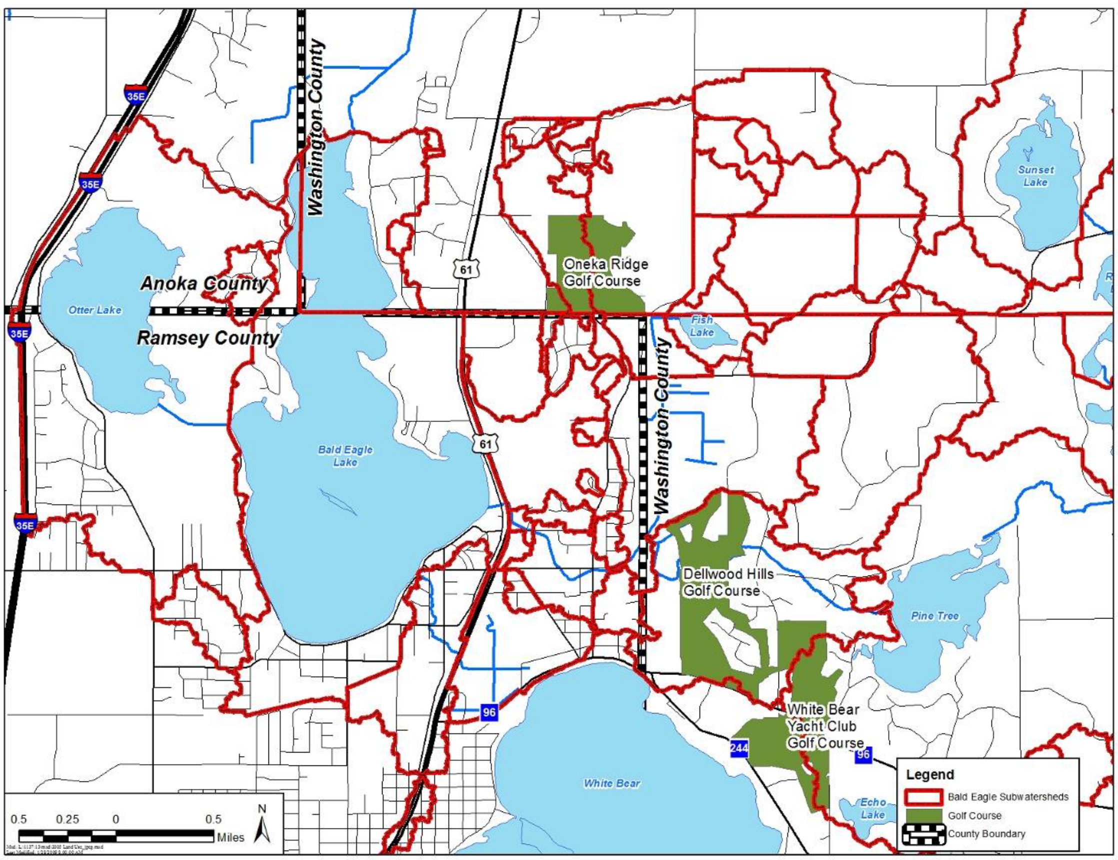

Figure 4.4. Golf courses in the Bald Eagle Lake watershed.

Estimated Cost: $20,000 each, total of $60,000
Funding Source: Property owners, RCWD Cost Share

4.3.2 Improve Agricultural Practices

There are a number of agricultural properties in the upper JD1 subwatershed that could be evaluated by the SWCD and other partners for potential improvements such as manure management plans, conservation tillage, nutrient management, buffer strips, and erosion and sedimentation control.

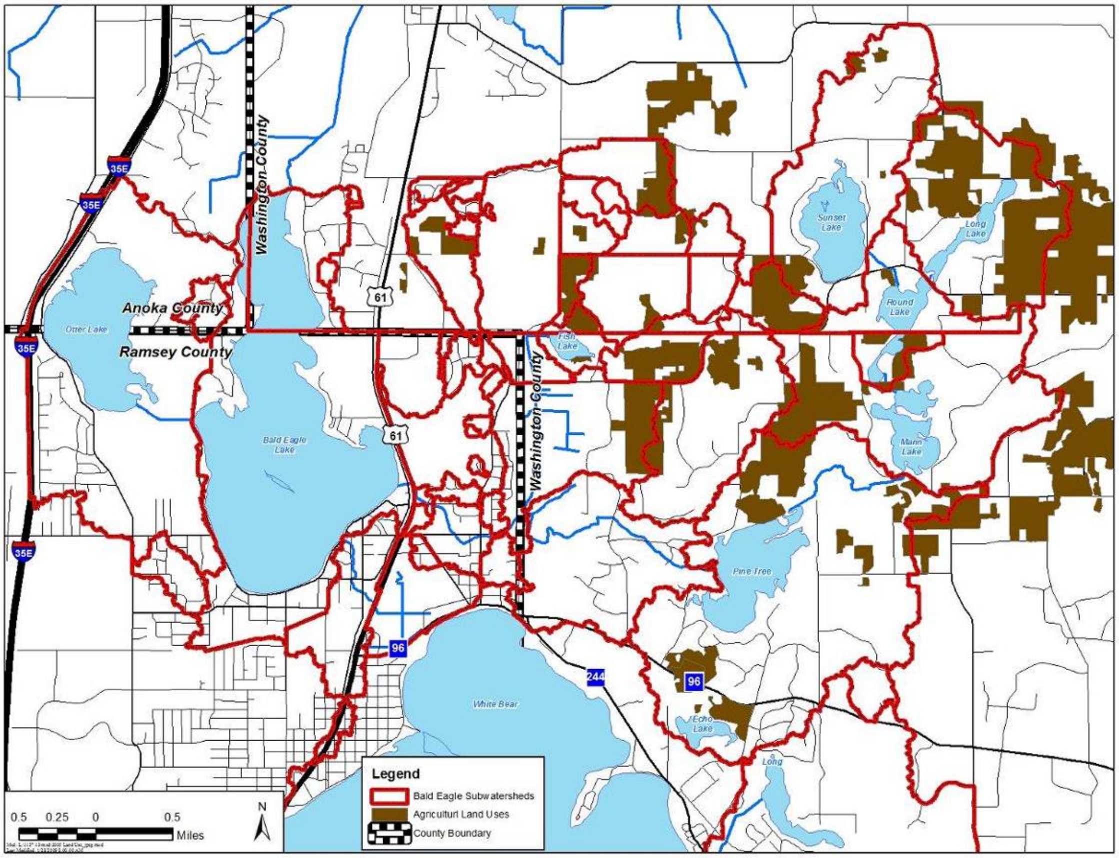

Figure 4.5. Agricultural properties in the Bald Eagle Lake subwatershed.

Figure 4.5shows those properties that are currently classified as agricultural land use. Many of these are grazing and animal management lands rather than in row crop production. The District will work in partnership with the local SWCDs to ensure that these properties are priorities for agricultural management.

Estimated Cost: Varies
Funding Source: SWCDs

4.3.3 Complete Fish Lake TMDL

Fish Lake was added to the state's 303(d) list of Impaired Waters in 2006 due to an excess of nutrients. Summer average phosphorus concentration exceeds 100 ug/L. The outflow of Fish Lake is routed to Bald Eagle Lake and is a modeled source of phosphorus load. The Bald Eagle Lake TMDL was developed assuming that the Fish Lake outflow meets state water quality standards. To achieve this, a TMDL study must be prepared for Fish Lake and implementation actions taken to reduce loading to that water body. The MPCA has targeted 2013 for the initiation of the Fish Lake TMDL, with completion by 2016.

Estimated Cost: $25,000
Funding Source: MPCA

4.3.4 Protect High Value Wetlands

Numerous high-value wetlands are present in the watershed. As development or redevelopment occurs, there is the potential for these wetlands to receive additional stormwater and nutrients, altering the hydroperiod and natural assimilative characteristics of the wetlands, converting them from nutrient sinks to nutrient sources. The proposed RCWD rules revision includes standards limiting impacts to wetland hydroperiod based on wetland classification as well as requiring pretreatment of discharges to wetlands.

Estimated Cost: Staff time
Funding Source: Developers

4.3.5 Monitor Outlet Wetlands

Wetlands that have been impacted by urban development or agricultural runoff can become phosphorus exporters instead of phosphorus sinks. Runoff from parts of the JD 1 and CD 11 subwatersheds flow through two large outlet wetlands (Figure 4.6), which then discharge into storm sewer that flows directly to the lake. Inflow and outflow of those wetlands should be monitored to determine if phosphorus export is occurring and under what flow regimes. This item includes flow and water quality modeling at the outlet and each routed inlet to the wetlands, and P8 models for each subwatershed.

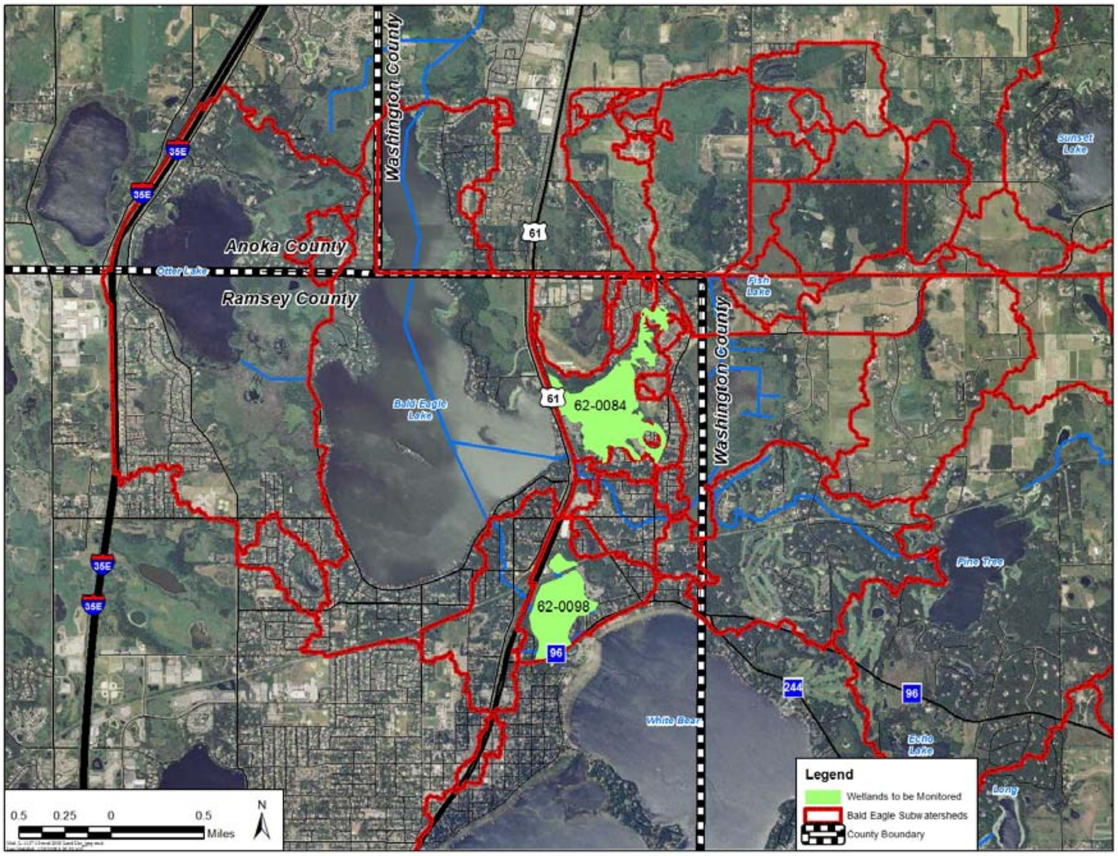

Figure 4.6. Recommended wetland outlet monitoring.

Estimated Cost: $35,000
Funding Source: RCWD

4.4 CD 11 SUBWATERSHED EXTERNAL LOAD REDUCTIONS

4.4.1 CD 11 Channel Stabilization

County Ditch 11 is an open channel draining a large portion of the RCD11 subwatershed. Excess channel erosion can be a source of sediment and nutrients to downstream waters. CD11 should be inspected and erosion issues inventoried and assessed for repair and restoration needs. Small spot improvements may be completed for $5,000-10,000 depending on severity. More significant erosion issues may require bioengineering or even hard armoring to improve stability.

Estimated Cost: $5,000 inventory, $10,000-50,000 (?) erosion repairs
Funding Source: Cities, RCWD Cost Share

4.4.2 In-Line Storm Sewer Treatment

Where space to install “traditional” treatment such as sedimentation ponds is limited, in-line treatment can be provided by installing storm sewer sumped manholes outfitted with “SAFL

Baffles." Developed at the University of Minnesota St. Anthony Falls Laboratory, the SAFL Baffle is a perforated steel plate installed in a sump manhole to minimize resuspension of sediment, floatables and other pollutants from the sump during large events (Figure 4.7). These sumps must be periodically cleaned using a vacuum sewer cleaner. Sumps are most effective at retaining floatables, particulate material and large sediment particles, and are less effective at providing nutrient reductions. However, there is value in removing organic debris such as leaves and phosphorus that is adsorbed to larger sediment particles, and these types of sumps are cost-effective and can be widely distributed.

Figure 4.7. The SAFL Baffle is installed in a sump manhole to minimize resuspension of pollutants collected in the sump.
(Images: University of Minnesota St. Anthony Falls Laboratory.)

Estimated Cost: $10,000-$15,000 each depending on size
Funding Source: Cities, RCWD Cost Share

4.4.3 White Bear Lake Commercial Area BMPs

The White Bear Lake commercial corridor along County Road 61 contains areas of high imperviousness (Figure 4.8). There are a number of small BMPs that could be retrofit into this dense commercial area. The area may also benefit from enhanced, monthly street sweeping.

Small Practices. Many sites can be successfully retrofit with minimal impact to the existing pavement and other infrastructure. Strip filters can be added along parking lots to treat sheet flow, raised traffic dividers can be replaced with raid gardens, and when pavement is replaced, porous or permeable pavements can be used to reduce runoff and increase infiltration.

Figure 4.9 shows a typical commercial site and its drainage patterns. Some BMP ideas including swales and rain gardens with engineered media, strip filters, and porous pavement are shown as examples of how these sites can easily be retrofit. Figure 4.10 is another example that incorporates small infiltration basins in the right of way.

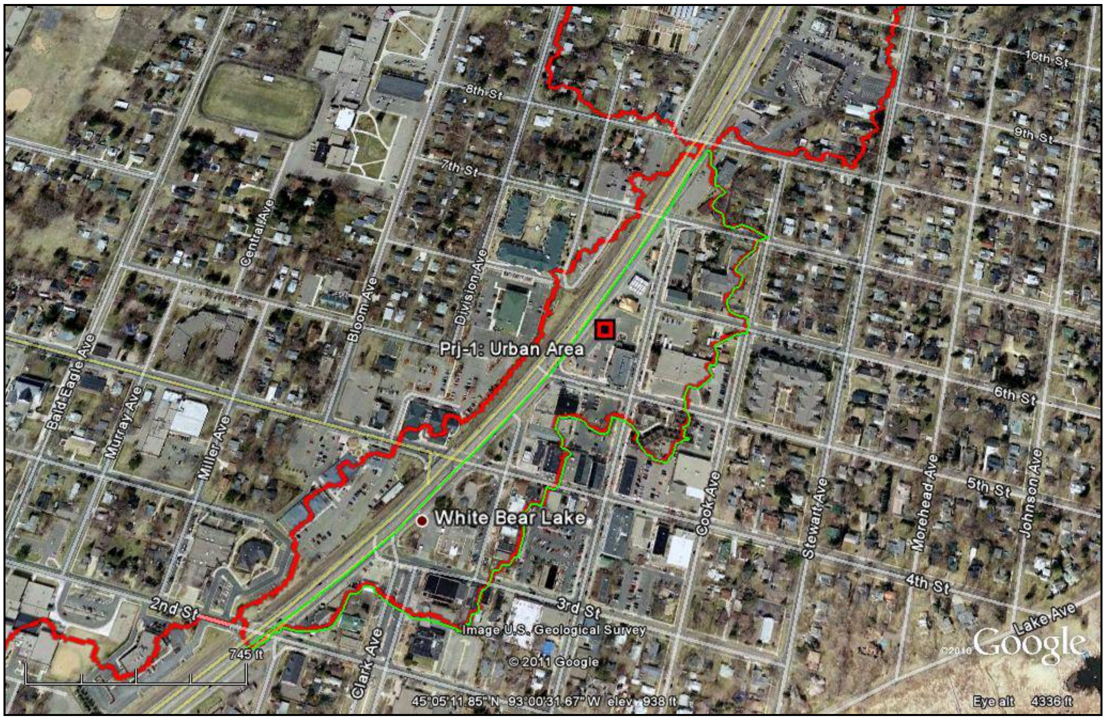

Figure 4.8. White Bear Lake commercial area.

To be most effective, a systematic review of the commercial area should be completed, parcel by parcel, with more detailed, small-site modeling completed to estimate potential load reductions. The total estimated annual load exported from this area is 31.6 pounds per year of total phosphorus. Assuming that small BMPs can be retrofit to treat runoff from up to a 1” event over 50% of the impervious area, the estimated load reduction could be 16 pounds per year (31.6 pounds/year * 50% time 85% of annual volume). Costs per BMP could range from $5,000 for simple bioretention basins to $25,000 to retrofit filter strips.

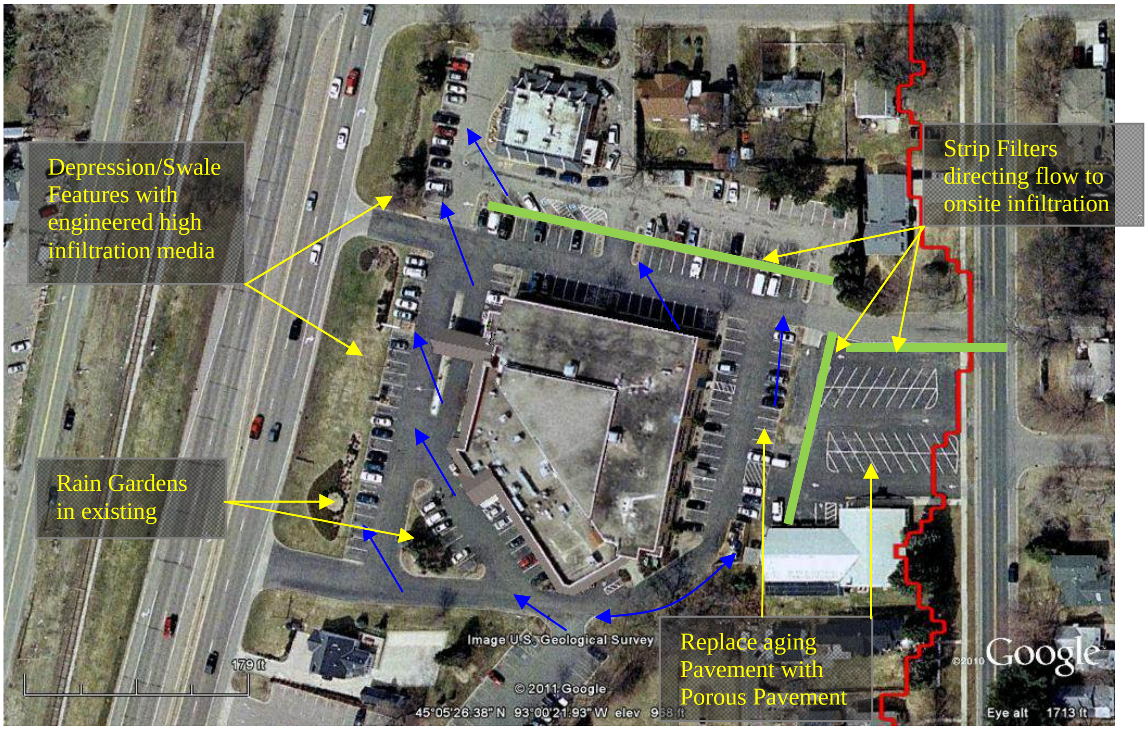

Figure 4.9. Example 1. Blue arrows indicate general flow direction.

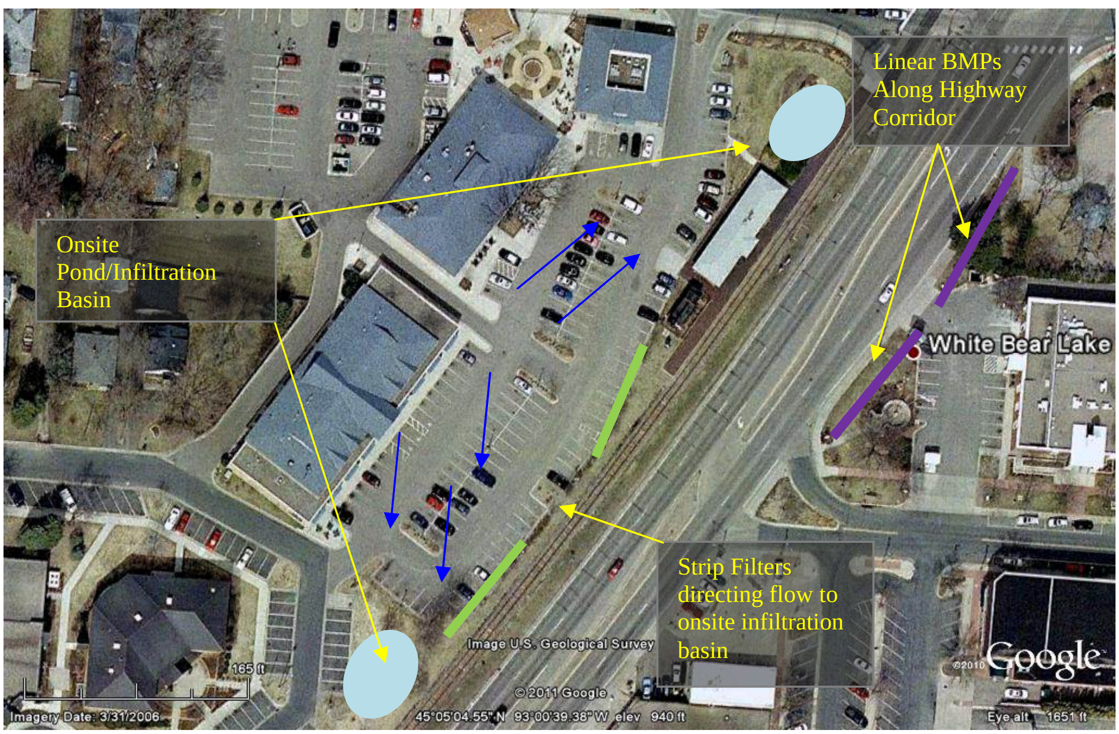

Figure 4.10. Example 2. Possible BMP retrofits in a commercial area.

Enhanced Sweeping. There are about 1.3 miles of commercial-area streets in the commercial zone that could benefit from high frequency, high efficiency street sweeping. High frequency sweeping (minimum of once per month) with a regenerative air sweeper could potentially reduce the pollutant load by 1 pound per year assuming a conservative 0.75 pound per curb mile per year removal rate.

Estimated Cost: BMPs: $35,000 to complete an overall assessment; $5,000-25,000 each for BMPs. Sweeping: $100,000 to 200,000 per new sweeper, $85-$110 per mile of sweeping
Funding Source: City, RCWD

4.5 DIRECT SUBWATERSHED EXTERNAL LOAD REDUCTIONS

4.5.1 Pipe Outfalls In-line Treatment

There are several pipe outfalls that have been identified as candidates for inline treatment, as shown in Figure 4.11. Outfalls O-1 and O-2 are the focus of discussion for this BMP. Outfall O-3 is an open channel and will be discussed in the next section. The surrounding areas are residential. Standard practices assume that 1 cfs is an approximate discharge given a 2.8 inch, 24 hour duration storm event (2 year storm) for one acre of residential area. Additionally it is estimated that 0.8 pounds of phosphorus is produced per acre of residential.

Inline treatment on pipe outfalls for total phosphorus removal is limited to ponds, settling basins, or hydrodynamic separation technologies. Ponds are the most economical and are the best at removing phosphorus; however, the need for available land can be a problem.

An appropriately-sized pond could service one or more outfalls as inline treatment. The contributing area for outfalls O-1 and O-2 is an estimated 22 acres. A pond that has a foot print of two tenths of an acre is sufficient to contain and treat the 2.8 inch event for 22 acres. The estimated reduction in total phosphorus for a pond this size would be approximately 67%. Assuming 0.8 pounds per year per acre of residential for a total annual load, the annual reduction in phosphorus loading is 11.8 pounds of phosphorus. Costs associated with such a pond are shown in Appendix A.

Hydrodynamic separation technologies are flow-through structures to remove sediments and other pollutants by separation and settling. The primary target for these devices is suspended sediments, and removal efficiencies range from 80% to 98%. Hydrodynamic separators do remove an estimated 20% to 40% of the particulate phosphorus in the stormwater. However, phosphorus that adheres to fine particles or is dissolved will not be removed by these devices. Removal rates are also subject to site-specific conditions and require these systems be accurately sized and designed to work for each application.

Several hydrodynamic separators are currently on the market and include such vendors as:

- Continuous Deflective Separation (CDS)
- Downstream Defender ™
- Stormceptor®
- Vortechs™

The cost for a unit that would be useable for the outfalls within the Bald Eagle Lake watershed ranges from $16,000 to $80,000 depending on the size of the area that would be treated. Regular maintenance is important to the function of these devices. Maintenance includes frequent inspections during the first year of installation to observe sediment accumulation rates. These units must be cleaned when the sediment accumulates within one foot of the top of the unit. A sump vacuum or vacuum truck is used to clean them. As an example of the applicability of hydrodynamic separators for Bald Eagle Lake, an approximate cost for a unit is estimated for treatment of 1 cfs per acre of residential with the Downstream Defender™. It is estimated from data provided by the vendor that a 72" unit would be required to achieve 90-95% total suspended solids removal and an estimated 20-30% total phosphorus removal given these flows. Using 0.8 pounds per year per acre for a total annual load of phosphorus, the net reduction is 0.16 to 0.24 pounds per year per acre treated at an estimated cost of $31,200. Costs are shown in Appendix A.

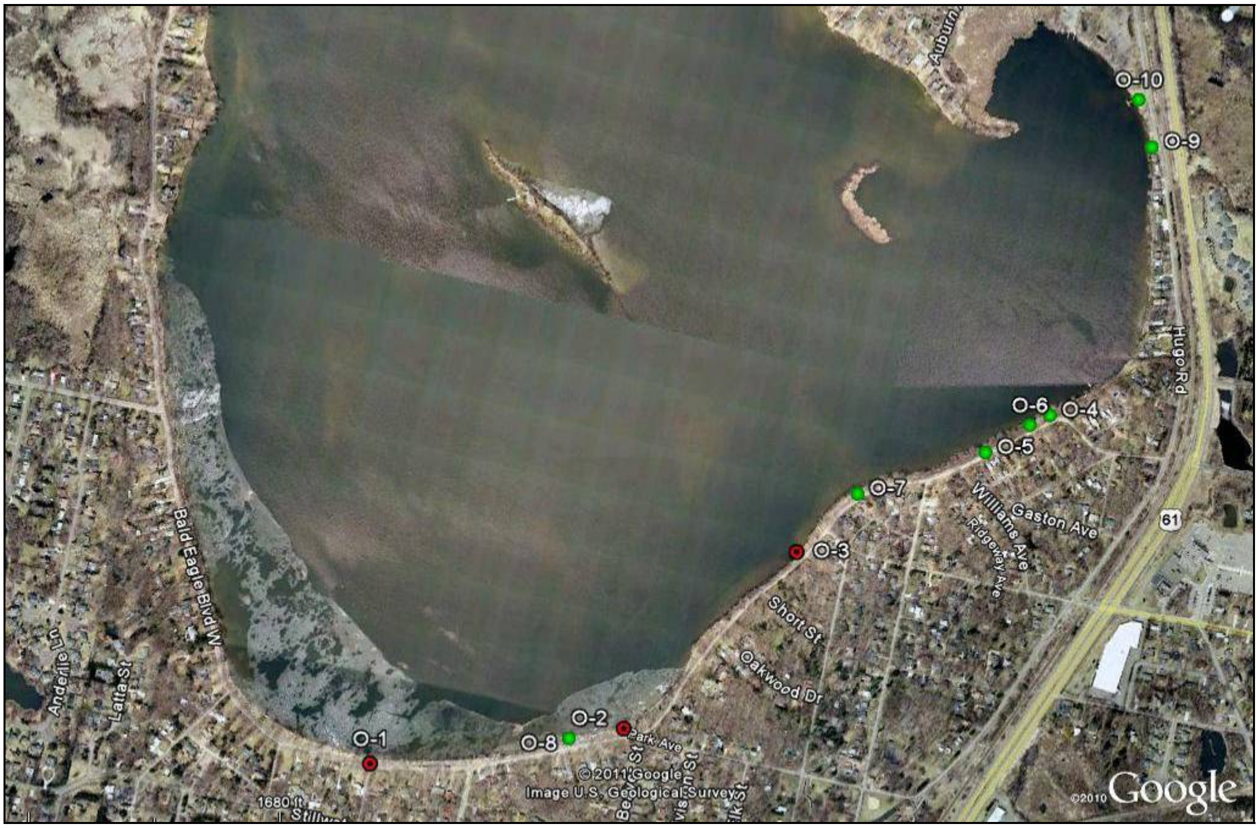

Figure 4.11. Location of identified outfalls within the Bald Eagle Lake area. The red outfalls are good candidates for inline treatments. The green outfalls are other outfalls in the area.

Estimated Cost: $31,200 construction plus $3,000 annually operations and maintenance per installation
Funding Source: Cities, RCWD cost share

4.5.2 Highway 61 Linear BMPs

Highway 61 bisects the Bald Eagle Lake watershed, at one point traveling immediately adjacent to the lake. Reconstruction or maintenance activities in this corridor may provide an opportunity to retrofit linear BMPs such as infiltration and treatment swales, grit chambers, and other underground treatment devices to reduce pollutant loading and runoff from the highway corridor. The type, extent, and cost of BMPs are dependent on the nature of the project. No study has been undertaken to determine which if any BMPs are feasible, and no specific projects are planned at this time.

Estimated Cost: Depends on the BMP
Funding Source: Mn/DOT

4.5.3 Regional Park Boat Landing BMP Enhancements

The parking lot area at the Bald Eagle/Otter Lakes Regional Park county boat ramp is approximately 1.5 acres of impervious surface with an annual total phosphorus load of 3.2 pounds per year. The pavement is relatively new and in good shape, thus BMP retrofits are limited to those that would not require significant impacts to the parking lot pavement. Another limitation is that the parking lot generally drains towards the southwest corner, where there is little room to retrofit improvements.

Given these constraints, parking lot perimeter sand filters are an option that would not disturb large areas of the parking lot and that could be installed in the limited space near the southeast corner of the lot (see Figure 4.12). The filters consist of two parallel trench chambers approximately 21 x 36 inches each. Figure 4.13 is a drawing of a typical perimeter sand filter with dimensions. The first trench captures heavy solids before water spills into the second chamber, which has approximately 18 inches of a sand and iron filings mixture. Literature suggests that perimeter sand filters can treat up to 1 acre of impervious surface per 100 linear feet of perimeter sand filter. The removal capacity of the sand filters are suggested for impervious areas less than or equal to 2 acres. The filters do not provide volume control but remove an estimated 90% of the total suspended solids and 55% of the phosphorus when iron filings are mixed in with the sand media.

For the 1.5 acres impervious acres at the county boat ramp, 150 linear feet of perimeter filter would be required. The load reduction would be approximately 0.9 pounds per year of phosphorus.

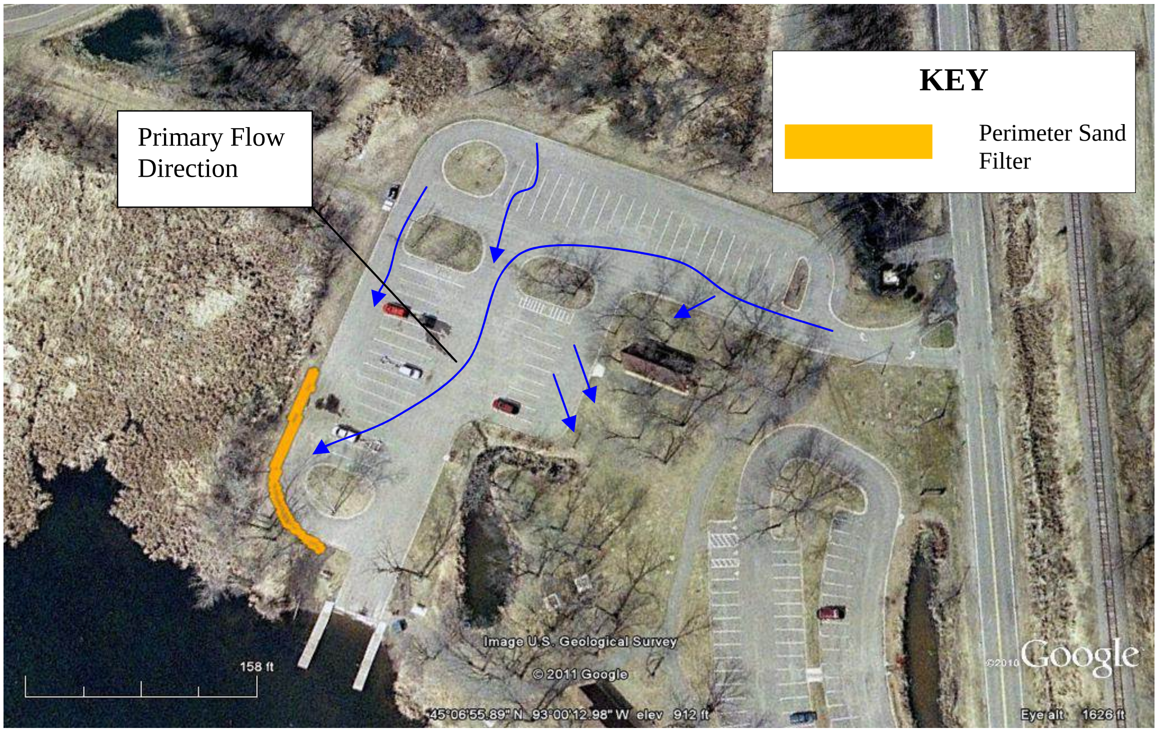

Figure 4.12. County boat ramp aerial image with location of proposed perimeter sand filter and primary flow directions.

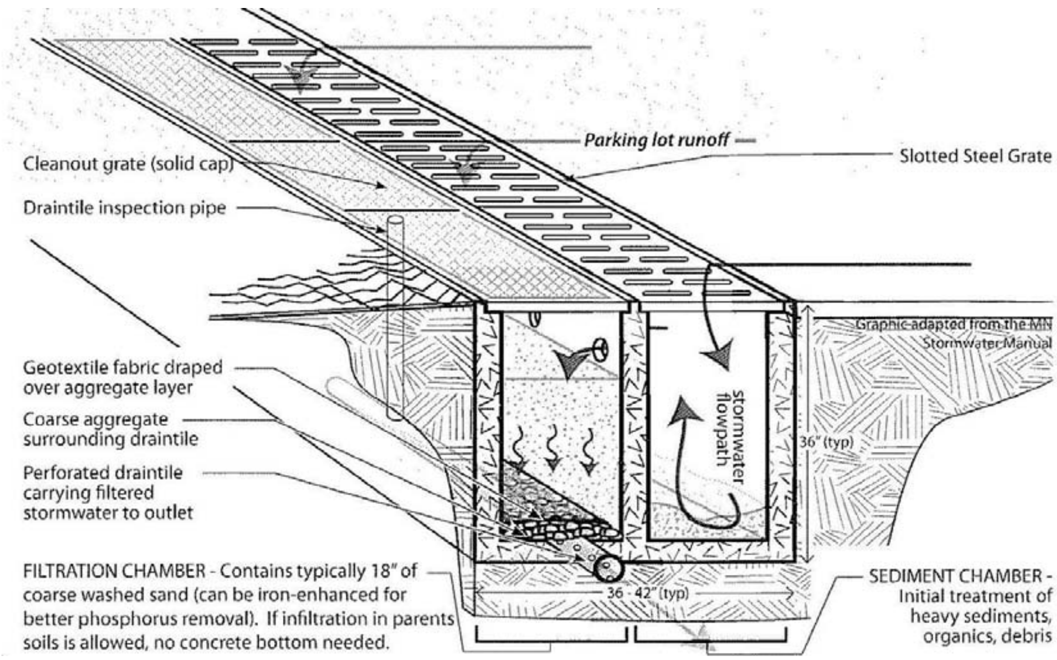

Figure 4.13. Perimeter sand filter detail.
(Source: Wood Crest Stormwater Retrofit assessment).

Estimated Cost: $19,800 construction plus $1,800 annually operations and maintenance
Funding Source: Ramsey County, RCWD cost share

4.5.4 High School Parking Lot Runoff

There is a large amount of impervious surface at the White Bear High School north campus that could be treated with BMPs to reduce the nutrient load. The phosphorus load is estimated to be around 14.9 pounds per year for all of the impervious surfaces. The impervious surfaces include three parking lots, a courtyard, and roof tops (see Figure 4.14). The types of BMPs at the school that will be most beneficial are those that utilize infiltration. The soil types at the school are those that suggest high to medium infiltration rate potential (mostly high – see Figure 4.15). Therefore, the BMPs suggested for this site are as follows:

- Swales
- Rain gardens
- Perimeter vegetative swales (for roof top runoff)
- Re-use / Irrigation
- Sand strip filters
- Porous pavement
- Depression areas

To better infiltrate runoff coming off the roof tops, vegetative swale features can be implemented around the perimeter of the buildings. These features are simply slightly depressed areas that are vegetated and have engineered soil fill material (much like a rain garden) to better infiltrate the runoff. The associated costs would be in line with costs typical for rain gardens. Implementation of vegetative strips around the perimeter of the buildings would reduce the total annual load on impervious surfaces at the school by an estimated 13%.

The parking lot runoff is best treated with swales and depression areas that will collect and infiltrate the runoff. Figure 4.16 and Figure 4.17 show the different BMPs that would be beneficial. In Figure 4.17 only one of the two infiltration areas (the swale or the depressed area) is necessary. Both are sufficient to infiltrate runoff when properly sized and engineered. Similarly, either the swale in the eastern parking lot B or the sand strip filter is necessary and sufficient – only one is needed. Swales can be added to the eastern parking lot A and B in existing green belt areas as shown in Figure 4.16. Additionally, a strip sand filter can be added along the perimeter of the pavement. The best location for the filter would be at the southern end of the eastern lot A as shown in Figure 4.16. These features would reduce the total load on impervious surfaces at the school by 34%. Using either the swale or depression areas for runoff from the western parking lot as shown in Figure 4.17 would reduce the total load by 19%.

The total load reduction for any combination of the suggested BMPs would reduce the total phosphorus load of 14.5 pounds per year by an estimated 66%.

The costs shown in Appendix A are BMP specific. Therefore a total project cost would be any combination of the costs shown.

Estimated Cost: Varies by specific project
Funding Source: School District, RCWD Cost Share

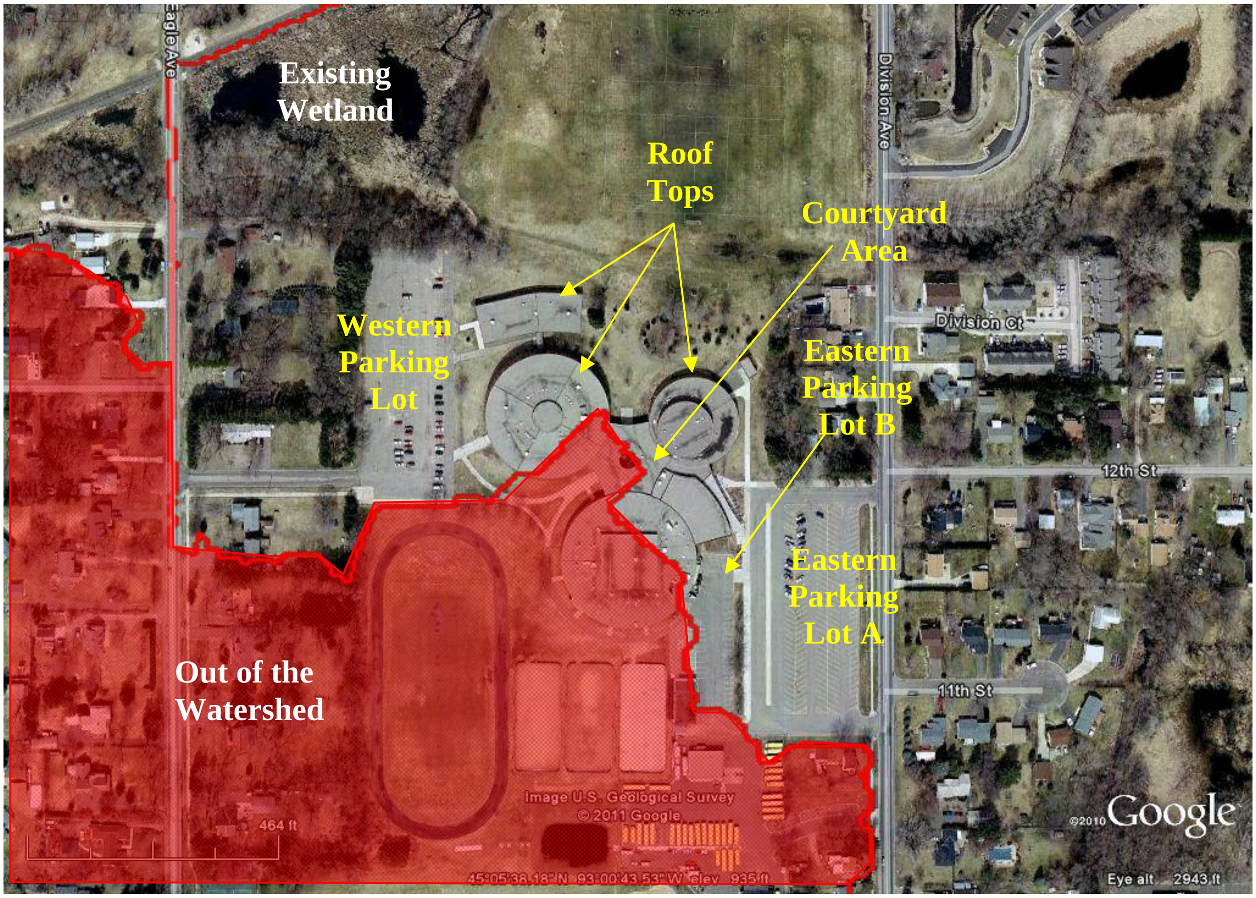

Figure 4.14. Impervious surfaces at the White Bear High School complex.

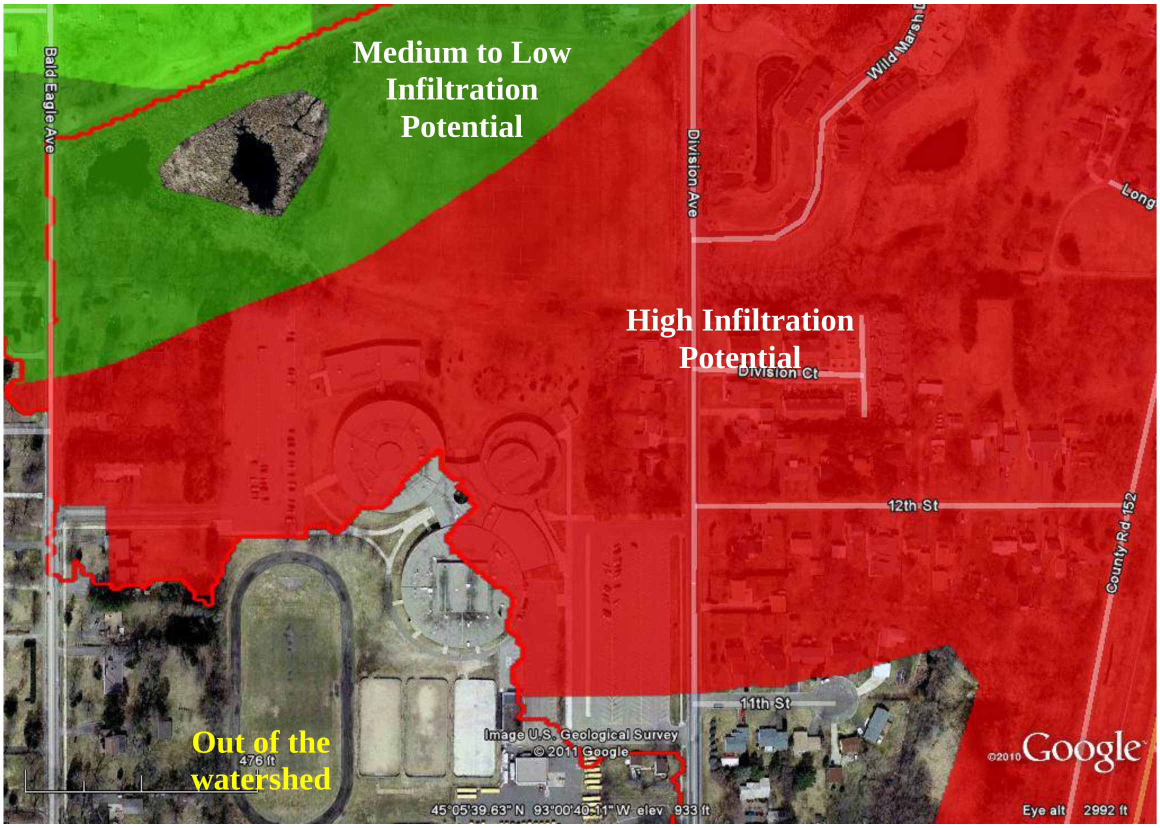

Figure 4.15. Infiltration potential at the White Bear High School complex.

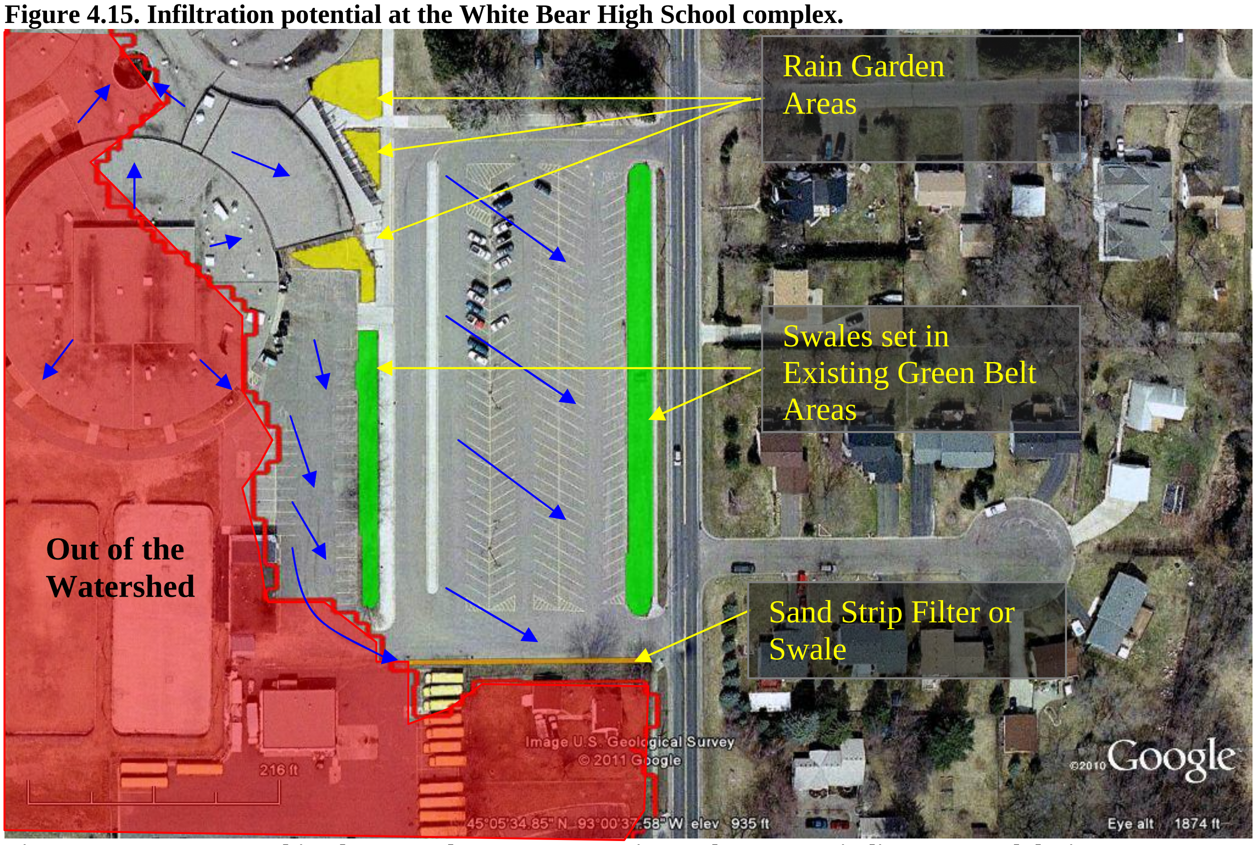

Figure 4.16. Eastern parking lots A and B BMP suggestions. Blue arrows indicate general drainage patterns.

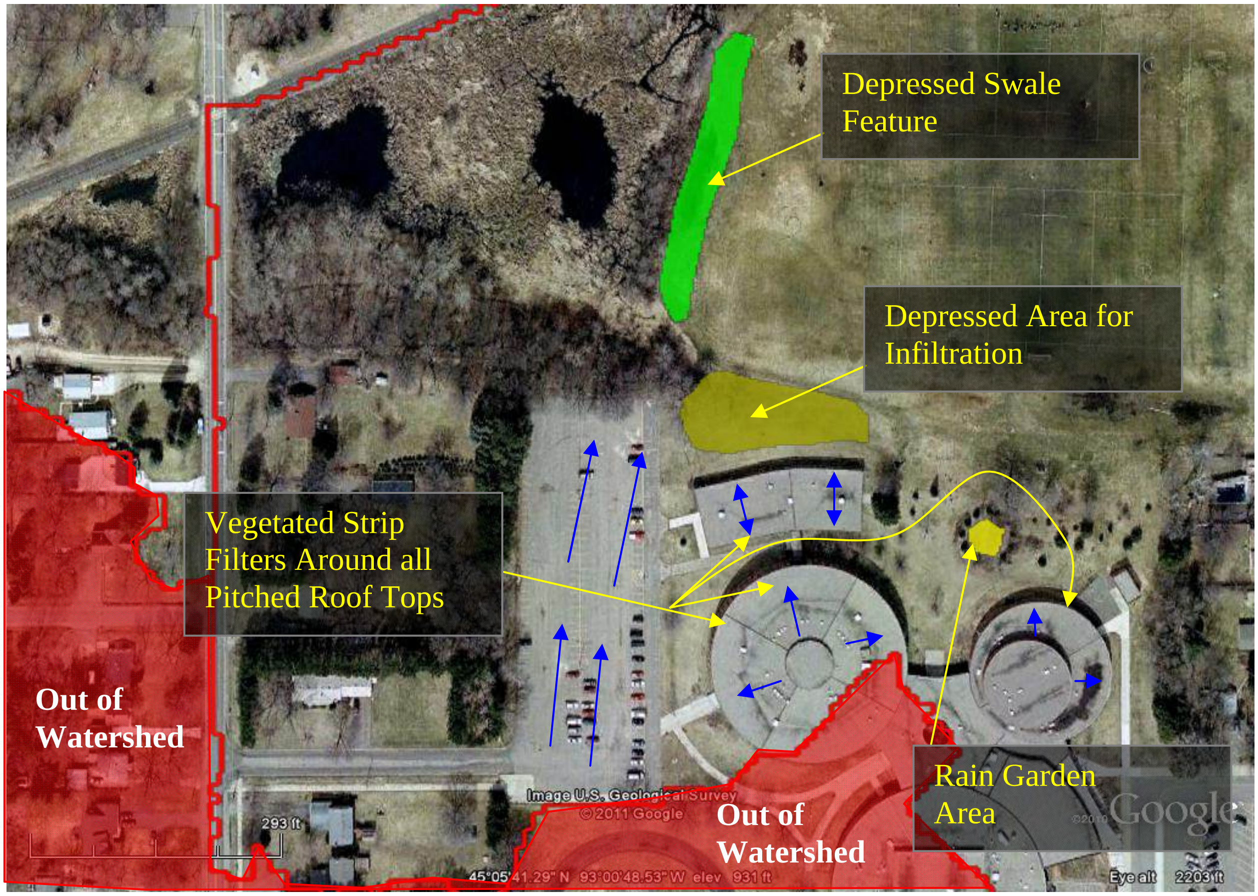

Figure 4.17. Western parking lot and roof top BMP suggestions. Blue arrows indicate general drainage patterns.

4.5.5 Stillwater Street Drainage Improvements

In 1997 a feasibility study for drainage improvements was completed for a segment of Stillwater Street in White Bear Township between Otter Lake Road and Division Street. The study found that during street reconstruction, stormwater can be rerouted to the east end of the project where a pond could be constructed on two city-owned vacant lots. In addition to stormwater runoff from Stillwater Street, the proposed ponding site also receives drainage from approximately 30 acres of the North Campus School site to the south via a culvert under the railroad. (See Figure 4.18.) The sizes of these watersheds, their percent impervious and the predicted annual runoff loads are shown in Table 4-1.

Table 4-1. Stillwater Street drainage area characteristics.

Subwatershed	Area (ac)	Percent Impervious	Annual TSS Load (lbs)	Annual TP Load (lbs)
Stillwater Street	50.5	45	14,790	51
North Campus School	30.0	25	4,900	17
Total	80.5	38	19,690	68

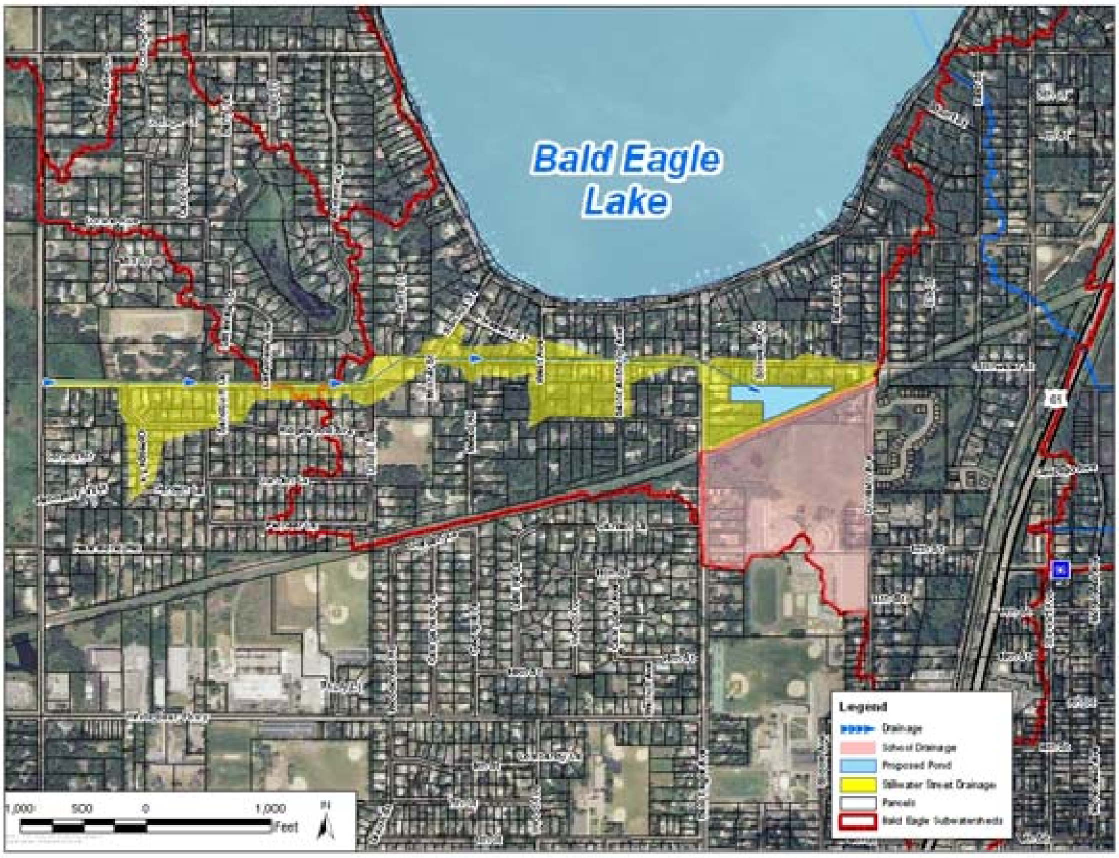

Figure 4.18. Stillwater Street drainage area.

The two city-owned lots are 2.5 acres in total. The 1999 study concluded that a pond can be constructed with approximately 3.9 acre-feet of dead storage (5 foot depth) and 8.3 acre-feet of live storage. (These values were verified for existing conditions. If both the Stillwater Street segment of this feasibility study and the North School Campus are routed to a pond of the size stated above, the removals in Table 4-2 are predicted by P8 on an annual basis.)

Table 4-2. Estimated annual load removals achieved by proposed Stillwater Street BMPs.

Percent TSS Removed	Pounds TSS Removed	Percent TP Removed	Pounds TP Removed
89	13,200	56	28

If additional BMPs were incorporated in the street reconstruction and implemented at the North School Campus, greater removals would be achieved. The estimated costs of the BMPs as proposed are detailed in Appendix A.

Estimated Cost: $486,000
Funding Source: County, cities, RCWD

4.5.6 Shoreline Management and Restoration

While shoreline restoration provides minimal phosphorus load reductions, it provides habitat, aesthetic, and shoreline stabilization benefits. Many of the property owners on Bald Eagle Lake maintain turf grass down to a riprapped shoreline. A full shoreline restoration with native plantings can cost $30-50 per linear foot, depending on the width of the buffer installed. Bald Eagle Lake contains about 22,280 linear feet of developed shoreline. A significant percentage of this shoreline is public access for the properties across the perimeter road from the lake, contains mainly docks and storage, and is likely less highly maintained and mowed than the shoreline of residences directly on the shoreline.

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 planting buffers or enhancing existing unmowed areas of 16,710 feet of shoreline. Education materials targeted to shoreline owners (for example, www.bluethumb.org), will be promoted to encourage voluntary shoreline restoration. The RCWD will develop some demonstration projects as well as work with all willing landowners to naturalize their shorelines. Residents will be encouraged to apply to the RCWD's Water Quality Cost-Share program.

Estimated Cost: $500,000 – $835,500
Funding Source: Private property owners, city, grant funds

4.6 INTERNAL NUTRIENT LOAD REDUCTIONS

Internal nutrient loads will need to be reduced to meet the TMDL allocations presented in this document. There are numerous options for reducing internal nutrient loads ranging from simple chemical inactivation of sediment phosphorus to complex infrastructure techniques including hypolimnetic aeration.

4.6.1 Internal Load Reduction

Internal nutrient loading is a driving nutrient source for Bald Eagle Lake and the TMDL calls for a 91% reduction in internal nutrient loading. Several options were considered to manage internal sources of nutrients, including hypolimnetic withdrawal, alum treatment, vegetation management and hypolimnetic aeration. Following are the results from the feasibility assessment for controlling internal loading in Bald Eagle Lake.

4.6.1.1 Alum Treatment

One of the more effective tools to control internal loading is sediment phosphorus inactivation, where phosphorus is permanently bound in the sediment using chemical addition. The most common chemicals used for phosphorus inactivation is aluminum sulfate, or alum. The aluminum-phosphorus bond is very stable under most environmental conditions and effectively removes internal phosphorus from the primary productivity cycle.

The process of applying alum to a lake typically includes injection of liquid alum just below the surface of the lake. The alum quickly forms a floc and settles to the bottom of the lake, forming a sediment seal. Additionally, phosphorus is stripped from the water column as the precipitate falls. The undisturbed floc provides a sediment barrier that binds any phosphorus released from the sediment, essentially eliminating internal phosphorus loading from that portion of the lake.

Effective application of alum to reduce internal loading requires detailed dosing calculations to effectively control phosphorus release from the sediment and to prevent aluminum toxicity that occurs if the pH drops below 6.

The alum dose needed to effectively reduce internal loading for Bald Eagle Lake was calculated using sediment assays developed by Rydin and Welch (1999). The dosing was based on an effective binding ratio of aluminum to phosphorus in either the top 5 or 10 centimeters. An aluminum concentration of ~96 gAl/m^2 for the top 10 cm of sediment and ~48 g Al/m^2 for the top 5 centimeters were determined to effectively treat internal loading. Dosing the top 10 cm provides the most aggressive dose for long-term efficacy, but would cost more than $1.1M if treated up to the 15-foot depth contour. Treating the top 5 cm to the 15-foot contour costs about half ($556,000) but does not provide for the long term effectiveness as well as the top 10 cm. Based on the sampled water chemistry, these doses can be applied to the lake without buffering the solution. However, it is important to note that whole water column pH and alkalinity will need to be verified prior to application.

Internal P release rates increased with depth (ACOE 2011) suggesting that treating the deeper depths will provide the greatest impact on internal loading. Furthermore, release rates were only slightly different between the 15 and 20 foot contour, and these shallower areas exhibit anoxia much less frequently than the deeper areas. Based on these results, there are several options for an alum treatment. These cost estimates include a 5% contingency and $10,000 for engineering and monitoring.

Option 1: Treat the top 10 centimeters for depths greater than 15 feet. Cost: $1,172,252; approximate 1,283 pound phosphorus load reduction

Option 2: Treat the top 10 centimeters for depths greater than 20 feet and treat the top 5 centimeters for depths between 15 and 20 feet. Cost: $869,395; approximate 1,195 pound phosphorus load reduction

Option 3: Treat the top 10 centimeters for depths greater than 20 feet. Cost: $571,791; approximate 1,108 pound phosphorus load reduction

All three of these options provide good control for internal loading. Option 2 provides the best balance between costs and effectiveness.

The MPCA may require an NPDES permit for an alum treatment. The rules and requirements associated with an NPDES permit for alum treatments were still under development at the time of this report. However, the current direction suggests the permit cost will be around $1,500.

Other agencies, most notably the DNR, will want to be informed of plans for an alum treatment so that they may provide comments or direction.

4.6.1.2 Hypolimnetic Aeration

Lake hypolimnetic aeration controls internal loads by aerating hypolimnetic waters (cold, dense water trapped at the bottom of a deep lake) to maintain oxic (oxygenated) conditions in the hypolimnion and sediment surface. It is the anoxic (no dissolved oxygen) condition of the hypolimnetic sediments that contribute to the internal phosphorus load. Hypolimnetic aeration only aerates water of the hypolimnion without causing it to mix with the epilimnion. This prevents the lake from destratifying and limits the amount of water to be aerated.

Addition of ferric chloride (an iron salt) solution may be necessary if iron becomes the limiting constituent in the deactivation of soluble phosphorus release. Therefore both aeration and ferric chloride lines would be installed in the lake during the initial construction. Iron levels are currently high enough in Bald Eagle Lake so that ferric chloride injection is not necessary; however, the additional installation costs are relatively small if it is needed in the future.

Cost estimates were competed for hypolimnetic aeration in Bald Eagle Lake (Figure 4.19) assuming that four aerators would be needed to effectively service the appropriate hypolimnetic volume (Figure 4.20). The assumed hypolimnetic volume was around 5,000 acre-feet based on an average thermocline of 15 feet. Because of the topography in Bald Eagle Lake, an underwater manifold would be required to distribute air to the four unit locations. A compressor is required to operate the aerators. The best assumed location for the compressors is the DNR operated boat launch on the east side of the lake. This location provides access to electricity and offers public land for the compressors and housing.

Two permits are required from the Minnesota DNR. The first is from the Division of Fisheries. The second is the General Work in Public Waters Permit due to work being conducted below the OHW elevation, such as the placement of the pipes, anchors and aeration units. The DNR Area Hydrologist recommends notifying the DNR early in the project, prior to permit application submittal, regardless of the type of project. This is suggested so that the DNR can work through any potential issues prior to the permitting process. The typical time frame to acquire a General Work in Public Waters permit is 60 days. However, depending on the complexity of the project and the potential for controversy with the lake shore residents and/or the general public, the permitting process could take considerably longer. DNR shoreline set-back requirements may apply to the blower house. The MPCA would also need to review the project in conjunction with the DNR permits.

The total estimated cost for a 20-year life-cycle hypolimnetic aeration is $1,459,000. This estimate includes an initial investment of $674,000 with an annual operating cost of $29,000. The estimate also assumes an overhaul will be required at 10 years for $219,000.

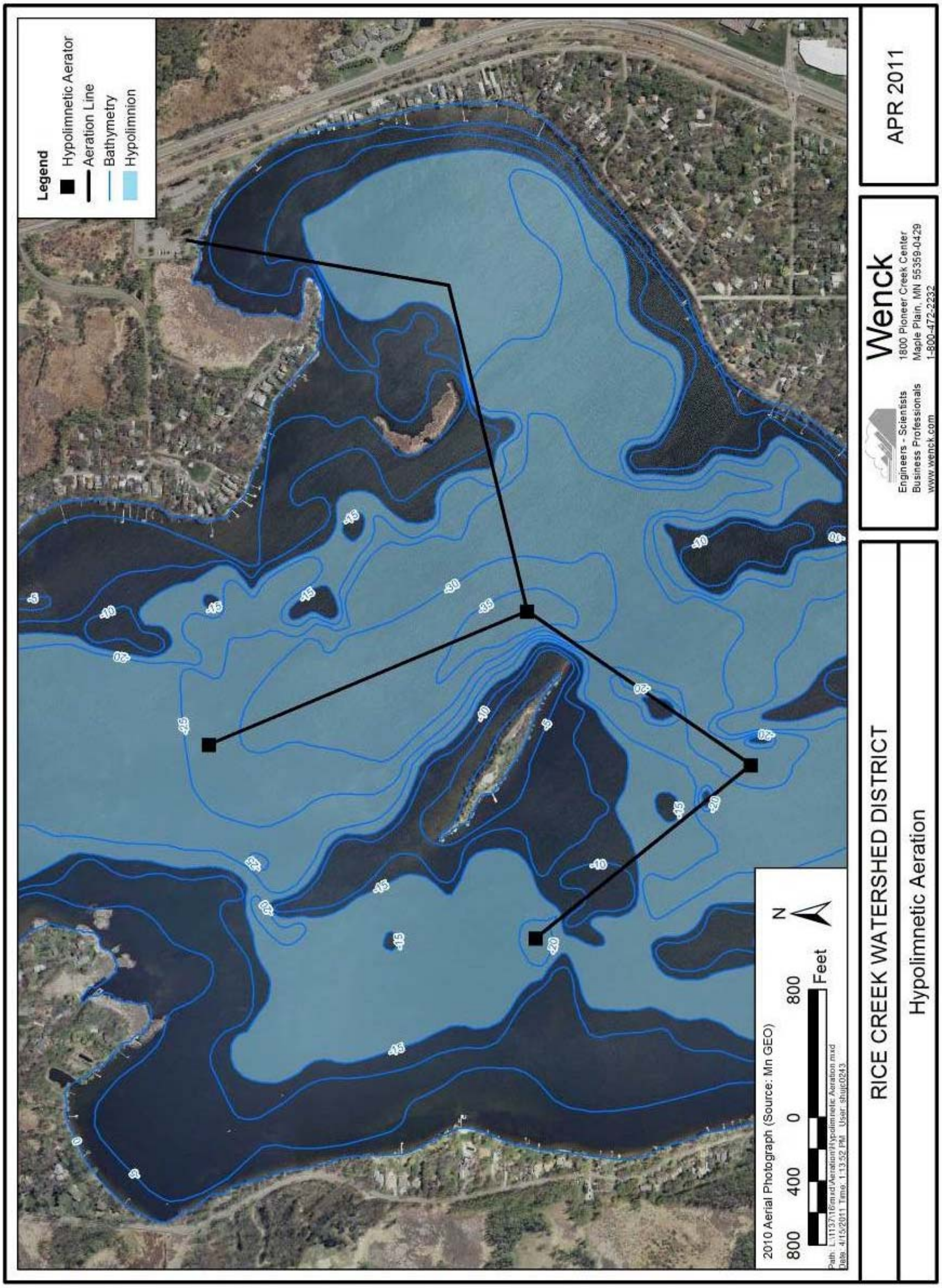

Figure 4.19. Bald Eagle Lake potential hypolimnetic aeration.

4.6.1.3 Hypolimnetic Withdrawal and Possible Alum Injection

Hypolimnetic withdrawal removes anoxic bottom water from the lake and either discharges it downstream or treats and returns it to the lake. Water would be discharged downstream of the lake. Hypolimnetic water in Bald Eagle Lake has exceeded 1 mg/L and may cause downstream water quality impacts. Therefore, hypolimnetic water will likely need to be treated prior to discharge. An overview of the potential hypolimnetic withdrawal system is shown in Figure 4.20.

Water would be pumped out of the hypolimnion into a pump house constructed on shore, located onshore near the lake outlet. Placing the pump house may require land acquisition or an easement. A force main would be laid on the bottom of the lake with a screen at the intake. The intake would be placed at approximately 30’ of depth. Placing the intake here instead of the bottom of the lake captures approximately 90% of the hypolimnetic volume and reduces the disturbance of the bottom sediments. The use of a siphon was not feasible due to the relatively low elevation change below the lake outlet.

Once water reaches the pump house, it is aerated over a cascade of concrete weirs into a basin. The water in the hypolimnion of Bald Eagle Lake likely contains hydrogen sulfide (H_2S) and the aeration process releases hydrogen sulfide gas into the air, creating a very potent “rotten egg” smell. Due to the close proximity of Bald Eagle Lake to residential neighborhoods, the hydrogen sulfide gas would need to be reduced to a suitable level before leaving the pump house. To reach this level, a series of air filters will be required. Along with the air filters in the pump house building, air monitoring equipment will also be required because even at low concentrations, hydrogen sulfide is potentially dangerous to maintenance personnel working in the building.

Several options exist for the removal of phosphorus from the hypolimnetic water. Phosphorus can be reduced through a constructed wetland by adsorption to wetland soils and precipitation with calcium, iron, and aluminum. Soils higher in these elements have a greater potential to reduce phosphorus in the downstream flow. Other non-organic substrates can be added to the constructed wetland to enhance the treatment capabilities similar to a media filter. Industrial by-products, iron filings, granular iron, sand mixtures, even crushed oyster shells have been used to bind phosphorus and can enhance treatment capabilities. Traditional wastewater treatment processes use chemical additions to create a floc with the phosphorus requiring physical removal. Each increase in treatment level will have a corresponding increase in operation and maintenance. For the purposes of this study, costs were estimated for treatment with and without alum injection. Alum injection can provide a much higher level of treatment and certainty that phosphorus will be removed to levels that will benefit the lake. Alum would be injected to form a floc at the pump house, and then the floc would be settled out in a primary settling pond. Acquisition of a site for the flocculation pond will be required below Bald Eagle Lake.

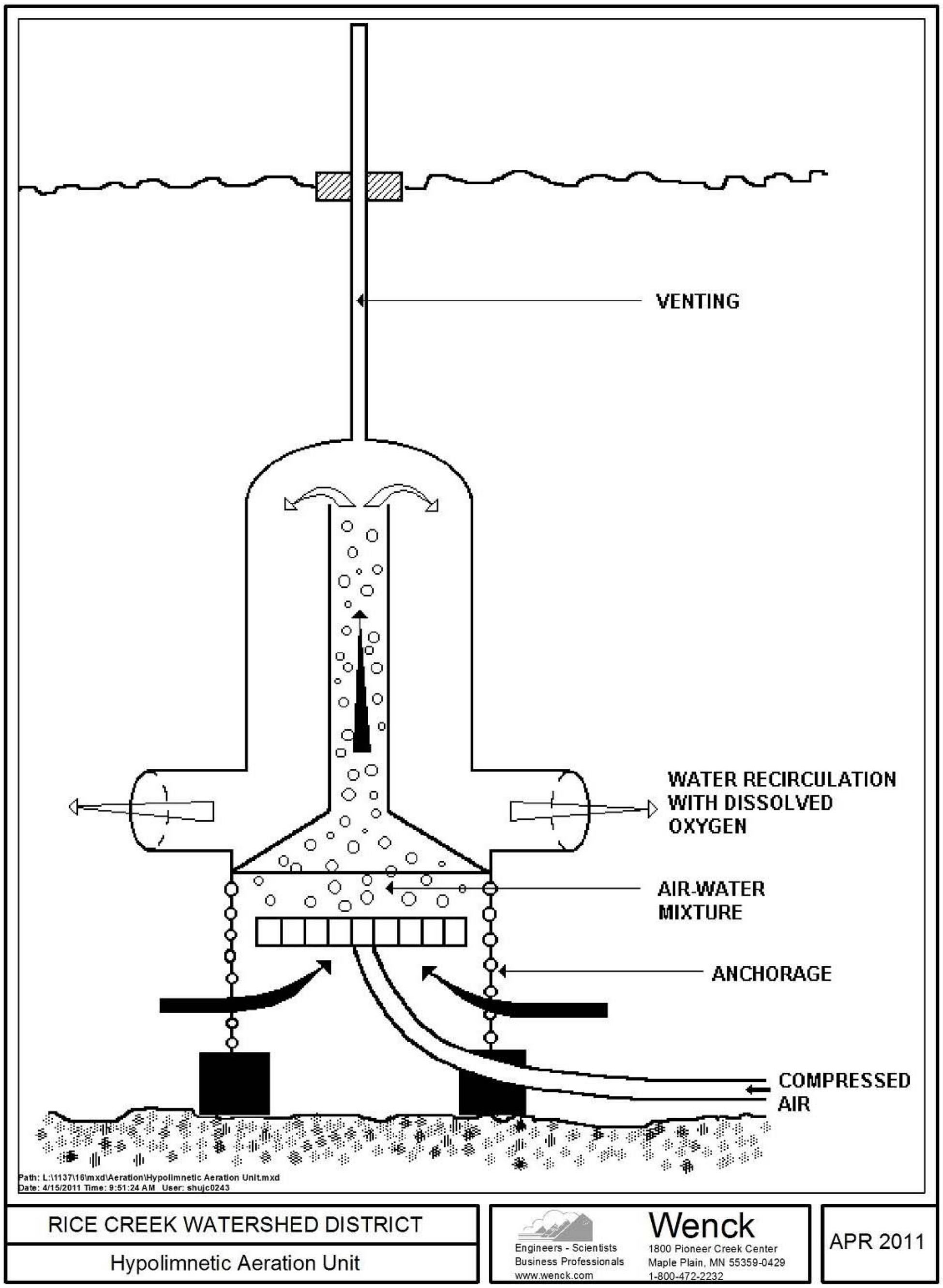

Figure 4.20. Typical hypolimnetic aeration unit.

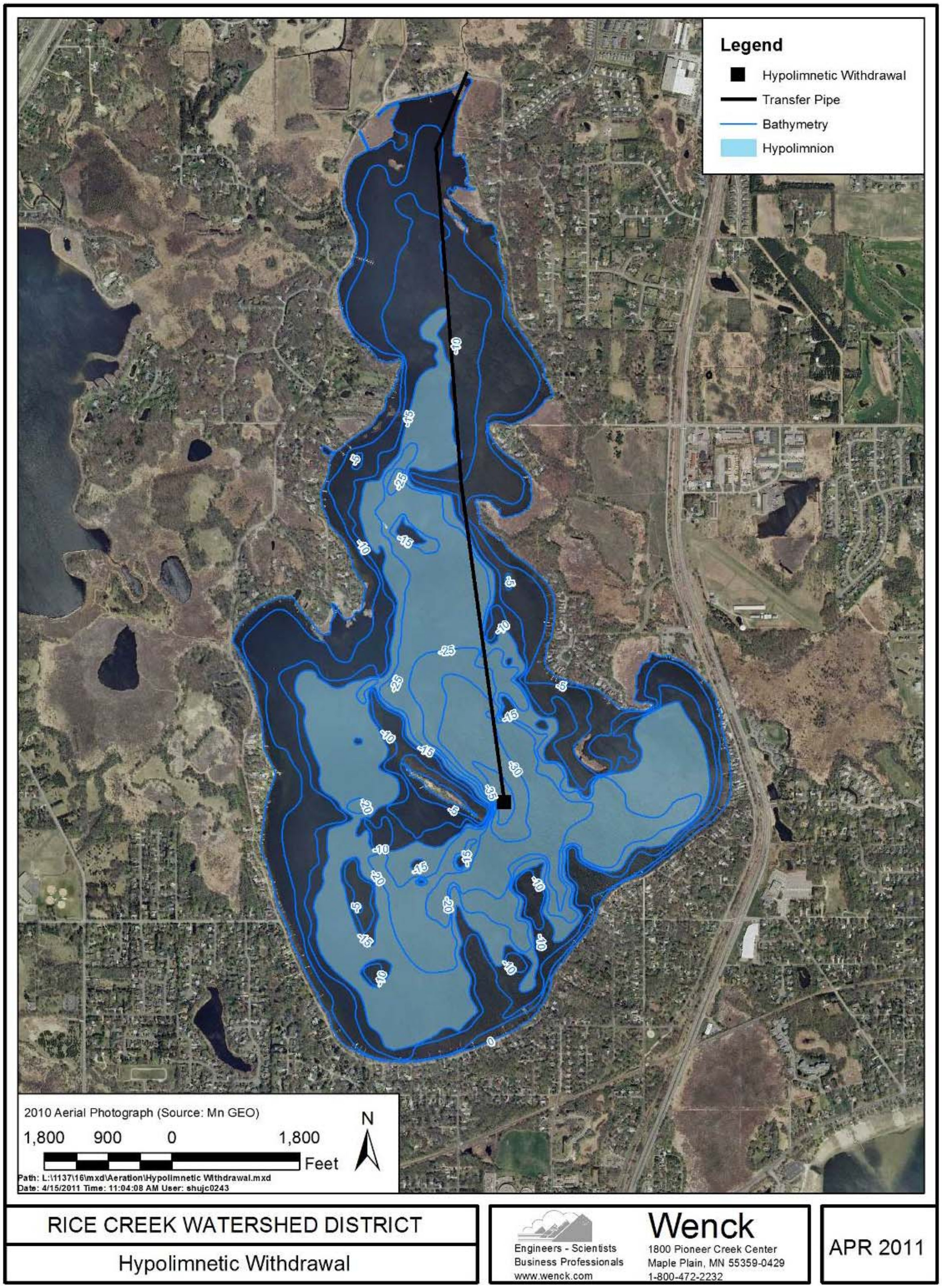

Figure 4.21. Bald Eagle Lake potential hypolimnetic withdrawal area.

Like hypolimnetic aeration, hypolimnetic withdrawal would require a General Work in Public Waters permits. Additionally, the project most likely will require a Water Appropriations permit from the DNR. The threshold for an appropriations permit is one million gallons per year. The current design would remove 50 million gallons per year. A third permit that may be required from the DNR is Partial Drawdown Waters Work permit. An analysis of the impact to the lake water levels as a result of the project will need to be conducted. The Partial Drawdown Waters Work permit is not defined by a certain minimum or maximum allowable level to fluctuate without requiring a permit. Instead the language is very general and reviewed on a case by case basis. If it is determined that a Partial Drawdown Waters Work permit is required, then all of the lake shore property owners would be required to approve the project before a permit could be issued. If multiple permits are required for the project, all could be handled under one application to the Area Hydrologist, who would circulate the application to any other parties in the DNR that may need to review or approve the application. The MPCA would need to review the project in conjunction with the DNR permit.

The costs estimate for hypolimnetic withdrawal ranged from $1,952,300 (no treatment of discharged water) to $2,565,200 (alum injection of discharged water) depending on the treatment for discharged water. As a result, hypolimnetic withdrawal was deemed to be cost prohibitive.

4.6.1.4 Recommended Internal Load Control Approach

Based on the analysis of the feasibility of each of the alternatives and the estimated cost, alum treatment is the most appropriate and cost effective approach for controlling internal nutrient loading. Alum treatment for Bald Eagle Lake would be approximately $869,395, plus an estimated permit cost of $1500.

Estimated Cost: $871,500
Funding Source: Private property owners, RCWD

4.6.2 Curly-leaf Pondweed Control

Curly-leaf pondweed is present in Bald Eagle Lake. Senescence of the curly-leaf pondweed in summer can be a significant source of internal phosphorus load that often results in a 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.

As BMPs are implemented and water clarity improves, the aquatic vegetation community will change. Surveys should be updated periodically and vegetation management plans amended to take into account appropriate management activities for that changing community.

Estimated Cost: $30,000 annually for treatment if necessary
Funding Source: Bald Eagle Lake Water Management District, RCWD

5.0 Summary

This Implementation Plan identifies a number of potential actions that would have the greatest effectiveness in reducing total phosphorus load and restoring beneficial use to Bald Eagle Lake (Table 5-1). The actions would be completed by various government jurisdictions and private property owners. This is not a comprehensive list and does not preclude additional or substitute actions. Given new knowledge and changing technology, it is likely that additional implementation actions will be identified in the future. The principle of Adaptive Management described in Section 3.4 of this report will guide the implementation process. This plan will be reviewed and amended from time to time to incorporate new or revised activities.

Table 5-1. Potential actions identified in the Bald Eagle Lake Nutrient TMDL Implementation Plan.

Implementation Action	Responsible Party	Schedule	Estimated Cost	Estimated Phosphorus Removal
Coordination of Efforts	RCWD	Ongoing	Varies	N/A
Annual Report	RCWD, MS4s	Every year	$1,000 annually	N/A
Rules and Standards	RCWD	Ongoing	Varies	Varies
Maximize Reduction Through Development	RCWD, cities	Ongoing	Varies	Varies
Better Site Design	RCWD, cities			
Public Education	RCWD, cities, property owners	Ongoing	$2,500 annually	N/A
Cost Share Assistance	RCWD, cities	Ongoing	Current budget - $365,000	Varies
Monitoring	RCWD, county	Ongoing	$3,500 annually	N/A
Watershed-External Load Reductions				
Publicly Owned and Institutional Properties BMPs	Cities, counties property owners	0-20 years	$2,500 - $25,000 each	Varies
Residential Rain Gardens	Property owners, RCWD	0-20 years	$200 to $2,000 each; $75,600 - $189,000 to treat 15% of annual runoff	41 pounds/year when 15% annual runoff is treated
Street and Highway Projects	Cities, counties	0-20 years	Varies	Varies
JD 1 Subwatershed External Load Reductions				
Golf Course Management Plans	Golf course owners and managers, RCWD	5-10 years	$20,000 each, $60,000 total	Goal is zero discharge
Improve Agricultural Management	SWCDs, property owners	0-10 years	Varies	Varies
Complete Fish Lake TMDL	MPCA	0-5 years	$25,000	Load reductions to improve Fish Lake to the state standard of 40 µg/L
Protect High Value Wetlands	RCWD	Ongoing	Ongoing	N/A
Monitor Outlet Wetlands	RCWD	0-10 years	$35,000	N/A

Table 5-1, cont. Potential actions identified in the Bald Eagle Lake Nutrient TMDL Implementation Plan.

Implementation Action	Responsible Party	Schedule	Estimated Cost	Estimated Phosphorus Removal
CD 11 Subwatershed External Load Reductions				
CD 11 Channel Stabilization	Cities, RCWD	0-5 years	$15,000 to $55,000	Varies
Storm Sewer In-line Treatment	City of White Bear Lake, town of White Bear Lake	0-10 years	$10,000 to $15,000 each	Varies
White Bear Lake Commercial Area BMPs	City of White Bear Lake	0-5 years	$35,000 for assessment, $5-25,000 each for BMPs	17 pounds/year for sweeping 5-10 pounds per site for BMPs
Bald Eagle Lake Direct Subwatershed External Load Reductions				
Pipe Outfalls In-line Treatment	Cities, RCWD	5-10 years	$31,200 each + $3,000 O&M	<1 pound/year per device
Highway 61 Linear BMPs	Mn/DOT	10+ years	Varies	Varies
Stillwater Street Reconstruction BMPs	White Bear Township	0-5 years	$486,000	28 pounds/year
Regional Park Boat Landing BMP	Ramsey County	0-10 years	$19,800 + $1,800 O & M	<1 pound/year
High School Parking Lot Runoff	School District, RCWD	0-5 years	Varies	14 pounds/year
Shoreline Restoration	Property owners	0-20 years	$500,000 - $835,500	N/A
In-lake Management				
Internal Load Reduction – Alum Treatment	RCWD	0-5 years	$871,500	1,800 pounds/year
Aquatic Vegetation Management	Lake Association	5-10 years	$30,000 annually	Varies

6.0 Literature Cited

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Appendix A

Cost and Removals Calculations

This appendix shows cost calculation details for certain activities in the Bald Eagle Lake Nutrient TMDL Implementation Plan. Section numbers refer to the sections in the April 2011 draft of the Plan.

Section 4.2.2: Rain Gardens

Table 6-1. Rain garden cost calculation

	Unit Cost	Units
Cost per square foot of rain garden, professionally installed	$10.00	cost per sq. ft
Cost per square foot of rain garden, owner installed	$4.00	cost per sq. ft
Total Cost per rain garden	$400 -1,000	
Total overall goal cost	$75,600 - $189,000	

Section 4.3.5: Wetland Outlet Monitoring

Table 6-2. Wetland monitoring costs.

	Cost
Monitoring and lab costs	$25,000
Monitoring equipment	$5,000
Develop P8 models	$5,000
Total Cost	$35,000

Section 4.5.1: In-line Treatment

Table 6-3. Estimated costs associated with a pond installation for outfall treatments.

Cost Parameter	Unit Cost	Units	Quantity	Sub Total
Wet pond installation costs	$5.00	per sq. ft	8712	$43,560
Land acquisition	$40,000	Per acre	0.4	$16,000
Total Project Costs				$59,560
Total Project Costs plus 20% contingency for engineering and design				$71,470
Total Annual O&M	$1,000	Per acre per year	0.4	$400.00

Table 6-4. Estimated costs for the Downstream Defender™ to treat 1 acre.
Note: Assumes 95-99% removal of TSS and 20-30% removal of TP for a 2.8 inch 24 hr event and 1 cfs per acre.

Cost Parameter	Unit Cost	Units	Quantity	Sub Total
72" Downstream Defender	$16,000.00	per unit	1	$16,000.00
Installation	$10,000.00	per location	1	$10,000.00
Total Project Costs				$26,000.00
Total Project Costs plus 20% contingency for engineering and design				$31,200.00
Total Annual O&M	$3,000.00	Per unit per year	1	$3,000.00

Section 4.5.3: Regional Park Boat Landing Enhancements

Table 6-5. Costs for a perimeter sand filter at the Bald Eagle/Otter Lakes Regional Park boat ramp.

Cost Parameter	Unit Cost	Units	Quantity	Sub Total
Concrete	$500.00	per cubic yard	31	$15,500
Grate/cover plate	$500.00	per trench	2	$1,000
Total Project Costs				$16,500
Total Project Costs plus 20% contingency for engineering and design				$19,800
Total Annual O&M	$12.00	per linear foot per year	150	$1,800

Section 4.5.4: High School Parking Lot Runoff

Table 6-6. White Bear High School parking lot BMP options.

Cost Parameter	Unit Cost	Units	Quantity	Sub Total
Perimeter Sand Filters				
Materials				
Concrete	$500.00	cost per cubic foot	39	$19,500.00
Grate Cover Plate	$500.00	cost per cover	2	$1,000.00
Swales				
Eastern Parking Lot A	$10.00	cost per square foot	7,800	$78,000.00
Eastern Parking Lot B (green belt)	$10.00	cost per square foot	4,000	$40,000.00
Eastern Parking Lot B (southern)	$10.00	cost per square foot	2,500	$25,000.00
Western Parking lot (soccer field)	$10.00	cost per square foot	7,000	$70,000.00
Depression Area for Western Parking Lot	$5.00	cost per square foot	15,246	$76,230.00
Building Perimeter Vegetative Depressions[1]	$10.00	cost per square foot	6,730	$67,300.00

[1]Building perimeter vegetative strips assume a 10 foot width
*All projects would require site visits for supervision of installation at $70 per hour (approximately 3 visits
**Assume for each project a 20% contingency cost for engineering and design.

Section 4.5.5: Stillwater Street BMPs

Table 6-7. Stillwater Street BMPs cost estimate (excludes street reconstruction costs).

Item	Unit	Quantity	Unit Cost	Total Cost
Mobilization	EA	1	$10,000	$10,000
Clearing and Grubbing	Acre	2.5	$5,000	$12,500
Excavation	Cu Yd	20,000	$15	$300,000
Erosion Control	EA	1	$15,000	$15,000
Construction Cost Estimate				$337,500
Contingency (20 %Construction Cost)				$67,500
Total Construction Cost				$405,000
Construction Management Services (5%)				$20,250
Design Fee (15 %)				$60,750
Preliminary Cost Estimate				**$486,000**